

PROGRAM STRUCTURE AND SYLLABUS

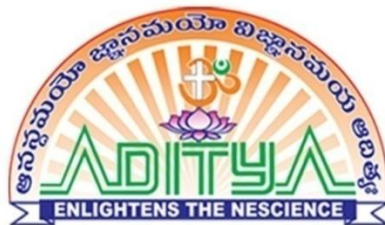
(I to VIII Semesters)

CIVIL ENGINEERING

for

B. TECH. FOUR YEAR DEGREE PROGRAM

(Applicable for the batches admitted in A.Y 2023-24)



ADITYA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE, Permanently Affiliated to JNTUK & Accredited by NBA (Tier-1), NAAC with 'A++' Grade

Recognized by UGC under the sections 2(f) and 12(B) of UGC act 1956

Aditya Nagar, ADB Road, Surampalem - 533 437

VISION & MISSION OF THE INSTITUTE

VISION

To emerge as a premier institute for quality technical education and innovation.

MISSION

M1: Provide learner centric technical education towards academic excellence

M2: Train on technology through collaborations

M3: Promote innovative research & development

M4: Involve industry institute interaction for societal needs

VISION & MISSION OF THE DEPARTMENT

VISION

To be a recognized center in Civil Engineering with values and innovation.

MISSION

M1: Practice learner-centric quality teaching-learning process abreast with changing industry needs and societal challenges

M2: Provide Quality infrastructure towards academics, research and innovation

M3: Establish effective industry and institutional collaboration

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of the Program will

PEO 1	Apply technical knowledge to excel in the industry and higher education
PEO 2	Analyze, design and build safe, sustainable and economical structures
PEO 3	Exhibit good leadership qualities in a multidisciplinary environment to meet societal needs

PROGRAM OUTCOMES (POs)

After successful completion of the program, the graduates will be able to

PO 1	Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
PO 2	Problem Analysis: Identify, formulate, research literature and analyze complex engineering problems, reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
PO 3	Design/Development of Solutions: Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO 4	Conduct Investigations of Complex Problems: Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO 5	Modern Tool Usage: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
PO 6	The Engineer and Society: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
PO 7	Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of, and need for sustainable development.
PO 8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
PO 9	Individual and Teamwork: Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.

PO 10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	Project Management and Finance: Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member and leader in a team and to manage projects in multidisciplinary environments.
PO 12	Life-Long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

After successful completion of the program, the graduates will be able to

PSO 1	Demonstrate the capability to plan, design and construct sustainable structures based on functional requirements
PSO 2	Apply standard practices in identifying quality of material for sturdy construction

Mission of the department – PEOs mapping

PEOs Statements	M1	M2	M3
PEO 1: Apply technical knowledge to excel in the industry and higher education.	3	3	3
PEO 2: Analyze, design and build safe, sustainable and economical structures.	3	3	3
PEO 3: Exhibit good leadership qualities in a multidisciplinary environment to meet societal needs	3	2	3

Note.

Mapping / Correlation levels
1: Slight (Low)
2: Moderate (Medium)
3: Substantial (High)

INDUCTION PROGRAMME

S.No.	Course Name	L-T-P-C
1	Physical Activities -- Sports, Yoga and Meditation, Plantation	0-0-6-0
2	Career Counselling	2-0-2-0
3	Orientation to all branches -- career options, tools etc.	3-0-0-0
4	Orientation on admitted Branch -- corresponding labs, tools and platforms	2-0-3-0
5	Proficiency Modules & Productivity Tools	2-1-2-0
6	Assessment on basic aptitude and mathematical skills	2-0-3-0
7	Remedial Training in Foundation Courses	2-1-2-0
8	Human Values & Professional Ethics	3-0-0-0
9	Communication Skills -- focus on Listening, Speaking, Reading, Writing skills	2-1-2-0
10	Concepts of Programming	2-0-2-0

PROGRAM STRUCTURE**I Semester**

S. No.	Course Code	Course Title	Course Component	L	T	P	Credits
1	231BS1T01	Engineering Physics	BSC	3	0	0	3
2	231BS1T02	Linear Algebra & Calculus	BSC	3	0	0	3
3	231ES1T01	Basic Civil and Mechanical Engineering	ESC	3	0	0	3
4	231ES1T02	Engineering Graphics	ESC	1	0	4	3
5	231HS1T01	Communicative English	HSMC	2	0	0	2
6	231ES1L02	Engineering Workshop	ESC	0	0	3	1.5
7	231BS1L01	Engineering Physics Lab	BSC	0	0	2	1
8	231ES1L01	IT Workshop	ESC	0	0	2	1
9	231HS1L01	Communicative English Lab	HSMC	0	0	2	1
10	231HS1L02	Health and wellness, Yoga and sports	HSMC	0	0	1	0.5
11	231MC1T01	Environmental Science	MC	2	0	0	0
TOTAL							19

II Semester

S.No.	Course Code	Course Title	Course Component	L	T	P	Credits
1	231BS2T04	Engineering Chemistry	BSC	3	0	0	3
2	231BS2T03	Differential Equations & Vector Calculus	BSC	3	0	0	3
3	231ES2T01	Basic Electrical and Electronics Engineering	ESC	3	0	0	3
4	231ES2T02	Introduction to Programming	ESC	3	0	0	3
5	231CE2T01	Engineering Mechanics	PCC	3	0	0	3
6	231BS2L03	Engineering Chemistry Lab	BSC	0	0	2	1
7	231ES2L01	Electrical and Electronics Engineering Lab	ESC	0	0	3	1.5
8	231ES2L02	Computer Programming Lab	ESC	0	0	3	1.5
9	231CE2L01	Engineering Mechanics Lab	PCC	0	0	3	1.5
10	231HS2L03	NSS/NCC/Scouts & Guides/Community Service	HSMC	0	0	1	0.5
11	231MC2T01	Constitution of India	MC	2	0	0	0
12	231MC2T02	Cognitive English for Engineers – I	MC	0	0	2	0
13	231MC2T03	Employability Skills-I	MC	2	0	0	0
TOTAL							21

III Semester

S. No.	Course Code	Course Title	Course Component	L	T	P	Credits
1	231BS3T01	Numerical Methods and Statistical Techniques	BSC	3	0	0	3
2	231ES3T01	Surveying	ESC	3	0	0	3
3	231CE3T01	Strength of Materials	PCC	3	0	0	3
4	231CE3T02	Fluid Mechanics	PCC	3	0	0	3
5	231CE3T03	Building Materials and Construction	PCC	3	0	0	3
6	231CE3L01	Surveying Lab	PCC	0	0	3	1.5
7	231CE3L02	Strength of Materials Lab	PCC	0	0	3	1.5
8	231CE3S01	Building Planning and Drawing	SC	0	1	2	2
9	231MC3T04	Universal Human Values	MC	2	1	0	0
10	231CE3P01	Community Service Project	PROJ	0	0	4	0
11	231MC3T03	Cognitive English for Engineers- II	MC	0	0	2	0
TOTAL							20

IV Semester

S. No.	Course Code	Course Title	Course Component	L	T	P	Credits
1	231HS4T01	Managerial Economics and Financial Analysis	HSMC	2	0	0	2
2	231ES4T01	Engineering Geology	ESC	3	0	0	3
3	231CE4T01	Concrete Technology	PCC	3	0	0	3
4	231CE4T02	Structural Analysis	PCC	3	0	0	3
5	231CE4T03	Hydraulics & Hydraulic Machinery	PCC	3	0	0	3
6	231CE4L01	Concrete Technology Lab	PCC	0	0	3	1.5
7	231CE4L02	Engineering Geology Lab	PCC	0	0	3	1.5
8	231CE4S01	Remote Sensing & Geographical Information Systems	SC	0	1	2	2
9	231ES4T04	Design Thinking & Innovation	ESC	1	0	2	2
10	231MC4T01	Essence of Indian Traditional Knowledge	MC	2	0	0	0
TOTAL							21

V Semester

S. No.	Course Code	Course Title	Course Component	L	T	P	Credits
1	231CE5T01	Design and Drawing of Reinforced Concrete Structures	PCC	3	0	0	3
2	231CE5T02	Engineering Hydrology	PCC	3	0	0	3
3	231CE5T03	Geotechnical Engineering -I	PCC	3	0	0	3
4		Professional Elective-I	PEC	3	0	0	3
5		Open Elective-I	OEC	3	0	0	3
6	231CE5L01	Geotechnical Engineering Lab	PCC	0	0	3	1.5
7	231CE5L02	Fluid Mechanics & Hydraulic Machines Lab	PCC	0	0	3	1.5
8	231CE5S01	Estimation, Specifications & Contracts	SEC/PCC	0	0	2	2
9	231CE5L03	Tinkering Lab: Structures in Scale	PCC	0	0	2	1
10	231CE5P01	Summer Internship-I	PROJ	0	0	0	2
11	231MC5T01	Professional Ethics and Human Values	MC	2	0	0	0
TOTAL							23

VI Semester

S. No.	Course Code	Course Title	Course Component	L	T	P	Credits
1	231CE6T01	Design and Drawing of Steel Structures	PCC	3	0	0	3
2	231CE6T02	Highway Engineering	PCC	3	0	0	3
3	231CE6T03	Environmental Engineering	PCC	3	0	0	3
4		Professional Elective-II	PEC	3	0	0	3
5		Professional Elective-III	PEC	3	0	0	3
6		Open Elective-II	OEC	3	0	0	3
7	231CE6L01	Environmental Engineering lab	PCC	0	0	3	1.5
8	231CE6L02	Highway Engineering lab	PCC	0	0	3	1.5
9	231CE6S01	CAD Lab	SEC	0	1	2	2
10	231MC6T01	Technical paper writing & IPR	MC	2	0	0	0
11	231MC6T02	Soft Skills	MC	2	0	0	0
TOTAL							23

Mandatory Industry Internship of 08 weeks duration during summer vacation

VII Semester

S. No.	Course Code	Course Title	Course Component	L	T	P	Credits
1	231CE7T01	Pre-stressed Concrete	PCC	3	0	0	3
2	231CE7T02	Advance Construction Management	PCC	2	0	0	2
3		Professional Elective-IV	PCC	3	0	0	3
4		Professional Elective-V	PCC	3	0	0	3
5		Open Elective-III	PCC	3	0	0	3
6		Open Elective-IV	PCC	3	0	0	3
7	231CE7S01	MATLAB	SEC	0	0	2	2
8	231CE7P01	Summer Internship-II	PROJ	0	0	0	2
9	231MC7T01	Research Methodology	MC	2	0	0	0
TOTAL							21

VIII Semester

S. No.	Course Code	Course Title	Course Component	L	T	P	Credits
1	231CE8P01	Project (Full semester Internship)	PROJ	0	0	24	12
TOTAL							12

Course Code and Definition:

Course Code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management Courses
PCC-CS	Professional Core Courses
PEC-CS	Professional Elective Courses
OEC-CS	Open Elective Courses
MC	Mandatory Courses
SEC	Skill Enhancement Courses
PROJ	Project / Internship

PROFESSIONAL ELECTIVES

Professional Electives I (V Semester)		
S.No	Course Code	Name of the Course
1.	231CE5E01	Advanced Structural Analysis
2.	231CE5E02	Architecture and Town Planning
3.	231CE5E03	Construction Technology and Management
4.		MOOCS-NPTEL/SWAYAM

Professional Electives II (VI Semester)		
S.No	Course Code	Name of the Course
1.	231CE6E01	Geotechnical Engineering-II
2.	231CE6E02	Repair and Rehabilitation of Structures
3.	231CE6E03	Valuation and Quantity Survey
4.		MOOCS-NPTEL/SWAYAM

Professional Electives III (VI Semester)		
S.No	Course Code	Name of the Course
1.	231CE6E04	Finite Element Method
2.	231CE6E05	Bridge Engineering
3.	231CE6E06	Water Resources Engineering
4.		MOOCS-NPTEL/SWAYAM

Professional Electives IV (VII Semester)		
S.No	Course Code	Name of the Course
1.	231CE7E01	Advanced Structural Engineering
2.	231CE7E02	Docks and Harbour Engineering
3.	231CE7E03	Railway Engineering
4.	231CE7E04	Industrial Waste & Waste-Water Engineering
5.	231CE7E05	Air Pollution Control
6.	231CE7E06	Watershed Management
7.		MOOCS-NPTEL/SWAYAM

Professional Electives V (VII Semester)		
S.No	Course Code	Name of the Course
1.	231CE7E07	Design of Tall Buildings
2.	231CE7E08	Advanced Foundation Engineering
3.	231CE7E09	Traffic Engineering
4.	231CE7E10	Sustainable Water Resources Development
5.	231CE7E11	Design and Drawing of Irrigation Structures
6.	231CE7E12	Environmental Impact Assessment
7.	231CE7E13	Advanced Environmental Engineering
8.		MOOCS-NPTEL/SWAYAM

Note : Open Elective Course (OEC) must be selected from the list of Open Elective Courses offered by Other Department(s) only.

OPEN ELECTIVE - I (V Semester)			
S. No	Course Code	Course Name	Offered By Department
1.	231CE5O01	Waste Water Management	CE
2.	231CE5O02	Construction Technology & Management	CE
3.	231CE5O03	Green Buildings	CE
4.	231EE5O01	Renewable Energy Sources	EEE
5.	231EE5O02	Concepts of Energy Auditing & Management	EEE
6.	231ME5O01	Sustainable Energy Technologies	ME
7.	231ME5O02	Applied Operations Research	ME
8.	231ME5O03	Nano Technology	ME
9.	231ME5O04	Thermal Management of Electronic systems	ME
10.	231ME5O05	Entrepreneurship	ME
11.	231ME5O06	Entrepreneurship Development & Venture Creation	ME
12.	231EC5O01	Principles of Signals and Systems	ECE
13.	231EC5O02	Introduction to Internet of Things	ECE
14.	231EC5O03	Digital Electronics and Logic Design	ECE
15.	231CS5O01	Database Management Systems	CSE
16.	231DS5O01	Python Programming	DS
17.	231IT5O01	Computer Organization	IT
18.	231AM5O01	Object Oriented Programming Through Java	AIML
19.	231PT5O01	Introduction to Petroleum Engineering	PT
20.	231PT5O02	Introduction to Petroleum Geology	PT
21.	231PT5O03	Introduction to Well Logging	PT
22.	231MI5O01	Introduction to Underground Mining	Min.E
23.	231MI5O02	Introduction to Surface Mining	Min.E
24.	231MI5O03	Tunnelling and Underground Space Design	Min.E
25.	231MI5O04	Introduction to Mine Environment	Min.E
26.	231AG5O01	Basic Crop Production Practices	Ag.E
27.	231AG5O02	Groundwater, Wells and Pumps	Ag.E

OPEN ELECTIVE - II (VI Semester)			
S. No	Course Code	Course Name	Offered By Department
1.	231CE6O01	Basic Concrete Technology	CE
2.	231CE6O02	Basic of Surveying	CE
3.	231CE6O03	Repair and rehabilitation of structures	CE
4.	231CE6O04	Air Pollution Control	CE
5.	231CE6O05	Integrated Solid Waste Management for a Smart City	CE
6.	231EE6O01	Fundamentals of Electric Vehicles	EEE
7.	231EE6O02	Electrical Wiring Estimation and Costing	EEE
8.	231ME6O01	Introduction to Industrial Robotics	ME
9.	231ME6O02	Industrial Management	ME
10.	231ME6O03	Additive Manufacturing	ME
11.	231ME6O04	Vehicle Technology	ME
12.	231ME6O05	Industrial Safety	ME
13.	231EC6O01	Principles of Communications	ECE
14.	231EC6O02	Biomedical Engineering	ECE
15.	231EC6O03	ECAD Tools	ECE
16.	231EC6O04	Quantum Science	ECE
17.	231CS6O01	Web Technologies	CSE
18.	231DS6O01	Introduction to Data Science	DS
19.	231IT6O01	Operating Systems	IT
20.	231AM6O01	Computer Organization and Architecture	AIML
21.	231PT6O01	Introduction to Drilling Technology	PT
22.	231PT6O02	Introduction to Well Completions	PT
23.	231PT6O03	Introduction to Petroleum Production Engineering	PT
24.	231MI6O01	Mineral Economics	Min.E
25.	231MI6O02	Landslides & Slope Stability Engineering	Min.E
26.	231MI6O03	Remote Sensing and GIS	Min.E
27.	231MI6O04	Geostatistics	Min.E
28.	231AG6O01	Engineering Properties of Agricultural Produce	Ag.E
29.	231AG6O02	Plastic Applications In Agriculture	Ag.E

OPEN ELECTIVE - III (VII Semester)			
S. No	Course Code	Course Name	Offered By Department
1.	231CE7O01	Industrial Waste Water Management	CE
2.	231CE7O02	Basics of RS&GIS	CE
3.	231CE7O03	Safety Engineering	CE
4.	231EE7O01	Battery Management Systems and Charging Stations	EEE
5.	231EE7O02	Concepts of Smart Grid Technologies	EEE
6.	231ME7O01	Finite Element Methods	ME
7.	231ME7O02	Introduction to Mechatronics	ME
8.	231ME7O03	Product design and development	ME
9.	231ME7O04	Advanced Materials	ME
10.	231ME7O05	Smart Manufacturing	ME
11.	231EC7O01	Discrete Time Signal Processing	ECE
12.	231EC7O02	Linear and digital IC Applications	ECE
13.	231EC7O03	Principles of Embedded Systems	ECE
14.	231CS7O01	Cyber Security	CSE
15.	231DS7O01	Bigdata Analytics	DS
16.	231IT7O01	Internet of things	IT
17.	231AM7O01	Computer Networks	AIML
18.	231PT7O01	Pipeline Engineering	PT
19.	231PT7O02	Introduction to Seismic methods	PT
20.	231PT7O03	Introduction to Artificial Lift Methods	PT
21.	231MI7O01	Mine Waste Management	Min.E
22.	231MI7O02	Sustainable developments in Mine Industry	Min.E
23.	231MI7O03	Mine Reclamation	Min.E
24.	231MI7O04	Impacts of Mining Environment	Min.E
25.	231AG7O01	Water Harvesting and Soil Conservation Structures	Ag.E

OPEN ELECTIVE - IV (VII Semester)			
S. No	Course Code	Course Name	Offered By Department
1.	231CE7O04	Basics of Soil Mechanics	CE
2.	231CE7O05	Construction Materials and Equipment	CE
3.	231CE7O06	Natural Disaster Management and Mitigation	CE
4.	231EE7O03	Concepts of Power Quality	EEE
5.	231EE7O04	Quantum Science and Technology	EEE
6.	231ME7O06	Optimization Techniques	ME
7.	231ME7O07	Advanced Manufacturing Processes	ME
8.	231ME7O08	Total Quality Management	ME
9.	231ME7O09	Operations Management	ME
10.	231ME7O10	Energy Auditing	ME
11.	231EC7O04	Fundamentals of Image Processing	ECE
12.	231EC7O05	Electronic Measurement Techniques	ECE
13.	231EC7O06	Sensors and Actuators	ECE
14.	231CS7O02	Introduction to Machine Learning	CSE
15.	231DS7O02	Data Visualization	DS
16.	231IT7O02	Cloud Computing	IT
17.	231AM7O02	Software Engineering	AIML
18.	231PT7O04	Deepwater Technology	PT
19.	231PT7O05	Introduction to acidizing and hydro-fracturing	PT
20.	231PT7O06	Introduction to Reservoir Engineering	PT
21.	231MI7O05	Principles of Mineral Engineering	Min. E
22.	231MI7O06	Mining Instrumentation	Min. E
23.	231MI7O07	Mine Safety & Ergonomics	Min. E
24.	231MI7O08	Mineral Exploration	Min. E
25.	231AG7O02	Agricultural Structures and Protected Cultivation	Ag. E

Minor Degree in Computer Science and Engineering
Offered by Department of Computer Science and Engineering

S.No.	Course Code	Course Name	L	T	P	C	Semester
1	231CS5M01	Principles of Database Management Systems	3	0	0	3	V
2	231CS5M02	Principles of Database Management Systems Lab	0	0	1.5	1.5	V
3	231CS6M01	Advanced Data Structures & Algorithm Analysis	3	0	0	3	VI
4	231CS6M02	Advanced Data Structures & Algorithm Analysis Lab	0	0	1.5	1.5	VI
5	231CS6M03	Computer Networks	3	0	0	3	VI
6	231CS7M01	MOOCS-I Principles of Operating Systems (or)	3	0	0	3	VII
	231CS7M02	Computer Organization and Architecture					
7	231CS8M01	MOOCS-II Principles of Software Engineering (or)	3	0	0	3	VIII
	231CS8M02	Object Oriented Programming through Java					
Total			15	0	3	18	

Minor Degree in Quantum Technologies
Offered By Department of Electronics and Communication Engineering

S.No.	Course Code	Course Name	L	T	P	C	Semester
Mandatory Courses							
1	231EC5M01	Survey of Quantum technologies and Application	3	0	0	3	V
2	231EC5M02	Foundations of Quantum Technologies	3	0	0	3	V
3	231EC6M01	Basic Programming Lab (or)	0	0	2	2	VI
	231EC6M02	Basic Laboratory Course for Quantum Technologies					

Atleast one course form 4, 5, 6, 7 is Mandatory							
4	231EC6M03	Introduction to Quantum Computation	3	0	0	3	VI
5	231EC6M04	Introduction to Quantum Communication	3	0	0	3	VI
6	231EC7M01	Introduction to Quantum Sensing	3	0	0	3	VII
7	231EC7M02	Introduction to Quantum Materials	3	0	0	3	VII
Optional / Additional Courses							
8	231EC5M03	Engineering Foundations of Quantum Technologies	3	0	0	3	V
9	231EC5M04	Solid State Physics for Quantum Technologies	3	0	0	3	V
10	231EC6M05	Quantum Optics	3	0	0	3	VI
11	231EC6M06	Quantum Cybersecurity	3	0	0	3	VI
12	231EC7M03	Quantum Machine Learning	3	0	0	3	VII
Atleast one of the following MOOC Course(s)							
13		Quantum Algorithms and Cryptography	12 week 3 Credit - NPTEL MOOC		3		VIII
Total			18	0	0	18	

ENGINEERING PHYSICS

(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)

I Semester**Course Code: 231BS1T01**

L	T	P	C
3	0	0	3

Course Outcomes:**At the end of the Course, Student will be able to:**

- CO1** Apply the principles of interference and diffraction to design and enhance the resolving power of grating.
- CO2** Familiarize with the basics of crystals and their structures.
- CO3** Explain the fundamental concepts of Quantum behaviour of matter.
- CO4** Explain the basic concepts of Semiconductors and identify the type of semiconductors using Hall effect.
- CO5** Summarize various types of polarizations of dielectrics and classify the magnetic materials.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	-	-	-	-	-	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	-
CO3	2	1	-	-	-	-	2	-	-	-	-	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-

Unit– I Wave Optics

Interference : Introduction Principle of Superposition-Interference of light- Conditions for sustained Interference- Interference in thin films (reflected geometry) – Colours in thin films – Newton’s Rings (reflected geometry) – Determination of wavelength and refractive index.

Diffraction : Introduction – Fresnel and Fraunhofer Diffraction - Diffraction due to Single slit (quantitative), Double slit, N– Intensity distribution curves – Diffraction Grating formula – Grating spectrum– Rayleigh’s criterion – Resolving powers of grating(qualitative), dispersive power of grating.

Unit– II Crystallography and X-ray diffraction

Crystal Structure: Basis and lattice – Crystal Systems – Bravais Lattice - Unit cell-packing fraction – coordination number- Miller indices – Separation between successive (h k l) planes.

X-ray Diffraction : Bragg’s law-Bragg’s x-ray spectrometer – crystal structure determination by Laue’s and powder methods.

Unit–III Quantum Mechanics and Free electron Theory

Quantum Mechanics: Introduction – Matter waves – de Broglie’s hypothesis – Heisenberg’s Uncertainty Principle – interpretation of wave function – Schrödinger Time Independent and Time Dependent wave equations– Particle in a potential box.

Free Electron Theory: Introduction–Classical free electron theory(merits and demerits only)- Fermi energy state – Fermi Dirac distribution function –Temperature dependence of Fermi-

Dirac distribution function- Quantum Free electron theory–electrical conductivity based on quantum free electron theory–Density of states.

Unit– IV Semiconductors

Semiconductor Physics : Formation of energy bands in crystalline solids – classification of crystalline solids - Intrinsic semi-conductors - density of charge carriers - Electrical conductivity – Fermi level – extrinsic semiconductors - p-type & n-type - Density of charge carriers -Dependence of Fermi energy on carrier concentration and temperature – Hall effect- Hall coefficient –Applications of Hall effect –Drift and Diffusion currents–Einstein’s equation.

Unit– V Magnetic & Dielectric Materials

Magnetic Materials: Introduction – Magnetic dipole moment – Magnetization – Magnetic susceptibility and permeability – Origin of permanent magnetic moment – Bohr magneton – Classification of magnetic materials :Dia, para & Ferro–Domain concept of Ferro magnetism Hysteresis–soft and hard magnetic materials–applications of Ferro magnetic material.

Dielectric Materials: Introduction - Dielectric polarization – Dielectric polarizability, Susceptibility, Dielectric constant - Relation between D, E & ϵ_0 -Types of polarizations- Electronic(Quantitative), Ionic(Quantitative) and Orientation polarizations (Qualitative) - Lorentz internal field - Clausius- Mossotti equation –Ferro electric materials– Frequency dependence of polarization—complex dielectric constant- dielectric loss –Applications.

Text Books:

1. “A Textbook of Applied Physics”by P.K. Palanisamy, Scitech Publishers
2. “Engineering Physics”by M.Arumugam, Anuradha publishers
3. “A Textbook of Engineering Physics”by M N Avadhanulu, P.G Kshirsagar & T.V.S.ArunMurthy S Chand & Company Ltd, 11th edition

Reference Books:

1. “Engineering Physics”by M.R.Srinivasan, New Age International publishers.
2. “Engineering Physics”by D.K.Bhattacharya and Poonam Tandon, Oxford press.
3. “Engineering Physics”by R.K Gaur. and S.L Gupta., -Dhanpat Rai publishers.

Web Links:

1. <http://nptel.ac.in/courses/122107035/11>
2. <http://nptel.ac.in/courses/115102023/>
3. <https://phet.colorado.edu/en/simulations/category/physics>
4. <http://physicsgecg.blogspot.in/p/reading-materials.html>
5. <https://sites.google.com/site/physicsbysureshsaganti/home>

LINEAR ALGEBRA AND CALCULUS
(Common to all branches)

I Semester**Course Code: 231BS1T02****L****3****T****0****P****0****C****3**

Course Outcomes: At the end of the course, student will be able to:

CO1: Solve the system of Linear equations

CO2: Calculate Eigen values and Eigen vectors

CO3: Apply Mean value theorems for given functions

CO4: Calculate the Maximum value and Minimum value of a function of several variables

CO5: Compute areas and volumes using multiple integrals

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-

Unit-I

Matrices : Rank of a matrix by echelon form, normal form, Cauchy–Binet formulae (without proof). Inverse of Non- singular matrices by Gauss-Jordan method, System of linear equations: Solving system of Homogeneous and Non-Homogeneous equations by Gauss elimination method, Jacobi and Gauss Seidel Iteration Methods.

Unit-II

Eigen values, Eigen vectors and Orthogonal Transformation : Eigen values, Eigen vectors and their properties, Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton Theorem, Quadratic forms and Nature of the Quadratic Forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation.

Unit-III

Calculus : Mean Value Theorems: Rolle's Theorem, Lagrange's mean value theorem with their geometrical interpretation, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders (without proof), Problems and applications on the above theorems.

Unit-IV**Partial differentiation and Applications (Multi variable calculus) :**

Functions of several variables: Continuity and Differentiability, Partial derivatives, total derivatives, chain rule, Taylor's and Maclaurin's series expansion of functions of two variables. Jacobians, Functional dependence, maxima and minima of functions of two variables, method of Lagrange multipliers.

Unit-V**Multiple Integrals (Multi variable Calculus) :**

Double integrals, triple integrals, change of order of integration, change of variables to polar, cylindrical and spherical coordinates. Finding areas (by double integrals) and volumes (by double integrals and triple integrals).

Text Books:

1. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 2017, 44th Edition
2. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons, 2018, 10th Edition.

Reference Books:

1. Thomas Calculus, George B. Thomas, Maurice D. Weir and Joel Hass, Pearson Publishers, 2018, 14th Edition.
2. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 2021 5th Edition (9th reprint).
3. Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 2018, 5th Edition.
4. Advanced Engineering Mathematics, Michael Greenberg, Pearson publishers, 9th edition
5. Higher Engineering Mathematics, H. K. Das, Er. Rajnish Verma, S. Chand Publications, 2014, Third Edition (Reprint 2021)

Web Links:

1. <https://archive.nptel.ac.in/courses/111/104/111104137/>
2. <https://archive.nptel.ac.in/courses/111/107/111107108/>

BASIC CIVIL AND MECHANICAL ENGINEERING

(Common to CE, EEE, ME, ECE, Min.E., PT, Ag.E)

I Semester

L T P C

Course Code: 231ES1T01

3 0 0 3

Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain various sub-divisions of Civil Engineering and basic characteristics of Civil Engineering Materials and attain knowledge on prefabricated technology.
- CO2:** Illustrate the concepts of surveying and to understand the measurement of distances, angles and levels through surveying.
- CO3:** Describe the significance and Engineering aspects of transportation, water storage and water conveyance structures.
- CO4:** Explain the role and applications of mechanical engineering and materials.
- CO5:** Explain the different manufacturing processes, mechanical power transmission systems and robotics.
- CO6:** Explain the working of IC Engines, Boilers and Power Plants.

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	1	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	1	1	-	-	-	-	-
CO5	3	1	-	-	-	1	1	-	-	-	-	-
CO6	3	1	-	-	-	1	1	-	-	-	-	-

Mapping of Course Outcomes with Program Outcomes

CO/PSO	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-
CO6	-	-

PART A: BASIC CIVIL ENGINEERING

UNIT I

Basics of Civil Engineering: Role of Civil Engineers in Society- Various Disciplines of Civil Engineering- Structural Engineering- Geo-technical Engineering- Transportation Engineering- Hydraulics and Water Resources Engineering - Environmental Engineering-Scope of each

discipline - Building Construction and Planning- Construction Materials-Cement - Aggregate – Bricks - Cement concrete- Steel. Introduction to Prefabricated construction Techniques.

UNIT II

Surveying: Objectives of Surveying- Horizontal Measurements- Angular Measurements- Introduction to Bearings Levelling instruments used for levelling -Simple problems on levelling and bearings-Contour mapping.

UNIT III

Transportation Engineering Importance of Transportation in Nation's economic development- Types of Highway Pavements- Flexible Pavements and Rigid Pavements - Simple Differences. Basics of Harbour, Tunnel, Airport, and Railway Engineering.

Water Resources and Environmental Engineering: Introduction, Sources of water- Quality of water- Specifications- Introduction to Hydrology–Rainwater Harvesting-Water Storage and Conveyance Structures (Simple introduction to Dams and Reservoirs).

Text Books:

1. Basic Civil and Mechanical Engineering, Omni Srikanth, M. Sreenivasa Reddy, S. Chand Publications.
2. Basic Civil Engineering, M.S.Palanisamy, , Tata Mcgraw Hill publications (India) Pvt. Ltd. Fourth Edition.
3. Introduction to Civil Engineering, S.S. Bhavikatti, New Age International Publishers. 2022. First Edition.
4. Basic Civil Engineering, Satheesh Gopi, Pearson Publications, 2009, First Edition.

Reference Books:

1. Surveying, Vol- I and Vol-II, S.K. Duggal, Tata McGraw Hill Publishers 2019. Fifth Edition.
2. Hydrology and Water Resources Engineering, Santosh Kumar Garg, Khanna Publishers, Delhi. 2016
3. Irrigation Engineering and Hydraulic Structures - Santosh Kumar Garg, Khanna Publishers, Delhi 2023. 38th Edition.
4. Highway Engineering, S.K.Khanna, C.E.G. Justo and Veeraraghavan, Nemchand and Brothers Publications 2019. 10th Edition.
5. Indian Standard DRINKING WATER — SPECIFICATION IS 10500-2012.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_ce42/preview
2. https://www.youtube.com/watch?v=chhuq_t40rY&list=PL20A0651466E8A776
3. https://www.youtube.com/results?search_query=Transportation+engineering+NPTel
4. <https://www.mcgill.ca/civil/undergrad/areas/water>

PART B: BASIC MECHANICAL ENGINEERING

UNIT I

Introduction to Mechanical Engineering: Role of Mechanical Engineering in Industries and Society- Technologies in different sectors such as Energy, Manufacturing, Automotive, Aerospace, and Marine sectors.

Engineering Materials: – Metals - Ferrous and Non-ferrous, Ceramics, Composites, Smart Materials.

UNIT II

Manufacturing Processes: Principles of Casting, Forming, Joining Processes, Machining, Introduction to CNC machines, 3D printing, and Smart manufacturing.

Mechanical Power Transmission - Belt Drives, Chain, Rope drives, Gear Drives and their Applications.

Introduction to Robotics - Joints & Links, Configurations, and Applications of Robotics.

UNIT III

Thermal Engineering – I.C Engine: Heat Engine – Types of Heat Engine –Classification of I.C. Engine, Working principle of SI and CI Engines, Comparison of 2-Stroke and 4-Stroke engines, Components of Electric and Hybrid Vehicles.

Boilers: Classification of Boilers – Simple Vertical Boiler – Cochran Boiler –Babcock and Wilcox Boiler – Benson Boiler.

Power Plants – Working principle of Steam, Diesel, Hydro, and Nuclear power plants.

(**Note:** The subject covers only the basic principles of Civil and Mechanical Engineering systems. The evaluation shall be intended to test only the fundamentals of the subject).

Text Books:

1. Internal Combustion Engines by V. Ganesan, By Tata McGraw Hill publications (India) Pvt. Ltd.
2. A Text book of Theory of Machines by S.S. Rattan, Tata McGraw Hill Publications, (India) Pvt. Ltd.
3. Introduction to Mechanical Engg by Jonathan Wicker and Kemper Lewis, Cengage learning India Pvt. Ltd.

Reference Books:

1. Appuu Kuttan KK, Robotics, I.K. International Publishing House Pvt. Ltd. Volume-I.
2. 3D printing & Additive Manufacturing Technology- L. Jyothish Kumar, Pulak M Pandey, Springer publications.
3. Thermal Engineering by Mahesh M Rathore Tata McGraw Hill publications (India) Pvt. Ltd.
4. G. Shanmugam and M.S. Palanisamy, Basic Civil and the Mechanical Engineering, Tata McGraw Hill publications (India) Pvt. Ltd.

Web Links:

1. <https://www.youtube.com/playlist?list=PL8tFFpsLHxMRZsJlJPLGVGthqSEJV11DZ>
2. <https://sedyono.files.wordpress.com/2015/10/ch-02.pdf>
3. <https://www.cedengineering.com/userfiles/Mechanical%20Power%20Transmission%20Fundamentals-R1.pdf>
4. <https://ccsuniversity.ac.in/bridge-library/pdf/Lecture-3-Engine.pdf>
5. https://www.sathyabama.ac.in/sites/default/files/course-material/2020-10/UNIT_5_14.pdf
6. <https://www.youtube.com/watch?v=q79bl99rWFM>

ENGINEERING GRAPHICS

(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)

I Semester

L T P C

Course Code: 231ES1T02

1 0 4 3

Course Outcomes: At the end of the Course, Student will be able to:

- CO 1:** Apply the principles of engineering drawing, to construct engineering curves and orthographic projection of points.
- CO 2:** Construct projections of Lines and planes in various positions in first quadrant.
- CO 3:** Construct projections of solids in various positions in first quadrant.
- CO 4:** Develop surfaces of the regular solids.
- CO 5:** Construct isometric and orthographic views of simple solids.

Mapping of course outcomes with program outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	2	-	-	-	-	1	-	-
CO2	3	2	1	-	2	-	-	-	-	1	-	-
CO3	3	2	1	-	2	-	-	-	-	1	-	-
CO4	3	2	1	-	2	-	-	-	-	1	-	-
CO5	3	2	1	-	2	-	-	-	-	1	-	-

UNIT I

Introduction to Drawing: Lines, Lettering and Dimensioning, Geometrical Constructions and Constructing regular polygons by general methods.

Curves: construction of ellipse, parabola and hyperbola by general method, Cycloid, Involute, Normal and tangent to Curves.

UNIT II

Projections of Points: Reference plane, importance of reference lines or Plane, Projections of a point situated in any one of the four quadrants.

Projections of Straight Lines: Projections of straight lines parallel to both reference planes, perpendicular to one reference plane and parallel to other reference plane, inclined to one reference plane and parallel to the other reference plane. Projections of Straight Line Inclined to both the reference planes.

UNIT III

Projections of Planes: Regular planes Perpendicular to both reference planes, parallel to one reference plane and inclined to the other reference plane; plane inclined to both the reference planes.

UNIT IV

Projections of Solids: Types of solids: Polyhedra and Solids of revolution. Projections of solids in simple positions: Axis perpendicular to horizontal plane, Axis perpendicular to vertical plane and Axis parallel to both the reference planes, Projection of Solids with axis inclined to one reference plane and parallel to another plane.

Development of Surfaces: Methods of Development: Parallel line development and radial line development. Development of a cube, prism, cylinder, pyramid and cone simple cases.

UNIT V

Conversion of Views: Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views. Creating 2D & 3D drawings of objects (prism, cylinder, pyramid and cone)

Text Books:

1. T Jeyapoovan, M. Sreenivasa Reddy, Computer Aided Engineering Graphics, Vikas Publications.
2. N. D. Bhatt, Engineering Drawing, Charotar Publishing House.
3. Venugopal, Engineering Drawing and Graphics, 2nd edition, New Age Publications, New Delhi.

Reference Books:

1. Engineering Drawing, K.L. Narayana and P. Kannaiah, Tata McGraw Hill.
2. Engineering Drawing, M.B.Shah and B.C. Rana, Pearson Education Inc.
3. Engineering Drawing with an Introduction to AutoCAD, Dhananjay Jolhe, Tata McGraw Hill.
4. Computer Aided Engineering Graphics, T. Jeyapoovan, Vikas Publishing house, New Delhi, First Edition.

Web Links:

1. <http://nptel.ac.in/courses/112103019>
2. <http://freevideolectures.com/Course/3420/Engineering-Drawing>
3. <http://engineeringdrawing.org>
4. <http://inoxwap.com/video/category/engineering-drawing-for-first-year-engineering.html>

COMMUNICATIVE ENGLISH
(Common to all branches)

I Semester	L	T	P	C
Course Code: 231HS1T01	2	0	0	2

Course Outcomes: At the end of the course, student will be able to:

- CO1:** Understand the context, topic, and pieces of specific information from social or Transactional dialogues.
- CO2:** Apply grammatical structures to formulate sentences and correct word forms.
- CO3:** Analyze discourse markers to speak clearly on a specific topic in informal discussions.
- CO4:** Evaluate reading/ listening texts and to write summaries based on global comprehension of these texts.
- CO5:** Create a coherent paragraph, essay, and resume.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	-	3	-	-
CO2	-	-	-	-	-	-	-	-	-	3	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	-
CO4	-	-	-	-	-	-	-	-	-	3	-	-
CO5	-	-	-	-	-	-	-	-	-	3	-	-

UNIT I

Lesson: HUMAN VALUES: The Gift of The Magi by O. Henry (Short Story)

Listening : Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions.

Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others.

Reading: Skimming to get the main idea of a text; scanning to look for specific pieces of information.

Writing: Mechanics of Writing-Capitalization, Spellings, Punctuation-Parts of Sentences.

Grammar: Parts of Speech, Basic Sentence Structures-forming questions

Vocabulary: Synonyms, Antonyms, Affixes (Prefixes/Suffixes), Root words.

UNIT II

Lesson: NATURE: The Brook by Alfred Tennyson (Poem)

Listening: Answering a series of questions about main ideas and supporting ideas after listening to audio texts.

Speaking: Discussion in pairs/small groups on specific topics followed by short structure talks.

Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

Writing: Structure of a paragraph - Paragraph writing (specific topics)

Grammar: Cohesive devices - linkers, use of articles and zero article; prepositions.

Vocabulary: Homonyms, Homophones, Homographs.

UNIT III

Lesson: BIOGRAPHY: Elon Musk

- Listening** : Listening for global comprehension and summarizing what is listened to.
Speaking : Discussing specific topics in pairs or small groups and reporting what is discussed
Reading : Reading a text in detail by making basic inferences -recognizing and interpreting specific context clues; strategies to use text clues for comprehension.
Writing : Summarizing, Note-making, paraphrasing
Grammar : Verbs - tenses; subject-verb agreement; Compound words, Collocations
Vocabulary : Compound words, Collocations

UNIT IV

Lesson: INSPIRATION: The Toys of Peace by Saki

- Listening** : Making predictions while listening to conversations/ transactional dialogues without video; listening with video.
Speaking : Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.
Reading : Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data.
Writing : Letter Writing: Official Letters, Resumes
Grammar : Reporting verbs, Direct & Indirect speech, Active & Passive Voice
Vocabulary : Words often confused, Jargons

UNIT V

Lesson: MOTIVATION: The Power of Intrapersonal Communication - (An Essay)

- Listening** : Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension.
Speaking : Formal oral presentations on topics from academic contexts.
Reading : Reading comprehension.
Writing : Writing structured essays on specific topics.
Grammar : Editing short texts –identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)
Vocabulary : Technical Jargons

Text Books:

1. Pathfinder: Communicative English for Undergraduate Students, 1st Edition, OrientBlack Swan, 2023 (Units 1,2 & 3)
2. Empowering with Language by Cengage Publications, 2023 (Units 4 & 5)

Reference Books:

1. Dubey, Sham Ji & Co. English for Engineers, Vikas Publishers, 2020
2. Bailey, Stephen. Academic writing: A Handbook for International Students. Routledge, 2014.
3. Murphy, Raymond. English Grammar in Use, Fourth Edition, Cambridge University Press, 2019.
4. Lewis, Norman. Word Power Made Easy- The Complete Handbook for Building a Superior Vocabulary. Anchor, 2014.

Web Links:**GRAMMAR:**

1. www.bbc.co.uk/learningenglish
2. <https://dictionary.cambridge.org/grammar/british-grammar/>
3. www.eslpod.com/index.html
4. <https://www.learngrammar.net/>
5. <https://english4today.com/english-grammar-online-with-quizzes/>
6. <https://www.talkenglish.com/grammar/grammar.aspx>

VOCABULARY

1. <https://www.youtube.com/c/DailyVideoVocabulary/videos>
2. https://www.youtube.com/channel/UC4cmBAit8i_NJZE8qK8sfpA

ENGINEERING WORKSHOP
(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)

I Semester**Course Code: 231ES1L02**

L	T	P	C
0	0	3	1.5

Course Outcomes:

At the end of the Course, Student will be able to:

CO 1: Prepare various wooden joints**CO 2:** Develop various fitting joints**CO 3:** Develop surfaces for making the various sheet metal models**CO 4:** Develop basic knowledge for house wiring and plumbing practice**CO 5:** Demonstrate and Practice on welding joints**Mapping of Course Outcomes with Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	-	-	-	-	2	1	-	1
CO2	1	1	-	-	-	-	-	-	2	1	-	1
CO3	2	1	-	-	-	-	-	-	2	1	-	1
CO4	1	-	-	-	-	-	-	-	2	1	-	1
CO5	2	-	-	-	-	-	-	-	2	1	-	1

Demonstration: Safety Practices and Precautions to be observed in workshop.**Carpentry:**

1. To make a T-Lap joint from the wood of given size
2. To make a Dovetail joint from the wood of given size

Fitting:

1. To make a V- fitting from the given two M.S pieces
2. To make a Square- fitting from the given two M.S pieces

Sheet Metal Work:

1. To make a Taper tray using given sheet metal
2. To make a conical funnel using given sheet metal

House Wiring:

1. To give connection to three bulbs by Series
2. To give connection to three bulbs by Parallel

Welding:

1. To make a butt joint using given M.S pieces by Arc Welding
2. To make a Lap joint using given M.S pieces by Arc Welding

List of Augmented Experiments:

(Any two of the following experiments can be performed)

1. Demonstration and prepare an Elbow joint by using plumbing tools.
2. To make a Mortise and Tenon joint from the wood of given size.
3. To make a T-joint using given M.S pieces and by Arc Welding.

Text Books:

1. Basic Workshop Technology: Manufacturing Process, Felix.; Workshop Processes, Practices and materials; Routledge Publishers.
2. A course in Workshop Technology Vol I & Vol II, B.S. Raghuwanshi, Dhanpath Rai & Co.

Reference Books:

1. Workshop Practice by H.S.Bawa, Tata-McGraw Hill, 2nd Edition.
2. Elements of Workshop Technology, VOL I by S.K. Hajra Choudhury & others 14th edition
3. Workshop Technology, Part 1, Fifth edition, W.A.J. Chapman.
4. Workshop Technology Manufacturing Processes by Dr. R. K. Singal, Vol II, Kat Books Publications.

ENGINEERING PHYSICS LAB
(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)

I Semester**L T P C****Course Code: 231BS1L01****0 0 2 1****Course Outcomes:****At the end of the Course, Student will be able to:**

- CO1:** Operate optical instruments like travelling microscope and spectrometer.
CO2: Study Temperature Resistance Characteristics of different materials.
CO3: Estimate magnetic field intensity, wave length and Frequency of electrical vibrator.
CO4: Estimate acceleration due to gravity and Elastic moduli by oscillatory methods.
CO5: Study voltage current characteristics of different semiconductors.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	-
CO3	2	1	-	-	-	-	-	-	-	-	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	-

List of Experiments:

(Any TEN of the listed experiments are to be conducted)

1. Determination of radius of curvature of a given Plano-convex lens by Newton's rings.
2. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration.
3. Verification of Brewster's law
4. Determination of dielectric constant using charging and discharging method.
5. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
6. Determination of wavelength of Laser light using diffraction grating.
7. Estimation of Planck's constant using photoelectric effect.
8. Determination of the resistivity of semiconductors by four probe methods.
9. Determination of energy gap of a semiconductor using p-n junction diode.
10. Magnetic field along the axis of a current carrying circular coil by Stewart Gee's Method.
11. Determination of Hall voltage and Hall coefficient of a given semiconductor using Hall effect.
12. Determination of temperature coefficients of a thermistor.
13. Determination of acceleration due to gravity and radius of Gyration by using a compound pendulum.
14. Determination of thickness of a thin wire by forming interference fringes.
15. Determination of rigidity modulus of the material of the given wire using Torsional pendulum.

16. Sonometer: Verification of laws of stretched string.
17. Determination of young's modulus for the given material of wooden scale by non-uniform bending (or single cantilever) method.
18. Determination of Frequency of electrically maintained tuning fork by Melde's experiment.

List of Augmented Experiments:

(Any **TWO** of the listed experiments are to be conducted)

19. Resolving power of grating.
20. Determination of V-I characteristics and Breakdown voltage of Zener Diode.
21. Determination of spring constant of springs using coupled oscillators.

Reference Books:

1. A Textbook of Practical Physics - S. Balasubramanian, M.N. Srinivasan, S. ChandPublishers.
2. Engineering Physics Lab Manual by Dr.C.V.Madhusudhana Rao, V.Vasanth Kumar, Scitech Publications
3. Laboratory Manual Cum Record for Engineering Physics I & II by Dr.Y.Aparna, Dr.K.Venkateswara Rao, VGS Techno series.

Web Links:

1. www.vlab.co.in
2. <https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype>

IT WORKSHOP

(Common to all branches)

I Semester**L T P C****Course Code: 231ES1L01****0 0 2 1****Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Experiment with assembling, disassembling hardware components of a computer.
CO2: Explain the process of safeguarding a computer system or network from virus/worm.
CO3: Demonstrate virtual machine and software installation.
CO4: Develop a Document, Spreadsheet and Presentation using MS-Office and AI Tools.
CO5: Make use of GIT for version control and LaTeX for document preparation.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	-	2	-	-	-	2	2	-	-
CO2	2	1	1	-	2	-	-	-	2	2	-	-
CO3	2	1	-	-	2	-	-	-	2	2	-	-
CO4	1	1	3	-	2	-	-	-	2	2	-	-
CO5	1	1	3	-	2	-	-	-	2	2	-	-

List of Experiments:**Week 1: Identification of peripherals of a computer**

- a. Block diagram of the CPU along with the configuration of the each peripheral and its functions.

Week 2: System Assembling and Disassembling

- a. Disassembling the components of a PC.
- b. Assembling the components back to working condition.

Week 3: Virtual Machine setup

- a. Setting up and configuring a new virtual machine.

Week 4: Installation of software

- a. Every student should individually install LINUX on the personal computer.
- b. Every student should individually install MS windows on the personal computer.
Lab instructor should verify the installation and follow it up with a Viva.

Week 5: Networking and Internet

- a. Networking commands.
- b. Exploring Internet and World Wide Web.
- c. Exploring Search Engines, Cyber hygiene.

Week 6: Text Editors

- a. Demonstration and Practice on Text Editors like Notepad++, Sublime Text, Atom, Brackets, Visual code, etc

Week 7: Word

- a. Demonstration and practice on Microsoft Word- Formatting, Page Borders, Reviewing, Equations, symbols.

Week 8: Excel

- a. Creating a Scheduler - Features to be covered: Gridlines, Format Cells, Summation, auto fill, Formatting Text
- b. Calculating GPA - Features to be covered: Cell Referencing, Formulae in excel – average, std. deviation, Charts, Renaming and Inserting worksheets, Hyper linking, Count function.

Week 9: Power Point

- a. Students will be working on basic power point utilities and tools which help them create basic power point presentations. PPT Orientation, Slide Layouts, Inserting Text, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Lines and Arrows in PowerPoint.
- b. Interactive presentations - Hyperlinks, Inserting –Images, Clip Art, Audio, Video, Objects, Tables and Charts.

Week 10: AI TOOLS – ChatGPT and Version Control - GITHUB

- a. Creative Writing: Use the model as a writing assistant. Provide the beginning of a story or a description of a scene, and let the model generate the rest of the content. This can be a fun way to brainstorm creative ideas • Ex: Prompt: In a world where gravity suddenly stopped working, people started floating upwards. Write a story about how society adapted to this new reality.
- b. Language Translation: Experiment with translation tasks by providing a sentence in one language and asking the model to translate it into another language. Compare the output to see how accurate and fluent the translations are. • Ex: Prompt: Translate the following English sentence to French: 'Hello, how are you doing today?'
- c. GIT Commands and GITHUB: config, init, clone, status, add, commit, push, branch, checkout, merge, pull, log

Week 11: LaTeX

- a. Installation of LaTeX and related Software's.
- b. Basic formatting using LaTeX.
- c. Handling the equations in LaTeX.
- d. Inserting the Tables in LaTeX.

Week 12: Internet & World Wide Web (WWW)

- a. Web Browsers, Surfing the Web: Students customize their web browsers with the LAN proxy settings, bookmarks, search toolbars and pop up blockers. Also, plug-ins like Macromedia Flash and JRE for applets should be configured.
- b. Cyber Hygiene: Students would be exposed to the various threats on the internet and would be asked to configure their computer to be safe on the internet. They

need to customize their browsers to block pop ups, block active downloads to avoid viruses and/or worms.

Week 13-16: List of Augmented Experiments: (Complete any 2)

13. Prepare a power point presentation for college information (Include 10 slides).
14. List the common computer hardware problem and write down the solutions.
15. Prepare your resume using MS-Word and LaTeX.
16. Upload all your documents into GIT and work with access permissions.

Reference Books:

1. Comdex Information Technology course tool kit, Vikas Gupta, WILEY Dream tech.
2. The Complete Computer upgrade and repair book, Cheryl A Schmidt, WILEY Dream tech, 2013, 3rd edition.
3. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education, 2012, 2nd edition.
4. PC Hardware - A Handbook, Kate J. Chase, PHI (Microsoft).
5. LaTeX Companion, Leslie Lamport, PHI/Pearson.
6. Essential Computer and IT Fundamentals for Engineering and Science Students, Dr.N.B.Vekateswarlu, S.Chand.

Web Links:

1. <https://assemblyourpc.net/>
2. <https://www.latex-tutorial.com/tutorials>
3. <http://www.teachmsoffice.com/>
4. <https://www.geeksforgeeks.org/top-12-most-used-git-commands-for-developers/>

COMMUNICATIVE ENGLISH LAB

(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)

I Semester	L	T	P	C
Course Code: 231HS1L01	0	0	2	1

Course Outcomes: At the end of the course, student will be able to:

- CO1: Understand the different aspects of the English language proficiency with emphasis on LSRW skills.
- CO2: Apply communication skills through various language learning activities
- CO3: Analyze the English speech sounds, stress, rhythm, intonation and syllable division for better listening and speaking comprehension.
- CO4: Evaluate and exhibit professionalism in participating in debates and group discussions.
- CO5: Develop the capacity to use various writing forms to achieve their professional needs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	-	3	-	-
CO2	-	-	-	-	-	-	-	-	-	3	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	-
CO4	-	-	-	-	-	-	-	-	-	3	-	-
CO5	-	-	-	-	-	-	-	-	-	3	-	-

List of Topics:

1. Communication Skills & JAM
2. Role Play - Conversational Practice
3. Phonetics -Vowels & Consonants
4. Neutralization/Accent Rules
5. Group Discussions-methods & practice
6. Debates - Methods & Practice
7. PPT Presentations/ Poster Presentation
8. Interview Skills
9. Resume Writing, Cover letter, SOP
10. E-mail Writing
11. Outstanding people – People you admire, Discuss a challenge, Write an article
12. Survival – Discuss dangerous situations, Write guidelines in a leaflet

Suggested Software:

- Walden Infotech
- Young India Films
- Cambridge Empower

Reference Books:

1. Raman Meenakshi, Sangeeta-Sharma. *Technical Communication*. Oxford University Press.2018.
2. Taylor Grant: *English Conversation Practice*, Tata McGraw-Hill Education India,2016
3. Hewing's, Martin. *Cambridge Academic English* (B2). CUP, 2012.
4. J. Sethi & P.V. Dhamija. *A Course in Phonetics and Spoken English*, (2nd Ed),Kindle, 2013
5. Cambridge Empower – Second Edition B2 Level

Web Links:**Spoken English:**

1. www.esl-lab.com
2. www.englishmedialab.com
3. www.englishinteractive.net
4. <https://www.britishcouncil.in/english/online>
5. <http://www.letstalkpodcast.com/>
6. <https://www.youtube.com/c/EnglishClass101/featured>
7. www.cambridgeone.org

Voice & Accent:

1. <https://www.youtube.com/user/letstalkaccent/videos>
2. <https://www.youtube.com/c/EngLanguageClub/featured>
3. https://www.youtube.com/channel/UC_OskgZBoS4dAnVUgJVexc
4. www.cambridgeone.org

HEALTH AND WELLNESS, YOGA AND SPORTS**(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)****I Semester****Course Code: 231HS1L02**

L	T	P	C
0	0	1	0.5

Course Outcomes: At the end of the course, Student will be able to**CO1:** Explain the importance of yoga and sports for Physical fitness and sound health.**CO2:** Demonstrate an understanding of health-related fitness components.**CO3:** Compare and contrast various activities that help enhance their health.**CO4:** Assess current personal fitness levels.**CO5:** Develop Positive Personality**Mapping of Course Outcomes with Program Outcomes:**

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	-	2	3	3	-	-
CO2	-	-	-	-	-	-	-	2	3	3	-	-
CO3	-	-	-	-	-	-	-	2	3	3	-	2
CO4	1	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	1	-	2	-	1

UNIT I

Concept of health and fitness, Nutrition and Balanced diet, basic concept of immunity Relationship between diet and fitness, Globalization and its impact on health, Body Mass Index(BMI) of all age groups.

Activities:

- Organizing health awareness programmes in community
- Preparation of health profile
- Preparation of chart for balance diet for all age groups

UNIT II

Concept of yoga, need for and importance of yoga, origin and history of yoga in Indian context, classification of yoga, Physiological effects of Asanas- Pranayama and meditation, stress management and yoga, Mental health and yoga practice.

Activities:

Yoga practices – Asana, Kriya, Mudra, Bandha, Dhyana, Surya Namaskar

UNIT III

Concept of Sports and fitness, importance, fitness components, history of sports, Ancient and Modern Olympics, Asian games and Commonwealth games.

Activities:

- Participation in one major game and one individual sport viz., Athletics, Volleyball, Basketball, Handball, Football, Badminton, Kabaddi, Kho-kho,

- Table tennis, Cricket etc. Practicing general and specific warm up, aerobics
- ii) Practicing cardiorespiratory fitness, treadmill, run test, 9 min walk, skipping and running.

Reference Books:

1. Gordon Edlin, Eric Golanty. Health and Wellness, 14th Edn. Jones & Bartlett Learning, 2022
2. T.K.V.Desikachar. The Heart of Yoga: Developing a Personal Practice
3. Archie J.Bahm. Yoga Sutras of Patanjali, Jain Publishing Company, 1993
4. Wiseman, John Lofty, SAS Survival Handbook: The Ultimate Guide to Surviving Anywhere Third Edition, William Morrow Paperbacks, 2014
5. The Sports Rules Book/ Human Kinetics with Thomas Hanlon. -- 3rd ed. Human Kinetics, Inc. 2014

General Guidelines:

1. Institutes must assign slots in the Timetable for the activities of Health/Sports/Yoga.
2. Institutes must provide field/facility and offer the minimum of five choices of as many Games/Sports.
3. Institutes are required to provide sports instructor / yoga teacher to mentor the students.

Evaluation Guidelines:

- Evaluated for a total of 100 marks.
- A student can select 6 activities of his/her choice with a minimum of 01 activity per unit. Each activity shall be evaluated by the concerned teacher for 15 marks, totalling to 90 marks.
- A student shall be evaluated by the concerned teacher for 10 marks by conducting viva voce on the subject.

ENVIRONMENTAL SCIENCE
(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)

I Semester

Course Code: 231MC1T01

L
2T
0P
0C
0

Course Outcomes: At the end of the Course, Student will be able to:

- CO1:** Outline the natural resources and their importance for the sustenance of the life
CO2: Explain about the biodiversity of India, threats and its conservation methods
CO3: Illustrate various attributes of the pollution, impacts and measures to control the pollution along with waste management practices
CO4: Describe social issues of both rural and urban environment to combat the challenges and the legislations of India in environmental protection
CO5: Explain the population growth and its implications
CO6: Summarize the Role of IT on Environment and Human Health

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	1	-	-	-	-	1	2	-	-	-	-	-
CO2	1	-	-	-	-	-	3	-	-	-	-	-
CO3	-	-	-	-	-	2	3	-	-	-	-	1
CO4	-	-	-	-	-	1	3	1	-	-	-	1
CO5	-	-	-	-	-	-	3	-	-	-	-	-
CO6	-	-	-	-	-	1	3	-	-	-	-	1

UNIT - I

Multidisciplinary Nature of Environmental Studies: Definition, Scope and Importance, Need for Public Awareness. Natural Resources: Renewable and non-renewable resources – Natural resources and associated problems.

UNIT – II

Ecosystem, Biodiversity and Its Conservation:

Ecosystems: Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers, and decomposers. Food chains, food webs and ecological pyramids.

Biodiversity And Its Conservation: Defi

UNIT – III

Environmental Pollution and Solid Waste Management: Environmental Pollution: Definition, Cause, effects, and control measures of:

- a. Air Pollution.
- b. Water Pollution
- c. Soil Pollution
- d. Marine Pollution
- e. Noise Pollution

Solid Waste

Management: Causes

UNIT – IV

Social Issues and The Environment: Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to Energy & Water. Resettlement and rehabilitation of people, Environmental ethics, Climate change, global warming,

UNIT – V

Human Population and The Environment: Population growth, variation among nations. Environment and human health, Human Rights, Value Education. Role of Information Technology in Environment and human health.

Text Books:

1. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission, Universities Press.
2. Environmental Studies by Palaniswamy – Pearson education
3. Environmental Studies by Dr.S.Azeem Unnisa, Academic Publishing Company.

Reference Books:

1. Textbook of Environmental Science by Deeksha Dave and E.Sai Baba Reddy, Cengage Publications.
2. Textbook of Environmental Sciences and Technology by M.Anji Reddy, B.S Publication.
3. Comprehensive Environmental studies by J.P.Sharma, Laxmi publications
4. Environmental sciences and engineering – J. Glynn Henry and Gary W. Heinke – Prentice Hall of India Private limited.
5. A Textbook of Environmental Studies by G.R.Chatwal, Himalaya Publishing House

Web Links:

1. <https://www.youtube.com/watch?v=mOwyPENHhbc>
2. https://www.youtube.com/watch?v=_mgvsPnCYj4
3. <https://www.youtube.com/watch?v=L5B-JMnBlyQ>
4. https://www.youtube.com/watch?v=3RDGV5i82_Q

ENGINEERING CHEMISTRY
(Common to CE, ME, Min.E, PT & Ag.E)

II Semester**Course Code: 231BS2T04**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, the students will be able to:

- CO1** Analyze the hardness of water and specification of drinking water
- CO2** Outline the difference between primary and secondary cells and controlling methods of corrosion
- CO3** Summarize the fundamentals and applications of polymers & importance of alternative fuels
- CO4** Interpret various engineering materials
- CO5** Summarize the importance of Nano materials and Green chemistry

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	1	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	2	-	-	-	-	-

UNIT I:

Water Technology

Soft and hard water, Estimation of hardness of water by EDTA Method, Estimation of dissolved Oxygen - Boiler troubles – Priming, foaming, scale and sludge, Caustic embrittlement, Industrial water treatment method (Zeolite and Ion-Exchange Process) – Specifications for drinking water, Bureau of Indian Standards(BIS)and World health organization(WHO) standards, desalination of brackish water, reverse osmosis (RO) and electrodialysis.

UNIT II:

Electrochemistry and Corrosion

Electrodes –electrochemical cell, Nernst equation, cell potential calculations.

Primary cells – Zinc-air battery, Secondary cells: Nickel-Cadmium (Ni-Cd), and lithium-ion batteries- Working principle of the batteries including cell reactions; Fuel Cells: Principle and working of hydrogen-oxygen Fuel cell.

Corrosion: Introduction to corrosion, Dry corrosion (Pilling Bed worth rule) electrochemical theory of corrosion, differential aeration cell corrosion, galvanic corrosion, Factors affecting the corrosion, cathodic and anodic protection, electroplating and electroless plating (Nickel and Copper).

UNIT III:**Polymers and Fuel Chemistry**

Introduction to polymers, functionality of monomers, Mechanism of chain growth (Free radical), step growth polymerization.

Thermoplastics and Thermosetting plastics-: Preparation, properties, and applications of Polystyrene, PVC, Nylon 6,6 and Bakelite.

Elastomers – Preparation, properties and applications of Buna S, Buna N, Thiokol rubbers.

Fuels – Types of fuels, calorific value of fuels, numerical problems based on calorific value; Analysis of coal (Proximate and Ultimate analysis), Liquid Fuels: Refining of petroleum, Octane and Cetane number, Alternative fuels: CNG and biodiesel.

UNIT IV:**Engineering Materials**

Composites- Definition, Constituents, Fibre reinforced composites, properties, and Engineering applications

Refractories- Classification, Properties, Failures of Refractories and Applications.

Lubricants- Classification, Functions of lubricants, Mechanism of lubrication, Properties of lubricating oils (Definition): Viscosity, Viscosity Index, Flash point & Fire point, Cloud point & Pour point and Applications of lubricants.

Building materials- Portland cement, constituents, Setting and Hardening of cement.

UNIT V:**Nanomaterials and Green chemistry**

Nano Materials: Introduction to Nano materials, chemical synthesis of nanomaterials: Sol-gel method, characterization of nanomaterials by SEM and TEM (includes basic principle of SEM and TEM), Applications of nanomaterials (waste water treatment, lubricants and engines).

NanoTubes: Carbon nano tubes- Types of CNT's-preparation methods–Arc vapourisation, Laser ablation and chemical vapour deposition –properties and applications.

Green chemistry: Principles of green chemistry and applications of green chemistry.

Text Books:

1. Prasanta Rath, S. Aruna Kumari Engineering Chemistry ,CENGAGE Learning,
2. Shikha Agarwal , Engineering Chemistry Fundamentals and Applications,Cambridge 2nd Edition

Reference Books:

1. H.F.W. Taylor, Cement Chemistry, 2/e, Thomas Telford Publications.
2. Dr S.S.Dara, Dr S.S.Umare , A Textbook of Engineering Chemistry, S.Chand Publication, 2022.

Web Links:

1. <https://nptel.ac.in/courses/105107207>
2. <https://nptel.ac.in/courses/113104082>
3. <https://nptel.ac.in/courses/113108051>
4. <https://archive.nptel.ac.in/courses/104/105/104105039/>
5. <https://nptel.ac.in/courses/118102003>

DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS (Common to all branches)

II Semester

Course Code: 231BS2T03

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, student will be able to:

- CO1:** Solve Linear differential equations of first order
- CO2:** Solve Linear differential equations of higher order
- CO3:** Identify methods of solution for various partial differential equations
- CO4:** Calculate the gradient, divergence and curl
- CO5:** Compute work done, flux using vector integration

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	2	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-

UNIT-I:

Differential equations of first order and first degree :

Linear differential equations – Bernoulli's equations- Exact equations and equations reducible to exact form. Applications: Newton's Law of cooling – Law of natural growth and decay, Electrical circuits.

UNIT-II:

Linear differential equations of higher order :

Definitions, homogenous and non-homogenous equations, complimentary function, general solution, particular integral, Wronskian, Method of variation of parameters. Simultaneous linear equations, Applications to L-C-R Circuit problems and Simple Harmonic motion.

UNIT-III:

Partial Differential Equations :

Introduction and formation of Partial Differential Equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equations using Lagrange's method. Homogeneous Linear Partial differential equations with constant coefficients.

UNIT-IV:

Vector differentiation :

Scalar and vector point functions, vector operator Del, Del applied to scalar point functions- Gradient and its applications, Directional derivative, del applied to vector point functions- Divergence and Curl, solenoidal and irrotational vectors, scalar potential, vector identities.

Unit-V:**Vector integration :**

Line integral-circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof) and related problems.

Text Books:

1. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 2017, 44th Edition
2. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons, 2018, 10th Edition.

Reference Books:

1. Thomas Calculus, George B. Thomas, Maurice D. Weir and Joel Hass, Pearson Publishers, 2018, 14th Edition.
2. Advanced Engineering Mathematics, Dennis G. Zill and Warren S. Wright, Jones and Bartlett, 2018.
3. Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 2018, 5th Edition.
4. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 2021 5th Edition (9th reprint).
5. Higher Engineering Mathematics, B. V. Ramana, , McGraw Hill Education, 2017

Web Links:

1. <https://archive.nptel.ac.in/courses/111/106/111106100/>
2. <https://archive.nptel.ac.in/courses/111/105/111105122/>

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)

II Semester
Course Code: 231ES2T01

L T P C
3 0 0 3

Course Outcomes: At the end of the Course, Student will be able to:

- CO1:** Analyze the concepts associated to AC and DC circuits.
CO2: Explain the operating principles of motors, generators and measuring instruments.
CO3: Analyze the Different Energy Resources and Equipment Safety Measures.
CO4: Explain the concept and the applications of semiconductor Diodes.
CO5: Analyze the Basic Electronic Circuits and Instrumentation.
CO6: Interpret numeric information in different code formats.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	3	1	-	-	-	-	-	-	-	-	-
CO2	2	3	1	-	-	-	-	-	-	-	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	-
CO6	2	3	1	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	-
CO2	1	-
CO3	1	-
CO4	1	-
CO5	1	-
CO6	1	-

PART A: BASIC ELECTRICAL ENGINEERING

UNIT-1 DC & AC Circuits

DC Circuits: Electrical circuit elements (R, L and C), Ohm's Law and its limitations, KCL & KVL, series, parallel, series-parallel circuits, source transformation technique, Super Position theorem, Simple numerical problems.

AC Circuits: A.C. Fundamentals: Equation of AC Voltage and current, waveform, time period, frequency, amplitude, phase, phase difference, average value, RMS value, form factor, peak factor, Voltage and current relationship with phasor diagrams in R, L, and C circuits, Concept of

Impedance, Active power, reactive power and apparent power, Concept of power factor series RLC circuit only (Simple Numerical problems).

UNIT-II Machines and Measuring Instruments

Machines: Construction, principle and operation of (i) DC Motor, (ii) DC Generator, (iii) Single Phase Transformer, (iv) Three Phase Induction Motor and (v) Alternator, Applications of electrical machines.

Measuring Instruments: Construction and working principle of digital multi meter, Permanent Magnet Moving Coil (PMMC), Moving Iron (MI) Instruments and Wheat Stone bridge. Tong tester and megger.

UNIT-III Energy Resources, Electricity Bill & Safety Measures

Energy Resources: Conventional and non-conventional energy resources; Layout and operation of various Power Generation systems: Hydel, Nuclear, Solar & Wind power generation.

Electricity bill: Power rating of household appliances including air conditioners, PCs, Laptops, Printers, etc. Definition of “unit” used for consumption of electrical energy.

Equipment Safety Measures: Working principle of Fuse and Miniature circuit breaker(MCB), merits and demerits. Personal safety measures: Electric Shock, Earthing and its types, Safety Precautions to avoid shock.

Text Books:

1. Basic Electrical and Electronics Engineering, Ramana Pilla, Venkata Lalitha Narla, Gulivindala suresh, S. Chand Publications.
2. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, First Edition
3. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co, 2013
4. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition

Reference Books:

1. Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Mc Graw Hill, 2019, Fourth Edition
2. Principles of Power Systems, V.K. Mehtha, S.Chand Technical Publishers, 2020
3. Basic Electrical Engineering, T. K. Nagsarkar and M. S. Sukhija, Oxford University Press, 2017
4. Basic Electrical and Electronics Engineering, S. K. Bhattacharya, Person Publications, 2018, Second Edition.

Web Links:

1. <https://nptel.ac.in/courses/108105053>
2. <https://nptel.ac.in/courses/108108076>

PART B: BASIC ELECTRONICS ENGINEERING

UNIT I

SEMICONDUCTOR DEVICES

Introduction - Characteristics of PN Junction Diode — Zener Effect — Zener Diode and its Characteristics. Bipolar Junction Transistor — CB, CE, CC Configurations and Characteristics.

UNIT II

BASIC ELECTRONIC CIRCUITS AND INSTRUMENTATION

Rectifiers and power supplies: Block diagram description of a dc power supply, working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple zener voltage regulator.

Electronic Instrumentation: Block diagram of an electronic instrumentation system.

UNIT III

DIGITAL ELECTRONICS

Overview of Number Systems, Logic gates including Universal Gates, BCD codes, Excess-3 code, Gray code, Hamming code. Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR. Simple combinational circuits–Half and Full Adders

Text Books:

1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.
2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009

Reference Books:

1. R. S. Sedha, A Textbook of Electronic Devices and Circuits, S. Chand & Co, 2010.
2. Santiram Kal, Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall, India, 2002.
3. R. T. Paynter, Introductory Electronic Devices & Circuits – Conventional Flow Version, Pearson Education, 2009.

Web Links:

1. https://www.electronics-tutorials.ws/diode/diode_2.html
2. <http://fourier.eng.hmc.edu/e84/lectures/ch4/node3.html>
3. <http://nptel.ac.in/courses/117103063/11> by Dr. Chitrlekha Mahanta, IIT Guwahati.

INTRODUCTION TO PROGRAMMING

(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)

II Semester

Course Code: 231ES2T02

L T P C

3 0 0 3

Course Outcomes: After completion of the course the student will be able to

CO1: Demonstrate basics of computer, algorithm and flow chart for problem solving.

CO2: Make use of an appropriate control structures to solve a given problem.

CO3: Solve complex problems using Arrays and Strings.

CO4: Develop modular programming using functions and dynamic memory allocation using pointers.

CO5: Utilize structure, union and file operations to handle heterogeneous data.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	-	-	-	-	-	-	-	-	-
CO2	1	1	2	-	-	-	-	-	-	-	-	-
CO3	1	1	3	-	-	-	-	-	-	-	-	-
CO4	1	1	3	-	-	-	-	-	-	-	-	-
CO5	1	1	2	-	-	-	-	-	-	-	-	-

UNIT I

Introduction to Programming and Problem Solving

History of Computers, Basic organization of a computer: ALU, input-output units, memory, program counter, Introduction to Programming Languages, Basics of a Computer Program- Algorithms, flowcharts (Using Dia Tool), pseudo code. Introduction to Compilation and Execution, Primitive Data Types, Variables, and Constants, Basic Input and Output, Operations, Type Conversion, and Casting.

Problem solving techniques: Algorithmic approach, characteristics of algorithm, Problem solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms.

UNIT II**Control Structures**

Simple sequential programs Conditional Statements (if, if-else, switch), Loops (for, while, do-while) Break and Continue.

UNIT III Arrays and Strings

Arrays indexing, memory model, programs with array of integers, two dimensional arrays, Introduction to Strings, string handling functions.

UNIT IV Functions & Pointers

Functions: Introduction to Functions, Function Declaration and Definition, Function call Return Types and Arguments, arrays as parameters, Scope and Lifetime of Variables, recursion.

Pointers: Introduction to Pointers, dereferencing and address operators, pointer and address arithmetic, array manipulation using pointers, modifying parameters inside functions using pointers, Command line Arguments.

UNIT V User Defined Data types & File Handling

Structures, Unions, Bit Fields: Introduction, Nested Structures, Arrays of Structures, Structures and Functions, Self-Referential Structures, Unions, Enumerated Data Type – enum variables, Using Typedef keyword, Bit Fields.

Data Files: Introduction to Files, Using Files in C, Reading from Text Files, Writing to Text Files, Random File Access.

Text Books:

1. Programming in C, Rema Theraja, Oxford, 3rd edition.
2. "The C Programming Language", Brian W. Kernighan and Dennis M. Ritchie, Prentice-Hall, 1988

Reference Books:

1. Computing fundamentals and C Programming, Balagurusamy, E., McGraw-Hill Education.
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
3. Let Us C Yashwanth Kanetkar, Eighth edition, BPB Publications.
4. Programming in C A-Practical Approach Ajay Mittal. Pearson Education
5. Programming for problem solving using C Behrouz A. Forouzan. Richard F. Gilberg.

Web Links:

1. <https://www.hackerrank.com/>
2. <https://www.codechef.com/>
3. <https://www.topcoder.com/>
4. <https://code-cracker.github.io/>
5. https://onlinecourses.nptel.ac.in/noc22_cs40/preview
6. <https://archive.nptel.ac.in/courses/106/104/106104128/>

Note: The syllabus is designed with **C Language** as the fundamental language of implementation.

ENGINEERING MECHANICS (Common to CE & ME)

II Semester

L T P C

Course Code:231CE2T01

3 0 0 3

Course Outcomes: On Completion of the course, the student will be able to

- CO 1:** Apply fundamental concepts of mechanics to find resultant of force systems and frictional forces.
- CO 2:** Analyze plane trusses, draw free body diagrams calculate their resultant using equations of equilibrium.
- CO 3:** Calculate the centroid, center of gravity and moment of inertia of standard geometrical shapes and composite sections.
- CO 4:** Apply the principles of D'Alembert, work-energy and impulse-momentum to find motion of a particle.
- CO 5:** Solve the problems involving the translational and rotational motion of rigid bodies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	-

UNIT I

Introduction to Engineering Mechanics– Basic Concepts. Scope and Applications

Systems of Forces: Coplanar Concurrent Forces– Components in Space–Resultant–Moment of Force and its Application –Couple and Resultant of Force Systems.

Friction: Introduction, limiting friction and impending motion, Coulomb's laws of dry friction, Co-efficient of friction, cone of Static friction.

UNIT II

Equilibrium of Systems of Forces: Free Body Diagrams, Lami's Theorem, Equations of Equilibrium of Coplanar systems

Analysis of trusses: Introduction, types of Trusses, Idealization of Joints, analysis of plane trusses by method of joints and method of sections.

UNIT III

Centroid: Centroid of simple figures (from basic principles)–Centroid of Composite Figures.

Centre of Gravity: Centre of gravity of simple body (from basic principles), Centre of gravity of

composite bodies, Pappus theorems.

Area Moments of Inertia: Definition– Polar Moment of Inertia –Radius of gyration - Transfer formula for moment of inertia - Moments of Inertia for Composite areas.

UNIT IV

Rectilinear and Curvilinear motion of a particle: Kinematics and Kinetics –D'Alembert's Principle - Work Energy method and applications to particle motion-Impulse Momentum method.

UNIT V

Rigid body Motion: Kinematics and Kinetics of translation, Rotation about fixed axis and plane motion.

Text Books:

1. Engineering Mechanics, Statics and Dynamics, Rogers and M A. Nelson., McGraw Hill Education.
2. N H Dubey, Engineering Mechanics: Statics and Dynamics, McGraw Hill.

Reference Books:

1. Engineering Mechanics, S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., McGraw Hill Education, 5th Edition.
2. Engineering Mechanics, Statics and Dynamics, I.H. Shames., PHI, 4th Edition.
3. Introduction to Statics and Dynamics, Basudev Battacharia, Oxford University Press, 2nd Edition.
4. Engineering Mechanics: Statics and Dynamics, Hibbeler R.C., Pearson Education, Inc., New Delhi, 14th Edition
5. Beer F.P. and Johnston E.R., Vector Mechanics for Engineers - Volume I - Statics, Volume II - Dynamics, McGraw Hill, New York.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc23_me74/unit?unit=17&lesson=18
2. youtube.com/watch?v=Z4WN2Z9okfs
3. https://www.youtube.com/watch?v=Hn_iozUo9m4
4. <https://www.youtube.com/watch?v=q2ueCg9bvvQ>

ENGINEERING CHEMISTRY LAB
(Common to CE, ME, Min.E, PT & Ag.E)

II Semester**L T P C****Course Code: 231BS2L03****0 0 2 1**

Course Outcomes: At the end of the course, the students will be able to:

- CO1** Analyze and improve the experimental skills.
- CO2** Summarize parameters of water
- CO3** Analyze the strength of acids by instrumentation.
- CO4** Preparation of polymer and nano particle
- CO5** Analysing calcium, Iron and micro nutrients

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	1	-	2	-	-	-
CO2	3	-	-	-	-	-	1	-	2	-	-	-
CO3	2	-	-	-	-	-	-	-	2	-	-	-
CO4	3	-	-	-	-	-	-	-	2	-	-	-
CO5	3	-	-	-	-	-	-	-	2	-	-	-

List of Experiments (Any ten experiments):

1. Determination of Hardness of a groundwater sample.
2. Estimation of Dissolved Oxygen
3. Determination of Vitamin-C
4. Conductometric titration of strong acid vs weak base
5. Potentiometry - determination of strong acid –strong base
6. Preparation of a Polymer (Bakelite)
7. Estimation of Calcium in port land Cement
8. Preparation of nano particle by Green Synthesis method.
9. Determination of percentage Moisture content in a coal sample
10. Analysis of Iron in Hematite

Augmented Experiments (Any One experiment to be conducted):

11. Determination of Viscosity of lubricating oil
12. Estimation of micro nutrients by flame photometry method

Reference:

"Vogel's Quantitative Chemical Analysis 6th Edition 6th Edition" Pearson Publications by J. Mendham, R.C. Denney, J.D. Barnes, and B. Sivasankar

ELECTRICAL & ELECTRONICS ENGINEERING LAB**(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)****II Semester**
Course Code:231ES2L01**L** **T** **P** **C**
0 **0** **3** **1.5****Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Analyze the circuits by using KCL, KVL& Superposition theorem to electrical circuits.
- CO2:** Analyze the active and reactive power using one wattmeter method.
- CO3:** Determine the resistance using Wheat stone bridge and Megger.
- CO4:** Analyze the characteristics of diodes and BJT.
- CO5:** Analyze the characteristics of Rectifiers and amplifier.
- CO6:** Examine the operation of logic gates.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	2	-	-	-	-	1	1	-	1
CO2	2	3	1	2	-	-	-	-	1	1	-	1
CO3	2	3	1	1	-	-	-	-	1	1	-	1
CO4	2	3	1	2	-	-	-	-	1	1	-	1
CO5	2	3	1	2	-	-	-	-	1	1	-	1
CO6	2	3	1	2	-	-	-	-	1	1	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	1	-
CO2	1	-
CO3	1	-
CO4	1	-
CO5	1	-
CO6	1	-

PART A: ELECTRICAL ENGINEERING LAB

List of experiments:

1. Verification of KCL and KVL
2. Verification of Superposition theorem
3. Measurement of Power and Power factor using Single-phase wattmeter
4. Measurement of Resistance using Wheat stone bridge
5. Measurement of Insulation Resistance using Megger.

List of Augmented Experiments:

(Any one of the following experiment can be performed)

6. Calculation of Electrical Energy for Domestic Premises.
7. Verification of KCL, KVL and ohm's law using simulation.
8. Magnetization Characteristics of DC shunt Generator.

Reference Books:

1. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, First Edition
2. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co, 2013
3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition

Web Links:

1. <https://nptel.ac.in/courses/108105053>
2. <https://nptel.ac.in/courses/108108076>

PART B: ELECTRONICS ENGINEERING LAB**List of Experiments:**

1. V-I characteristics of PN Junction diode A) Forward bias B) Reverse bias.
2. V-I characteristics of Zener Diode and its application as voltage Regulator.
3. Input & Output characteristics of BJT in CE configuration.
4. Implementation of half wave and full wave rectifiers (ripple factor & waveform analysis)
5. Verification of Truth Table of AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates using ICs.

List of Augmented Experiments:

(Any one of the fallowing experiment can be performed)

6. Input & Output characteristics of BJT in CB configuration.
7. Design and verify Half Adder and Full Adder circuits.

References:

1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.
2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill.
3. R. T. Paynter, Introductory Electronic Devices & Circuits – Conventional Flow Version, Pearson Education.

Web Links:

1. https://www.electronics-tutorials.ws/diode/diode_2.html
2. <http://fourier.eng.hmc.edu/e84/lectures/ch4/node3.html>
3. <http://nptel.ac.in/courses/117103063/11> by Dr. Chitrlekha Mahanta, IIT Guwahati.

COMPUTER PROGRAMMING LAB

(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)

II Semester

L T P C

Course Code: 231ES2L02

0 0 3 1.5

Course Outcomes: After completion of the course the student will be able to

- CO1:** Develop the basic C programs in different environments.
- CO2:** Utilize appropriate control structures, arrays and strings for problem solving.
- CO3:** Develop modular programming using functions.
- CO4:** Apply pointers for dynamic memory allocation and file operations for file handling.
- CO5:** Make use of structures and unions to handle heterogeneous data.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	3	-	1	-	-	-	2	2	-	-
CO2	1	1	3	-	1	-	-	-	2	2	-	-
CO3	1	1	2	-	1	-	-	-	2	2	-	-
CO4	1	1	2	-	1	-	-	-	2	2	-	-
CO5	1	1	2	-	1	-	-	-	2	2	-	-

List of Experiments:

Develop the following programs using ‘C’

Week 1: Explore different platforms

- a. Basic Linux environment and its editors like Vi, Vim & Emacs etc.
- b. Exposure to Turbo C, gcc
- c. Explore to Hacker Rank or any other Online coding platform and compiler environment.
- d. “Hello World” in C
Objective: Learn about the syntax of reading from stdin and writing to stdout.
<https://www.hackerrank.com/challenges/hello-world-c/problem?isFullScreen=true>
- e. Write a simple program to read int, float, char and string using scanf() and display using printf() in all the above given platforms.

Week 2: Basics and Operators

- a. Sum and Difference of 2 numbers
Objective: Learn int and float data types.
<https://www.hackerrank.com/challenges/sum-numbers-c/problem?isFullScreen=true>
- b. Playing with Characters
Objective: Learn how to take a character, a string and a sentence as input in C.
<https://www.hackerrank.com/challenges/playing-with-characters/problem?isFullScreen=true>
- c. Bitwise Operators
Objective: Learn how to work with bits (0,1) and bitwise operators.
<https://www.hackerrank.com/challenges/bitwise-operators-in-c/problem?isFullScreen=true>

- d. Conversion of Fahrenheit to Celsius and vice versa.
- e. Distance travelled by an object.
- f. Calculate Simple interest and compound interest.

Week 3: Operators and Expressions, Variables and Type conversions

- a. Evaluate the following expressions
 - i. $a/b*c-b+a*d/3$
 - ii. $j = (i++) + (++i)$
- b. Square root of a given number.
- c. Find the area of circle, square, rectangle and triangle.
- d. Find the maximum of three numbers using conditional operator.
- e. Take marks of 5 subjects in integers, find the total in integer and average in float.

Week 4: Conditional Statements

- a. Conditional statements in C.
Objective: Understand *if* and *else*.
<https://www.hackerrank.com/challenges/conditional-statements-in-c/problem?isFullScreen=true>
- b. Roots of a Quadratic Equation.
- c. Generate electricity bill.
- d. Simulate a calculator using switch case.
- e. Find the given year is a leap year or not.

Week 5: Loops

- a. “for” Loop in C.
Objective: Learn the usage of the *for* loop.
<https://www.hackerrank.com/challenges/for-loop-in-c/problem?isFullScreen=true>
- b. Sum of the digits of a 5-digit number.
Objective: Learn the usage of while loop and usage of operators - % and /.
<https://www.hackerrank.com/challenges/sum-of-digits-of-a-five-digit-number/problem?isFullScreen=true>
- c. Given number is a prime or not. (Also Prime numbers between a given range.)
- d. Armstrong Number or not.
- e. Palindrome or not.
- f. Printing patterns using Loops.
Objective: Print a pattern of numbers.
<https://www.hackerrank.com/challenges/printing-pattern-2/problem?isFullScreen=true>
- g. Construct a Pyramid pattern.

Week 6: Arrays

- a. 1D Arrays in C
Objective: Print the sum and free the memory where the array is stored.
<https://www.hackerrank.com/challenges/1d-arrays-in-c/problem?isFullScreen=true>
- b. Array reversal
Objective: Working with indices in array
<https://www.hackerrank.com/challenges/reverse-array-c/problem?isFullScreen=true>
- c. Search an element in array (Linear Search)
- d. Find min and max elements in array
- e. Insert an element into array

- f. Eliminate duplicate elements from array
- g. Sorting of elements in an array using Bubble sort

Week 7: 2-D Arrays

- a. Sum of two 2-D arrays
- b. Multiplication of two 2-D arrays
- c. Transpose of a Matrix
- d. Trace of a Matrix
- e. Lower Triangular Matrix

Week 8: Strings

- a. Printing Tokens
Objective: print each word of the sentence in a new line
<https://www.hackerrank.com/challenges/printing-tokens-/problem?isFullScreen=true>
- b. Count number of alphabets (lowercase, uppercase, consonants, vowels) and digits
Objective:
- c. Lowercase to Uppercase, Uppercase to Lowercase, Toggle case, Sentential case
Objective:
- d. Digit Frequency
Objective: find the frequency of each digit in the given string.
<https://www.hackerrank.com/challenges/frequency-of-digits-1/problem?isFullScreen=true>
- e. Find string length, concatenate 2 strings, reverse a string using built-in and without built-in string functions.

Week 9: Functions and Recursion

- a. Functions in C
Objective: Learn simple usage of functions.
<https://www.hackerrank.com/challenges/functions-in-c/problem?isFullScreen=true>
- b. Fibonacci Numbers
Objective: Complete the recursive function.
<https://www.hackerrank.com/challenges/ctci-fibonacci-numbers/problem>
- c. Factorial
Objective: N! (N factorial) using recursion.
<https://www.hackerrank.com/contests/coc-veltech-practice-set-ende/challenges/factorial-using-recursion-1>
- d. Digit Sum
Objective: find the *super digit* of the integer.
<https://www.hackerrank.com/challenges/recursive-digit-sum/problem>
- e. LCM
- f. Calculate the Nth term
Objective: Find the Nth term.
<https://www.hackerrank.com/challenges/recursion-in-c/problem?isFullScreen=true>

Week 10: Pointers

- a. Pointers in C
Objective: learn to implement the basic functionalities of pointers in C.
<https://www.hackerrank.com/challenges/pointer-in-c/problem?isFullScreen=true>
- b. Students Marks Sum

Objective: Learn using Pointers with Arrays and Functions

<https://www.hackerrank.com/challenges/students-marks-sum/problem?isFullScreen=true>

c. Sorting Array of Strings

Objective: sort a given array of strings into lexicographically increasing order or into an order in which the string with the lowest length appears first.

<https://www.hackerrank.com/challenges/sorting-array-of-strings/problem?isFullScreen=true>

d. Find the sum of a 1D array using malloc()

e. Swap two numbers using functions and pointers - call by value and reference.

f. Dynamic Array in C

Objective: Handling requests by a Librarian to place the books in the shelves.

<https://www.hackerrank.com/challenges/dynamic-array-in-c/problem?isFullScreen=true>

Week 11: Structure, Union, typedef, bit-fields and enum

a. Write a C program to find the total, average of n students using structures

b. Boxes through a Tunnel

Objective: Using a structure for transporting some boxes through a tunnel

<https://www.hackerrank.com/challenges/too-high-boxes/problem?isFullScreen=true>

c. Post Transition

Objective: Storing and transferring packages using pointers in structures.

<https://www.hackerrank.com/challenges/post-transition/problem?isFullScreen=true>

d. Copy one structure variable to another structure of the same type.

e. Read student name and marks from the command line and display the student details along with the total.

f. Shift/rotate using bitfields.

Week 12: Files

a. Write text into and read text from a file

b. Write into text and read text from a binary file using fread() and fwrite()

Objective:

c. Copy the contents of one file to another file.

d. Merge two files into the third file using command-line arguments.

e. Find no. of lines, words and characters in a file

Week 13-17: Logic Building – Augmented Experiments (Complete any 2)

13. Variadic functions in C

Objective: Understanding variable number of arguments

<https://www.hackerrank.com/challenges/variadic-functions-in-c/problem?isFullScreen=true>

14. Querying the Document

Objective: representing the words, sentences, paragraphs, and documents using pointers.

<https://www.hackerrank.com/challenges/querying-the-document/problem?isFullScreen=true>

15. Structuring the Document

Objective: Using structure with pointers

<https://www.hackerrank.com/challenges/structuring-the-document/problem?isFullScreen=true>

16. Small Triangles, Large Triangles

Objective: Print sorted by their areas

<https://www.hackerrank.com/challenges/small-triangles-large-triangles/problem?isFullScreen=true>

17. Permutations of Strings

Objective: print all strings permutations in strict lexicographical order

<https://www.hackerrank.com/challenges/permutations-of-strings/problem?isFullScreen=true>

Text Books:

1. Programming for problem solving using C Behrouz A.Forouzan. Richard F.Gilberg.
2. Programming in C, Rema Theraja, Oxford, 2016, 2nd edition

Reference Books:

1. The C Programming Language, Brian W. Kernighan and Dennis M. Ritchie, Prentice-Hall, 1988
2. Computing fundamentals and C Programming, Balagurusamy, E., McGraw-Hill Education, 2008.
3. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
4. Let Us C Yashwanth Kanetkar, Eighth edition, BPB Publications.
5. Programming in C A-Practical Approach Ajay Mittal. Pearson Education

Web Links:

1. <https://www.hackerrank.com/>
2. <https://www.codechef.com/>
3. <https://www.topcoder.com/>
4. <https://code-cracker.github.io/>
5. <https://nptel.ac.in/courses/106105085/2>

NOTE: The Students are expected to complete C Programming with five star badge in Hacker Rank Platform.

Practice Programs:

Write a C program to implement the following,

1. Print the values, address and size of variables of different data types.
2. Add, subtract, divide, multiply the given numbers.
3. Convert Centigrade to Fahrenheit.
4. Swap 2 numbers using 2 , 3 variables .
5. Find the area of the circle.
6. Find the simple interest and compound interest.
7. Convert the distance kms into mts, cms, mms and vice versa
8. Find the result of $(ax+b)/(ax-b)$.
9. Demonstrate arithmetic, assignment, increment/decrement relational ,logical Bitwise and conditional operators.
10. Find the total distance travelled by vehicle in 't' seconds is given by distance = $ut + \frac{1}{2}at^2$ where 'u' and 'a' are the initial velocity (m/sec) and acceleration (m/sec^2). Write C program to find the distance travelled at regular intervals of time given the values of 'u' and 'a'. The program should provide the flexibility to the user to select his own time intervals and repeat the calculations for different values of 'u' and 'a'.
11. Check the given number is even or odd.
12. Find the largest and smallest of 2 numbers and 3 numbers.
13. Find the student grade.
14. Calculate the income tax.
15. Print the given 3 numbers in ascending order.
16. Check the given year is a leap year or not.
17. Find roots of a Quadratic equation.
18. Print the given number in words using Switch statement.
19. Print the colour based on a given character.
20. Print from first 'n' natural numbers (1 2 3 10 & 10 9 8 1).
21. Find the sum of first 'n' natural numbers using do-while loop.
22. Find the squares of N numbers using do - while loop.
23. Find the sum of even and odd numbers & count number of even and odd numbers.
24. Find the factors and factorial of a given number
25. Find whether the given number is prime or not and within a given range.
26. Calculate the sum of the digits of a given number (Eg: 123 $\rightarrow$ 1+2+3=6).
27. Display a given number in reverse order (Eg: 123 $\rightarrow$ 321).
28. Display a given number is a Palindrome or not.
29. Find the given number is Armstrong or not.
30. Find the given number is Perfect or not.
31. Find the given number is Strong or not.
32. Calculate the sum of the digits of a given number upto single digit (Lucky Number)
33. Display the Fibonacci series [Hint: 0 1 1 2 3 5 ...(sum of the consecutive numbers)].
34. Display from 1 to 20 [Eg: $5 * 1 = 5$ $5 * 20 = 100$].

35. Display following format

```

1
1   2
1   2   3
1   2   3   .....   n

```

36. Display following format (Floyd's Triangle)

```

1
2   3
4   5   6

```

37. Display following format

```

1
1   2
1   2   3
.....n
3   2   1
2   1
1

```

38. Generate pyramid structure format

```

          0
        1   0   1
      2   1   0   1   2
    3   2   1   0   1   2   3

```

39. Generate Pascal triangle format

```

          1
        1   1
      1   2   1
    1   3   3   1
  1   4   6   4   1

```

40. Find the value of nCr [Hint : $n!/r!(n-r)!$].

41. Print the sum of the following series. $1 + x + x^2 + x^3 + \dots + x^n$

42. Print the sum of the following series. $1 + x + x^2/2 + x^3/3 + \dots + x^n/n$

43. Print the sum of the following series. $1 + x + x^2/2! + x^3/3! + \dots + x^n/n!$

44. Print the sum of the following series. $X + x^3/3! + \dots + x^n/n!$

45. Find LCM & GCD of given numbers.

46. Convert decimal number to binary number and vice versa

47. Convert Decimal number to Octal number and vice versa.

48. Convert Decimal number to Hexa-Decimal number and vice versa.

49. Read elements into array and display them.

50. Accept 'n' cells into integer array

- i) copy into another array in reverse order.
- ii) accept a number to search and how many times that number is found and print the positions at which it is found.
- iii) accept the delete position and delete that position value from the array.
- iv) accept a value and a position to insert the accepted value into that position.
- v) accept delete value and delete that value from array.
- vi) and place the even numbers in one array and odd numbers in another array.
- vii) count number of even, odd values and display.

- viii) find the Maximum and Minimum number of the array.
 - ix) sort the elements in Ascending order.
 - x) display elements in a right angle triangle format.
51. Read the order of a matrix and read elements into 2-D array and display in a Matrix format. Do the following Operations
- i) Addition ii) Multiplication iii) Transpose iv) Trace v) Display Upper & Lower triangular vi) Symmetric matrix or not vii) Norm of a Matrix
52. Declare and initialize strings in different ways.
[Hint : “hello”, {‘h’, ‘e’, ‘l’, ‘l’, ‘o’, ‘\0’}, {{‘h’}, {‘e’}, {‘l’}, {‘l’}, {‘o’}, {‘\0’}}
53. Read a string from keyboard in different ways.
54. Accept a string and
- i) find its length and display.
 - ii) copy that string into another and display both strings
 - iii) copy that string into another in reverse order and display both strings.
 - iv) concatenate second string at the end of the first string.
 - v) count number of upper case, lower case, digits and special characters.
 - vi) count number of vowels, consonants and special characters.
 - vii) convert into upper case string.[eg: hello → HELLO]
 - viii) convert into lower case.[eg: HELLO → hello]
 - ix) convert into toggle case.[eg: hElLo→HeLlO : upper to lower & lower to upper]
 - x) convert into proper case.[eg: i TeAch cDs → I teach cds]
 - xi) count number of words in string.
 - xii) until we press ctrl+z and count number of lines, words and characters.
 - xiii) check whether that string is Palindrome or not.
 - xiv) display in the format.
- ```

h
h a
h a i
h a
h

```
- xv) insert second string into first string at a given position.
  - xvi) find a substring in each string.
  - xvii) perform sorting of strings and display them.
55. 5 string-handling functions
56. Find one’s and two’s compliment.
57. Perform arithmetic operations using functions.
58. Demonstrate difference between local and global variables using functions.
59. Demonstrate all function prototypes.
60. Demonstrate “Call By Value” and “Call By Reference” in functions.
61. Find Factorial , Fibonacci series , Tower of Hanoi and GCD of a given number using Recursion.
62. Storage classes (auto, extern, static, register).
63. User-Defined header files.
64. Built-in or Standard library functions.
65. Find sum of odd and even series using function with argument and with return value.
66. Write a program to evaluate the equation  $s = \text{sqr}(m) + n()$  using function.
67. Generate Fibonacci series using “with argument and return type”.

68. Find sum of given series by using function with argument and return value  $e = 2$   
 $+ 3/1! - 6/2! + 9/3! - 12/4! \dots$
69. Demonstrate the concept of pointers using
  - i) &(address) operator.
  - ii) malloc() i.e., dynamic allocation
  - iii) printing array elements using arrays and pointers
  - iv) Declare and read elements into array using dynamic pointers.
  - v) pointer variable to access array elements.
  - vi) a pointer to access 2-dimensional arrays.
  - vii) Access 2-dimensional array using array name itself as pointer.
70. Program to sort the string using array of pointers to functions.
71. Command-Line Arguments
72. Demonstrate the concept of Structures
  - i) using arrays.
  - ii) within structures using local and global scope.
  - iii) functions and arrays.
  - iv) pointers and arrays.
  - v) pointers(dynamic memory allocation) as arrays.
  - vi) functions and pointers.
  - vii) arrays, functions and pointers.
  - viii) self-referential structures
  - ix) Unions
  - x) union of structures
  - xi) Unions within Structures.
  - xii) Unions within Unions.
73. Demonstrate the concept of “typedef to define datatypes” and “typedef to define structures”.
74. Demonstrate the concept of Bit fields.
75. Demonstrate the concept of enum (Enumerated datatypes).
76. Demonstrate the concept of creating and storing information in a text file.
77. Demonstrate the concept of reading information from a text file.
78. Demonstrate the concept of appending information in a text file.
79. Demonstrate the concept of copying a file to another file.
80. Demonstrate the concept of Merging two files and write them to another file.
81. Demonstrate the concept of fseek(), ftell() and rewind().

**Links for Practice Programs**

1. <https://www.hackerrank.com/c-practice-programs-1-7>
2. <https://www.hackerrank.com/c-practice-programs-8-14>
3. <https://www.hackerrank.com/c-practice-programs-15-21>
4. <https://www.hackerrank.com/c-practice-programs-22-28>
5. <https://www.hackerrank.com/c-practice-programs-29-39>
6. <https://www.hackerrank.com/c-practice-programs-40-48>
7. <https://www.hackerrank.com/c-practice-programs-49-52>

**ENGINEERING MECHANICS LAB**  
**(Common to CE & ME)**

II Semester

L T P C

Course Code: 231CE2L01

0 0 3 3

**Course Outcomes:** On Completion of the course, the student will be able to

- CO 1:** Verify Triangle Law, Parallelogram Law and Polygon's Law of coplanar-concurrent forces acting on a particle in equilibrium.
- CO 2:** Check the law of moments and conditions of equilibrium of a rigid body under the action of force system.
- CO 3:** Draw the Free body diagram of force system to find the unknown forces and coefficient of friction.
- CO 4:** Determine the Centre of Gravity of Plane lamina.
- CO 5:** Determine the Moment of inertia of Compound pendulum and Flywheel.
- CO 6:** Determine the Acceleration due to gravity using Compound Pendulum.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 3   | 2   | -   | -   | -   | -   | -   | -   | 2   | 1    | -    | 1    |
| CO2   | 3   | 2   | -   | -   | -   | -   | -   | -   | 2   | 1    | -    | 1    |
| CO3   | 3   | 2   | -   | -   | -   | -   | -   | -   | 2   | 1    | -    | 1    |
| CO4   | 3   | 2   | -   | -   | -   | -   | -   | -   | 2   | 1    | -    | 1    |
| CO5   | 3   | 2   | -   | -   | -   | -   | -   | -   | 2   | 1    | -    | 1    |
| CO6   | 2   | 2   | -   | -   | -   | -   | -   | -   | 2   | 1    | -    | 1    |

**List of Experiments:**

1. Verification of Law of Parallelogram of Forces.
2. Verification of Law of Triangle of Forces.
3. Verification of the Law of polygon for coplanar-concurrent forces acting on a particle in equilibrium and to find the value of unknown forces considering particle to be in equilibrium using universal force table.
4. Verification of Law of Moment using Rotation Disc Apparatus and Bell Crank Lever.
5. Verification of the conditions of equilibrium of a rigid body under the action of coplanar non-concurrent, parallel force system with the help of a simply supported beam.
6. Study the systems of pulleys and draw the free body diagram of the system.
7. Determination of coefficient of Static and Rolling Frictions
8. Determination of Centre of Gravity of different shaped Plane Lamina.
9. Determine the Moment of Inertia of the compound pendulum about an axis perpendicular to the plane of oscillation and passing through its centre of mass.
10. Determine the Moment of Inertia of a Flywheel.

11. Find the efficiency of Screw jack.
12. Determine the acceleration due to gravity using a compound pendulum.

**References:**

1. S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., Engineering Mechanics, 5<sup>th</sup> Edition, McGraw Hill Education.
2. Hibbeler R.C., Engineering Mechanics: Statics and Dynamics, 14<sup>th</sup> Edition, Pearson Education, Inc., New Delhi.
3. Beer F.P. and Johnston E.R., Vector Mechanics for Engineers - Volume I - Statics, Volume II - Dynamics, McGraw Hill, New York.

**Web Links:**

1. <https://vlab.amrita.edu/index.php?sub=1&brch=74>
2. <https://www.youtube.com/watch?v=YQUDqfivqd8>
3. <https://www.youtube.com/watch?v=V86OLIC2Hvk>

**NSS/NCC/SCOUTS & GUIDES/COMMUNITY SERVICE**

(Common to CE, EEE, ME, ECE, Min.E, PT &amp; Ag.E)

**II Semester****Course Code:231HS2L03**

|          |          |          |            |
|----------|----------|----------|------------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b>   |
| <b>0</b> | <b>0</b> | <b>1</b> | <b>0.5</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1:** Explain the importance of discipline, character and service motto.
- CO2:** Solve some societal issues by applying acquired knowledge, facts, and techniques.
- CO3:** Explore human relationships by analyzing social problems.
- CO4:** Determine to extend their help for the fellow beings and downtrodden people.
- CO5:** Develop leadership skills and civic responsibilities.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | -   | -   | -   | -   | -   | -   | -   | 2   | -   | 1    | -    | 1    |
| CO2   | -   | -   | -   | -   | -   | 2   | 1   | 1   | 1   | -    | -    | -    |
| CO3   | -   | -   | -   | -   | -   | 2   | -   | -   | 2   | 2    | -    | -    |
| CO4   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 3    | -    | -    |
| CO5   | -   | -   | -   | -   | -   | 1   | 1   | -   | 3   | 3    | -    | -    |

**UNIT I****Orientation**

General Orientation on NSS/NCC/ Scouts &amp; Guides/Community Service activities, careerguidance.

**Activities:**

- Conducting –ice breaking sessions-expectations from the course-knowing personal talents and skills
- Conducting orientations programs for the students –future plans-activities-releasing road map etc.
- Displaying success stories-motivational biopics- award winning movies on societal issues etc.
- Conducting talent show in singing patriotic songs-paintings- any other contribution.

**UNIT II****Nature & Care****Activities:**

- Best out of waste competition.
- Poster and signs making competition to spread environmental awareness.
- Recycling and environmental pollution article writing competition.
- Organising Zero-waste day.
- Digital Environmental awareness activity via various social media platforms.
- Virtual demonstration of different eco-friendly approaches for sustainable living.
- Write a summary on any book related to environmental issues.

**UNIT III****Community Service****Activities:**

- i) Conducting One Day Special Camp in a village contacting village-area leaders- Survey in the village, identification of problems- helping them to solve via media- authorities- experts-etc.
- ii) Conducting awareness programs on Health-related issues such as General Health, Mental health, Spiritual Health, HIV/AIDS,
- iii) Conducting consumer Awareness. Explaining various legal provisions etc.
- iv) Women Empowerment Programmes- Sexual Abuse, Adolescent Health and Population Education.
- v) Any other programmes in collaboration with local charities, NGOs etc.

**Reference Books:**

1. Nirmalya Kumar Sinha & Surajit Majumder, *A Text Book of National Service Scheme* Vol; I, Vidya Kutir Publication, 2021 ( ISBN 978-81-952368-8-6)
2. *Red Book - National Cadet Corps* – Standing Instructions Vol I & II, Directorate General of NCC, Ministry of Defence, New Delhi
3. Davis M. L. and Cornwell D. A., “Introduction to Environmental Engineering”, McGraw Hill, New York 4/e 2008
4. Masters G. M., Joseph K. and Nagendran R. “Introduction to Environmental Engineering and Science”, Pearson Education, New Delhi. 2/e 2007
5. Ram Ahuja. *Social Problems in India*, Rawat Publications, New Delhi.

**General Guidelines:**

1. Institutes must assign slots in the Timetable for the activities.
2. Institutes are required to provide instructor to mentor the students.

**Evaluation Guidelines:**

- Evaluated for a total of 100 marks.
- A student can select 6 activities of his/her choice with a minimum of 01 activity per unit. Each activity shall be evaluated by the concerned teacher for 15 marks, totalling to 90 marks.
- A student shall be evaluated by the concerned teacher for 10 marks by conducting vivavoce on the subject.

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## CONSTITUTION OF INDIA

(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)

**II Semester**

**Course Code:231MC2T01**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>0</b> | <b>0</b> |

**Course Outcomes:**

At the end of the Course, Student will be able to:

- CO1** Explain historical background of the constitution making and its importance for building a democratic India
- CO2** Compare the functioning of three wings of the government i.e., executive, legislative and judiciary
- CO3** Interpret the value of the fundamental rights and duties for becoming good citizen of India
- CO4** Compare the decentralization of power between central, state and local self-government
- CO5** Extend the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.
- CO6** Understand the Electoral Process and Amendment procedure.

**Mapping of course outcomes with program outcomes:**

| CO/PO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | -   | -   | -   | -   | -   | 3   | -   | 1   | 2   | -    | -    | -    |
| <b>CO2</b> | -   | -   | -   | -   | -   | 2   | -   | 1   | 3   | -    | -    | -    |
| <b>CO3</b> | -   | -   | -   | -   | -   | 3   | -   | 2   | 3   | -    | -    | -    |
| <b>CO4</b> | -   | -   | -   | -   | -   | 3   | -   | 2   | 1   | -    | -    | -    |
| <b>CO5</b> | -   | -   | -   | -   | -   | 2   | -   | 1   | 3   | -    | -    | -    |
| <b>CO6</b> | -   | -   | -   | -   | -   | 3   | -   | 1   | 2   | -    | -    | -    |

**UNIT-I**

**Introduction to Indian Constitution:** Constitution' meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

**UNIT-II**

**Union Government and its Administration Structure of the Indian Union:** Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions.

**UNIT-III**

State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organization, Structure and Functions.

**UNIT-IV**

Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation PachayatiRaj: Functions PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy.

**UNIT-V**

**Election Commission:** Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission, Functions of Commissions for the welfare of SC/ST/OBC and women.

**Text Books:**

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd. NewDelhi.
2. Subash Kashyap, Indian Constitution, National BookTrust.

**Reference Books:**

1. J.A. Siwach, Dynamics of Indian Government & Politics.
2. D.C. Gupta, Indian Government andPolitics.
3. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication).
4. J.C. Johari, Indian Government and PoliticsHans.

**Web Links:**

1. [nptel.ac.in/courses/109104074/8](http://nptel.ac.in/courses/109104074/8)
2. [nptel.ac.in/courses/109104045/](http://nptel.ac.in/courses/109104045/)
3. [nptel.ac.in/courses/101104065/](http://nptel.ac.in/courses/101104065/)
4. [www.hss.iitb.ac.in/en/lecture-details](http://www.hss.iitb.ac.in/en/lecture-details)
5. [www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution](http://www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution)

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**COGNITIVE ENGLISH FOR ENGINEERS - I****(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)****II Semester****Course Code: 231MC2T02**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>0</b> | <b>2</b> | <b>0</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1: Understand the different aspects of the English language proficiency with emphasis on LSRW skills.
- CO2: Apply communication skills through various language learning activities
- CO3: Analyze the English speech sounds, stress, rhythm, intonation and syllable division for better listening and speaking comprehension.
- CO4: Evaluate and exhibit professionalism in participating in debates and group discussions.
- CO5: Develop the capacity to use various writing forms to achieve their professional needs.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 3    | -    | -    |
| CO2   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 3    | -    | -    |
| CO3   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 3    | -    | -    |
| CO4   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 3    | -    | -    |
| CO5   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 3    | -    | -    |

**List of Topics:**

1. Talent – Discuss ability and achievement, Sports activities and issues, suggestions, write a description of data
2. Life Lessons – Discuss events that changed your life, describe rules, photos, write an email to apply for work.
3. Chance – Discuss possible future events, Prepare for a job interview, write an argument for and against an idea.
4. Around the Globe – Discuss choices, Changes, Introduce request and say you are grateful, Write a travel blog.

**Suggested Software:**

- Walden Infotech
- Young India Films
- Cambridge Empower

**Reference Books:**

1. Raman Meenakshi, Sangeeta-Sharma. *Technical Communication*. Oxford University Press.2018.
2. Taylor Grant: *English Conversation Practice*, Tata McGraw-Hill Education India,2016
3. Hewing's, Martin. *Cambridge Academic English* (B2). CUP, 2012.
4. J. Sethi & P.V. Dhamija. *A Course in Phonetics and Spoken English*, (2<sup>nd</sup> Ed),Kindle, 2013
5. Cambridge Empower – Second Edition B2 Level

**Web Links:****Spoken English:**

1. [www.esl-lab.com](http://www.esl-lab.com)
2. [www.englishmedialab.com](http://www.englishmedialab.com)
3. [www.englishinteractive.net](http://www.englishinteractive.net)
4. <https://www.britishcouncil.in/english/online>
5. <http://www.letstalkpodcast.com/>
6. <https://www.youtube.com/c/EnglishClass101/featured>
7. [www.cambridgeone.org](http://www.cambridgeone.org)

**Voice & Accent:**

1. <https://www.youtube.com/user/letstalkaccent/videos>
2. <https://www.youtube.com/c/EngLanguageClub/featured>
3. [https://www.youtube.com/channel/UC\\_OskgZBoS4dAnVUgJVexc](https://www.youtube.com/channel/UC_OskgZBoS4dAnVUgJVexc)
4. [www.cambridgeone.org](http://www.cambridgeone.org)

## NUMERICAL METHODS AND STATISTICAL TECHNIQUES (CIVIL ENGINEERING)

**III Semester**

**Course Code: 231BS3T01**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:**

**At the end of the Course, Student will be able to:**

- CO1:** Apply numerical methods to find the solution of equations and interpolate the polynomials.
- CO2:** Apply numerical methods to find the solution initial value problems and integrations.
- CO3:** Apply discrete and continuous probability distributions.
- CO4:** Compute the components of a classical hypothesis test.
- CO5:** Apply the statistical inferential methods based on large and small sampling tests

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 2   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | -     | -     |
| CO 2   | -     | -     |
| CO 3   | -     | -     |
| CO 4   | -     | -     |
| CO 5   | -     | -     |

### **Unit – I: Iterative Methods:**

Introduction – Solutions of algebraic and transcendental equations: Bisection method – Secant method – Method of false position – Iteration method – Newton-Raphson method (One variable and simultaneous Equations) Interpolation: Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula.

### **Unit – II:**

#### **Numerical Integration:**

Trapezoidal rule– Simpson's 1/3rd and 3/8th rule.

**Solution of ODE:** Solution of initial value problems by Taylor's series– Picard's method of successive approximations– Euler's method –Runge Kutta method (second and fourth order) – Milne's Predictor and Corrector Method.

**Unit – III: Probability and Distributions:**

Baye's theorem – Random variables – Discrete and Continuous random variables – Distribution functions – Probability mass function, Probability density function and Cumulative distribution functions – Mathematical Expectation and Variance – Binomial, Poisson, Uniform and Normal distributions.

**Unit – IV: Sampling Theory:**

Introduction – Population and Samples – Sampling distribution of Means and Variance (definition only) – Point and Interval estimations – Maximum error of estimate – Central limit theorem (without proof) – Estimation using t,  $\chi^2$ , F-distributions.

**Unit – V: Tests of Hypothesis:**

Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors – Level of significance – One tail and two-tail tests – Test of significance for large samples and Small Samples: Single and difference means – Single and two proportions – Student's t- test,  $\chi^2$  -test, F-test.

**Text Books:**

1. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. Miller and Freund's, Probability and Statistics for Engineers, 7/e, Pearson

**Reference Books:**

1. M. K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publications
2. S. C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications.

**Web links:**

1. <https://archive.nptel.ac.in/courses/111/107/111107105/>
2. <http://www.infocobuild.com/education/audio-video-courses/mathematics/NumericalAnalysis-IIT-Madras/lecture-21.html>
3. <https://archive.nptel.ac.in/courses/111/105/111105090/>

**SURVEYING**

**III Semester**  
**Course Code: 231ES3T01**

**L T P C**  
**3 0 0 3**

**Course Outcomes:**

**At the end of the Course, Student will be able to:**

- CO 1** Apply the principle and methods of surveying and measuring of horizontal and vertical- distances and angles
- CO 2** Identify the source of errors and rectification methods
- CO 3** Apply surveying principles to determine areas and volumes
- CO 4** Setting out curves and using modern surveying equipment
- CO 5** Apply the basics of Photogrammetry Surveying in field

**Mapping of Course Outcomes with Program Outcomes**

| CO/PO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 3   | 3   | -   | 2   | 1   | 3   | -   | 3   | 3   | 3    | -    | 1    |
| <b>CO2</b> | 2   | 2   | -   | 2   | 2   | 2   | -   | 2   | 2   | 2    | -    | 2    |
| <b>CO3</b> | 3   | 1   | -   | 1   | 1   | 1   | -   | 1   | 2   | 2    | -    | 2    |
| <b>CO4</b> | 2   | 3   | -   | 3   | 3   | 1   | -   | 1   | 1   | 1    | -    | 2    |
| <b>CO5</b> | 2   | 1   | -   | 3   | 3   | 1   | -   | 1   | 1   | 1    | -    | 2    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | 1     | -     |
| <b>CO 2</b> | 2     | -     |
| <b>CO 3</b> | 3     | -     |
| <b>CO 4</b> | 1     | -     |
| <b>CO 5</b> | 3     | -     |

**UNIT – I Introduction and Basic Concepts**

**Introduction and Basic Concepts:** Introduction, Objectives, classification and principles of surveying, Surveying accessories. Introduction to Compass, leveling and Plane table surveying.

**Linear distances-** Approximate methods, Direct Methods- Chains- Tapes, ranging, Tape corrections.

**Prismatic Compass-** Bearings, included angles, Local Attraction, Magnetic Declination, and dip –systems and W.C.B and Q.B systems of locating bearings.

**UNIT – II Levelling, Contouring and Areas**

**Leveling-** Types of levels, methods of levelling, and Determination of levels, Effect of Curvature of Earth and Refraction.

**Contouring-** Characteristics and uses of Contours, methods of contour surveying.

**Areas -** Determination of areas consisting of irregular boundary and regular boundary.

**Volumes -** Determination of volume of earth work in cutting and embankments for level section, capacity of reservoirs.

### **UNIT – III Theodolite surveying & Traversing**

**Theodolite Surveying:** Types of Theodolites, temporary adjustments, measurement of horizontal angle by repetition method and reiteration method, measurement of vertical Angle, Trigonometrical leveling when base is accessible and inaccessible.

**Traversing:** Methods of traversing, traverse computations and adjustments, Introduction to Omitted measurements.

### **UNIT – IV Curves & Modern Survey Methods**

**Curves:** Types of curves and their necessity, elements of simple, compound, reverse curves. Introduction to Tacheometric Surveying.

**Modern Surveying Methods:** Principle and types of E.D.M. Instruments, Total station- advantages and Applications. Introduction to Global Positioning System. Introduction to Drone survey and LiDAR Survey (Light Detection and Ranging).

### **UNIT – V Photogrammetry Surveying:**

Introduction, Basic concepts, perspective geometry of aerial photograph, relief and tilt displacements, terrestrial photogrammetry, flight planning; Stereoscopy, ground control extension for photographic mapping- aerial triangulation, radial triangulation, methods; photographic mapping- mapping using paper prints, mapping using stereo-plotting instruments, mosaics, map substitutes.

### **Text Books:**

1. Surveying (Vol 1& 2) by Duggal S K, Tata McGraw Hill Publishing Co.Ltd. New Delhi, 5<sup>th</sup> edition, 2019.
2. Textbook of Surveying by C Venkatramaiah , Universities Press 1<sup>st</sup> Edition.

### **Reference Books:**

1. Surveying (Vol – 1, 2, 3), by B. C. Punmia, Ashok Kumar Jain and Arun Kumar Jain - Laxmi Publications (P) Ltd., New Delhi, 18<sup>th</sup> edition 2024.
2. Plane Surveying and Higher Surveying by Chandra A M, New age, International, PVT. Ltd, publishers, New Delhi, 3<sup>rd</sup> Edition.

### **Web links:**

1. <https://nptel.ac.in/courses/105107122>
2. <https://archive.nptel.ac.in/courses/105/107/105107158/>
3. <https://archive.nptel.ac.in/courses/105/104/105104100/>
4. <https://archive.nptel.ac.in/courses/105/107/105107218/>



## STRENGTH OF MATERIALS

**III Semester**

**Course Code: 231CE3T01**

**L T P C**

**3 0 0 3**

**Course Outcomes:**

**At the end of completion of the course, the student will be able to**

- CO 1** Demonstrate the relationships between loads, member forces, deformations, material stresses and strains in structural members.
- CO 2** Build the shear force, bending moment diagram of beams under varying load and support conditions.
- CO 3** Determine the flexural and shear stresses in beams subjected to bending moment.
- CO 4** Analyze the deflections due to various loading conditions.
- CO 5** Determine the load carrying capacity of columns

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 3   | 2   | -   | 2   | -   | -   | -   | -   | -   | 2    | 1    | 3    |
| <b>CO2</b> | 2   | 1   | -   | 1   | -   | -   | -   | -   | -   | 1    | 1    | 2    |
| <b>CO3</b> | 2   | 2   | -   | 1   | -   | -   | -   | -   | -   | 2    | 1    | 2    |
| <b>CO4</b> | 1   | 2   | -   | 1   | -   | -   | -   | -   | -   | 2    | 1    | 1    |
| <b>CO5</b> | 2   | 1   | -   | 2   | -   | -   | -   | -   | -   | 1    | 1    | 2    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | 3     | 1     |
| <b>CO 2</b> | 3     | 1     |
| <b>CO 3</b> | 3     | 2     |
| <b>CO 4</b> | 3     | 2     |
| <b>CO 5</b> | 3     | 2     |

**UNIT - I: Simple Stresses and Strains:**

Elasticity and plasticity — Types of stresses and strains — Hooke's law — Factor of safety, Poisson's ratio - Relationship between Elastic constants — Bars of varying section — stresses in composite bars.

**UNIT - II: Shear Force and Bending Moment:**

Definition of beam — Types of beams — Concept of shear force and bending moment — Point of contra flexure — Relation between S.F., B.M and rate of loading at a section of a beam; S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed loads, uniformly varying loads, partial uniformly distributed loads, couple and combination of these loads.

**UNIT - III: Flexural and Shear Stresses:**

**Flexural Stresses:** Theory of simple bending — Assumptions — Derivation of bending equation, Neutral axis — Determination of bending stresses — section modulus of rectangular and circular sections (Solid and Hollow), I, T, Angle and Channel sections — Design of simple beams

**Shear Stresses:** Derivation of formula — Shear stress distribution across various beam sections like rectangular, circular, I, T Angle sections. Torsion – circular shafts only.

**UNIT - IV: Deflection of Beams:**

Double integration and Macaulay's methods — Determination of slope and deflection for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed loads, uniformly varying loads, partial uniformly distributed loads, couple and combination of these loads. Mohr's theorems — Moment area method — application to simple cases of cantilever.

**UNIT - V: Columns and Shells**

**Columns:** Introduction – Classification of columns – Axially loaded compression members – Euler's crippling load theory – Derivation of Euler's critical load formulae for various end conditions – Equivalent length – Slenderness ratio – Euler's critical stress – Limitations of Euler's theory – Rankine – Gordon formula – Eccentric loading and Secant formula – Prof. Perry's formula.

**Thin and Thick cylindrical shells** — Derivation of formula for longitudinal and circumferential stresses — hoop, longitudinal and volumetric strains — changes in diameter, and volume of thin cylinders. Lames theory for thick cylinders, Derivation of Lames formulae, distribution of hoop and radial stresses across the thickness, compound cylinders- distribution of stresses

**Textbooks:**

1. Strength of Materials by R. K. Bansal, Lakshmi Publications, 16<sup>th</sup> Edition, 2022.
2. Strength of Materials by B. S. Basavarajaiah and P. Mahadevappa, Universities Press 3<sup>rd</sup> Edition.
3. Strength of Materials by J.K. Gupta and S.K. Gupta, Cengage publications 2<sup>nd</sup> edition, 2024.

**References Books:**

1. Advanced Mechanics of Solids, L.S Srinath, McGraw Hill Education, 3rd Edition
2. Strength of Materials - Fundamentals and Applications, T.D.Gunneswara Rao and Mudimby Andal, Cambridge University Press, 1st Edition.

**Web links:**

1. <http://nptel.ac.in/courses/105105108/2>
2. <http://www.aboutcivil.org/solid-mechanics.html>
3. <https://accessengineeringlibrary.com/maps/strength-of-materials>
4. <https://lecturenotes.in/subject/260/strength-of-materials-som>

## FLUID MECHANICS

**III Semester**  
**Course Code: 231CE3T02**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

**On Completion of the course, the students will be able to**

- CO1** Analyse and differentiate between the fundamental properties of fluids and solids
- CO2** Apply the laws of fluid statics and concepts of buoyancy
- CO3** Classify different types of fluid flow and analyze fluid motion using concepts
- CO4** Apply the Principle of conservation of energy for flow measurement.
- CO5** Analyse the losses in pipes and discharge through pipe network.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 2   | 1   | -   | -   | -   | 1   | -   | -   | 1   | -    | 1    | 1    |
| <b>CO2</b> | 2   | 2   | -   | -   | -   | 1   | -   | -   | 2   | -    | 2    | 1    |
| <b>CO3</b> | 2   | 1   | -   | -   | -   | 2   | -   | -   | 1   | -    | 1    | 1    |
| <b>CO4</b> | 2   | 1   | -   | -   | -   | 1   | -   | -   | 1   | -    | 1    | 1    |
| <b>CO5</b> | 2   | 2   | -   | -   | -   | 1   | -   | -   | 2   | -    | 2    | 2    |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | 1     | -     |
| <b>CO 2</b> | 1     | -     |
| <b>CO 3</b> | 1     | -     |
| <b>CO 4</b> | 1     | -     |
| <b>CO 5</b> | 1     | -     |

### UNIT – I : Basic concepts and definitions:

Distinction between a fluid and a solid; Density, Specific weight, Specific gravity, Kinematic and dynamic viscosity; Variation of viscosity with temperature, Newton law of viscosity; Vapor pressure, Boiling point, Surface tension, Capillarity, Bulk modulus of elasticity, Compressibility

### UNIT – II : Fluid statics:

Fluid Pressure: Pressure at a point, Pascal's law, pressure variation with temperature, density and altitude. Piezometer, U-Tube Manometer, Single Column Manometer, U Tube Differential Manometer. Pressure gauges, Hydrostatic pressure and force: horizontal, vertical and inclined surfaces. Buoyancy and stability of floating bodies

**UNIT – III: Fluid kinematics:**

Classification of fluid flow: steady and unsteady flow; uniform and non-uniform flow; laminar and turbulent flow; rotational and irrotational flow; compressible and incompressible flow; ideal and real fluid flow; one-, two- and three-dimensional flows; Stream line, path line, streak line and stream tube; stream function, velocity potential function. One, two and three - Dimensional continuity equations in Cartesian coordinates.

**UNIT – IV: Fluid Dynamics:**

Surface and body forces; Equations of motion - Euler's equation; Bernoulli's equation – Derivation; Energy Principle; Practical applications of Bernoulli's equation : Venturimeter, orifice meter and Pitot tube; Momentum principle; Forces exerted by fluid flow on pipe bend; Vortex Flow – Free and Forced; Definitions of Reynolds Number, Froude Number, Mach Number, Weber Number and Euler Number.

**UNIT – V: Analysis of Pipe Flow:**

Energy losses in pipelines; Darcy – Weisbach equation; Minor losses in pipelines; Hydraulic Grade Line and Total Energy Line; Concept of equivalent length – Pipes in Parallel and Series.

**Textbooks:**

1. P. M. Modi and S. M. Seth, Hydraulics and Fluid Mechanics, Standard Book House. 2019.
2. K. Subrahmanya, Theory and Applications of Fluid Mechanics, Tata McGraw Hill, 2<sup>nd</sup> edition 2019.

**Reference Books:**

1. R. K. Bansal, A text of Fluid mechanics and hydraulic machines, Laxmi Publications (P) Ltd., New Delhi 11<sup>th</sup> edition, 2024.
2. Introduction to Fluid Mechanics & Fluid Machines by S K Som, Gautam Biswas, S Chakraborty Tata McGraw Hill, 3<sup>rd</sup> edition

**Web links:**

1. <https://archive.nptel.ac.in/courses/112/105/112105269/>
2. <https://nptel.ac.in/courses/112104118>
3. <https://nptel.ac.in/courses/105103192>

## BUILDING MATERIALS AND CONSTRUCTION

**III Semester**
**Course Code: 231CE3T03**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:**
**At the end of the Course, Student will be able to:**

- CO 1:** Explain the sources, properties and applications of common building materials.
- CO 2:** Demonstrate the properties of different materials and carry out various tests on cement and concrete.
- CO 3:** Illustrate different types of brick and stone masonry.
- CO 4:** Choose different types of structural components for constructions.
- CO 5:** Examine the concept of finishings.

**Mapping of course outcomes with program outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO1</b> | 2    | -    | -    | -    | -    | 2    | 2    | -    | -    | -     | -    | -    |
| <b>CO2</b> | 2    | -    | -    | -    | -    | 2    | 2    | -    | -    | -     | -    | 1    |
| <b>CO3</b> | 3    | -    | -    | -    | -    | 3    | 2    | -    | -    | -     | -    | 1    |
| <b>CO4</b> | 3    | -    | -    | -    | -    | 3    | 2    | -    | -    | -     | -    | 1    |
| <b>CO5</b> | 2    | -    | -    | -    | -    | 2    | 2    | -    | -    | -     | -    | 1    |

**Mapping of course outcomes with program Specific Outcomes:**

| CO / PSO   | PSO 1 | PSO 2 |
|------------|-------|-------|
| <b>CO1</b> | 1     | 1     |
| <b>CO2</b> | 1     | 1     |
| <b>CO3</b> | 2     | 2     |
| <b>CO4</b> | 2     | 2     |
| <b>CO5</b> | 1     | 1     |

**UNIT-I: Stones, Bricks and Tiles**

Properties of building stones – relation to their structural requirements, classification of stones – stone quarrying – precautions in blasting, dressing of stone, Aggregates -Classification of aggregate- tests conducted on aggregate. Composition of good brick

earth, various methods of manufacturing of bricks. Tests for good bricks as per IS code, including field tests, special forms of Bricks and their uses. Characteristics of good tile - manufacturing methods, types of tiles. Special materials like Gypsum, Glass, Bituminous materials and Recycled materials.

**UNIT-II: Lime and Cement**

Lime: Various ingredients of lime – Constituents of lime stone – classification of lime – various methods of manufacture of lime.

Cement: Portland cement- Chemical Composition – Hydration, setting and fineness of cement. Various types of cement and their properties. Various field and laboratory tests for Cement. Various ingredients of cement concrete and their importance – various tests for concrete.

### **UNIT-III: Masonry and Timber**

Types of masonry, English and Flemish bonds, Rubble and Ashlar Masonry. Cavity and partition walls.

Wood: Structure – Properties- Seasoning of timber- Classification of various types of woods used in buildings- Defects in timber. Wood based Products: Veneers, Plywood and its types. Alternative materials for wood – Galvanized Iron, Fiber Reinforced Plastics, Steel, Aluminum.

### **UNIT-IV: Building Components**

Lintels, arches, vaults, stair cases – types. Different types of floors – Concrete, Mosaic, and Terrazzo floors, Pitched, flat roofs. Lean to roof, Coupled Roofs. Trussed roofs – King and Queen Post Trusses. R.C.C Roofs, Madras Terrace and Pre-fabricated roofs.

### **UNIT-V: Finishings**

Damp Proofing and Water Proofing Materials and uses – Plastering Pointing, white washing and distempering.

Paints: Constituents of a paint – Types of paints – Painting of new/old wood- Varnish. Form Works and Scaffoldings.

### **Text Books:**

1. Engineering Materials, Rangwala, Charotar Publications.
2. Building Materials, B. C. Punmia, Laxmi Publications private ltd, Eleventh Edition.

### **Reference Books:**

1. Building Materials, S.K. Duggal, New Age International Publishers, Fourth Edition.
2. Building Materials, P. C. Verghese, PHI learning (P) ltd, Second Edition.

### **Web Links:**

1. <http://www.sciencedirect.com/science/journal/09500618?sdc=1>
2. <http://nptel.ac.in/courses/105102088/>
3. <https://theconstructor.org/>
4. <https://ondoc.logand.com/d/4061/pdf>

**SURVEYING LAB****III Semester**

|          |          |          |            |
|----------|----------|----------|------------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b>   |
| <b>0</b> | <b>0</b> | <b>3</b> | <b>1.5</b> |

**Course Code: 231CE3L01****Course Outcomes:****At the end of the Course, Student will be able to:****CO1:** Handle various linear and angular measuring instruments**CO2:** Measure the linear and angular measurements**CO3:** Calculate the area and volume by interpreting the data obtained from surveying activities**CO4:** Handle modern equipment such as total station**CO5:** Prepare field notes from survey data**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO1</b> | 2    | 2    | -    | 2    | 1    | -    | -    | -    | 3    | 2     | 2    | 2    |
| <b>CO2</b> | 2    | 2    | -    | 2    | 1    | -    | -    | -    | 2    | 3     | 3    | 2    |
| <b>CO3</b> | 2    | 2    | -    | 2    | 1    | -    | -    | -    | 3    | 2     | 2    | 2    |
| <b>CO4</b> | 1    | 2    |      |      | 3    | -    | -    | -    | 2    | 2     | 2    | 1    |
| <b>CO5</b> | 2    | 1    |      |      | -    | -    | -    | -    | 2    | 2     | 2    | 1    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | 2     | -     |
| <b>CO 2</b> | 2     | -     |
| <b>CO 3</b> | 2     | -     |
| <b>CO 4</b> | 1     | -     |
| <b>CO 5</b> | 1     | -     |

**List of Experiments:**

1. Chain survey of road profile with offsets in case of road widening.
2. Determination of distance between two inaccessible points by using compass.
3. Plane table survey; finding the area of a given boundary by the method of Radiation
4. Fly levelling: Height of the instrument method (differential leveling).
5. Fly levelling: Rise and fall method.
6. Theodolite survey: determining the horizontal and vertical angles by the method of repetition method
7. Theodolite survey: finding the distance between two in accessible points.
8. Theodolite survey: finding the height of far object.
9. Determination of area perimeter using total station.
10. Determination of distance between two inaccessible point by using total station.

**List of Augmented Experiments (Any 2 out of 3):**

11. Setting out a curve
12. Determining the levels of contours
13. To find the height and distance problem using tacheometric principles (Tacheometric survey)

**Reference Books:**

1. Surveying (Vol No.1, 2 &3), B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, Laxmi Publications (P) Ltd.
2. Advance Surveying, Satish Gopi, R. Sathi Kumar and N. Madhu, Pearson Publications Jan 12.
3. Plane Surveying, Alak de, S. Chand & Company.

**Web Links:**

1. <http://www.nptelvideos.in/2012/11/surveying.html>
2. <http://nptel.ac.in/courses/105107122/home.htm>
3. <http://nptel.ac.in/courses/105107158/20>
4. [https://onlinecourses.nptel.ac.in/noc18\\_ce03/unit?unit=38&lesson=42](https://onlinecourses.nptel.ac.in/noc18_ce03/unit?unit=38&lesson=42)
5. [https://onlinecourses.nptel.ac.in/noc18\\_ce03/unit?unit=46&lesson=52](https://onlinecourses.nptel.ac.in/noc18_ce03/unit?unit=46&lesson=52)



## STRENGTH OF MATERIALS LAB

III Semester

**L T P C**  
**0 0 3 1.5**

**Course Code: 231CE3L02**

**Course Outcomes:**

**Upon the successful completion of this course, the students will able to:**

- CO1:** Develop the stress-strain relationship for steel specimen.
- CO2:** Determine modulus of rigidity of spring.
- CO3:** Determine the Brinell & Rockwell hardness number of the given specimen
- CO4:** Determine the impact resistance of steel specimen by charpy & izod tests.
- CO5:** Determine the young's modulus of beam material from elastic curve of a beam.
- CO6:** Determine the Compressive and shear strength of a specimen.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 2    | 2    | -    | -    | 3    | -    | -    | -    | 2    | 2     | 2    | -    |
| CO2   | 3    | 2    | -    | -    | 3    | -    | -    | -    | 2    | 2     | 2    | -    |
| CO3   | 3    | 2    | -    | -    | 3    | -    | -    | -    | 2    | 2     | 2    | -    |
| CO4   | 3    | 2    | -    | -    | 3    | -    | -    | -    | 2    | 2     | 2    | -    |
| CO5   | 3    | 2    | -    | -    | 3    | -    | -    | -    | 2    | 2     | 2    | -    |
| CO6   | 3    | 2    | -    | -    | 3    | -    | -    | -    | 2    | 2     | 2    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | -    | 3    |
| CO2    | -    | 3    |
| CO3    | -    | 3    |
| CO4    | -    | 3    |
| CO5    | -    | 2    |
| CO6    | -    | 2    |

**List of Experiments:**

1. To estimate the of mechanical properties of Mild Steel specimen under Tensile load by Direct Tension.
2. To estimate of Young's modulus of different beams of simply supported beams.
3. To estimate Young's modulus of cantilever beam.
4. To determine of Rigidity modulus of mild steel specimen by performing Torsion test.
5. To determine the Brinell & Rockwell hardness number of the given Specimen.
6. To determine the spring properties (stiffness and rigidity modulus) under Tensile and compressive loads.

7. To find the Compressive strength of given wood or concrete.
8. To find the impact strength of mild steel specimen by performing IZOD And Charpy Impact test
9. To determine the ultimate shear strength of mild steel specimen test.
10. To find the strain of given sample by using electrical resistance strain gauge.
11. To determine Young's modulus of different continuous beams.
12. To study non destructive testing methods on various materials (Demonstration).

**List of Augmented Experiments:**

(Any two of the following experiments can be performed)

13. To compare compressive strength of clay brick and reinforced cement Concrete cube.
14. To verify of Maxwell's Reciprocal theorem on beams.
15. To perform shear test on given specimen.

**Reference Books:**

1. Strength of Materials, Ramamrutham, 6th edition.
2. Strength of materials, R.Subrahmanyam, Oxford university press, 3rd edition.

**Web Links:**

1. <http://nptel.ac.in/courses/105105108/2>
2. <http://www.citchennai.edu.in/wp-content/uploads/2015/02/SOM.pdf>
3. [http://www.ace-edu.in/wp-content/uploads/2017/02/LM\\_SomLab.pdf](http://www.ace-edu.in/wp-content/uploads/2017/02/LM_SomLab.pdf)
4. <https://home.iitm.ac.in/kramesh/Strength%20of%20Materials%20Laboratory%20Manual.pdf>

## BUILDING PLANNING AND DRAWING

**III Semester**

**Course Code: 231CE3S01**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>1</b> | <b>2</b> | <b>2</b> |

### Course Outcomes:

Upon successful completion of this course the students will be able to:

**CO 1:** Plan various buildings as per the building by-laws.

**CO 2:** Distinguish the relation between the plan, elevation and cross-section and identify the form and functions among the buildings.

**CO 3:** Draw signs and bonds

**CO 4:** Draw different building units

**CO 5:** Learn the skills of drawing building elements and plan the buildings as per requirements.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 1    | 1    | 2    | -    | -    | 3    | 3    | 2    | -    | 2     | 2    | 2    |
| CO2   | 1    | 1    | 2    | -    | -    | 3    | 2    | -    | -    | 2     | 1    | 1    |
| CO3   | 1    | 1    | 2    | -    | -    | 3    | 3    | 2    | -    | 2     | 2    | 2    |
| CO4   | 1    | 1    | 2    | -    | -    | 3    | 3    | 2    | -    | 2     | 2    | 2    |
| CO5   | 1    | 1    | 2    | -    | -    | 3    | 3    | 2    | -    | 2     | 2    | 2    |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | 3     | -     |
| CO 2   | -     | -     |
| CO 3   | 3     | 1     |
| CO 4   | 3     | 1     |
| CO 5   | 3     | 1     |

### List of Experiments:

1. Detailing & Drawing of Sign Conventions.
2. Detailing & Drawing of English Bond.
3. Detailing & Drawing of Flemish Bond.
4. Detailing & Drawing of Doors.
5. Detailing & Drawing of Windows.
6. Detailing & Drawing of Ventilators & Roofs.
7. Drawing of Line Diagram of Residential Buildings by using Building Bye- Laws.
8. Drawing of Plan, Elevation & Section from line diagram for a single Storey Building.
9. Drawing of Plan, Elevation & Section for Hospital Building.
10. Drawing of Plan, Elevation & Section for Industrial Building.

**Text Books:**

1. Planning, designing and Scheduling, Gurcharan Singh and Jagdish Singh
2. Building planning and drawing by M. Chakraborti.

**Reference Books:**

1. National Building Code (Volume- I & II).
2. Principles of Building Drawing, M G Shah and C M Kale, Trinity Publications, New Delhi.

**Web Links:**

1. <https://sites.google.com/a/mitr.iitm.ac.in/iitmcivil/ce2050>
2. <http://www.crcpress.com/>
3. <http://www.cadmatesoftware.com/>

## UNIVERSAL HUMAN VALUES

**III Semester**

**L   T   P   C**  
**2   1   0   0**

**Course Code: 231MC3T04**

**Course Outcomes:** On Completion of the course, the student will be able to

- CO 1:** Understand the core principles and significance of Universal Human Values
- CO 2:** Analyse the relationship between individual values, cultural norms, and societal expectations
- CO 3:** Evaluate the role of empathy, compassion, and self-awareness in fostering positive relationships and building strong communities.
- CO 4:** Apply Universal Human Values to resolve conflicts, promote social justice, and address global challenges.
- CO 5:** Demonstrate ethical decision-making and problem-solving skills in personal and professional contexts.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | -    | -    | -    | -    | -    | -    | 2    | 1    | 1    | -     | -    | -    |
| CO2   | -    | -    | -    | -    | -    | -    | 2    | 1    | 1    | -     | -    | -    |
| CO3   | -    | -    | -    | -    | -    | -    | 2    | 1    | 1    | -     | -    | -    |
| CO4   | -    | -    | -    | -    | -    | -    | 2    | 1    | 1    | -     | -    | -    |
| CO5   | -    | -    | -    | -    | -    | -    | 2    | 1    | 1    | -     | -    | -    |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | -     | -     |
| CO 2   | -     | -     |
| CO 3   | -     | -     |
| CO 4   | -     | -     |
| CO 5   | -     | -     |

#### UNIT I: Introduction to value education:

Right Understanding, Relationship and Physical Facility, Understanding Value Education, self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human, Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations

**Tutorial:** Practice Session PS1 Sharing about Oneself, Practice Session PS2 Exploring Human Consciousness, Practice Session PS3 Exploring Natural Acceptance

#### UNIT II: Harmony in the Human Being:

Understanding Human being as the Co-existence of the self and the body, Understanding Human being as the Co-existence of the self and the body, the body as an Instrument of the self, Harmony of the self with the body, Programme to ensure self-regulation and Health

**Tutorial:** Practice Session PS4 Exploring the difference of Needs of self and body, Practice Session PS5 Exploring Sources of Imagination in the self , Practice Session PS6 Exploring Harmony of self with the body

### **UNIT III: Harmony in the Family and Society:**

Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, Practice Session PS7 Exploring the Feeling of Trust, 'Respect' – as the Right Evaluation of Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order.

**Tutorial:** Practice Session PS7 Exploring the Feeling of Trust, Practice Session PS8 Exploring the Feeling of Respect, Practice Session PS9 Exploring Systems to fulfill Human Goal

### **UNIT IV: Harmony in the session)Nature/Existence:**

Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence

**Tutorial:** Practice Session PS10 Exploring the Four Orders of Nature, Practice Session PS11 Exploring Co-existence in Existence.

### **UNIT V: Implications of the Holistic Understanding**

Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session): Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession

**Tutorial:** Practice Session PS12 Exploring Ethical Human Conduct, Practice Session PS13 Exploring Humanistic Models in Education, Practice Session PS14 Exploring Steps of Transition towards Universal Human Order

### **Text Books:**

1. R R Gaur, R Asthana, G P Bagaria, A Foundation Course in Human Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. The Teacher's Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G

**Reference Books:**

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi.

**Web Links:**

1. <https://www.youtube.com/playlist?list=PLWDeKF97v9SMRfe5PK1HPYnEcrrJOL6K7>
2. <https://www.uhv.org.in/uhv-ii>
3. <http://www.uptu.ac.in/>

**COGNITIVE ENGLISH FOR ENGINEERS - II**  
**(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>III Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231MC3T03</b> | <b>0</b> | <b>0</b> | <b>2</b> | <b>0</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1: Understand the different aspects of the English language proficiency with emphasis on LSRW skills.
- CO2: Apply communication skills through various language learning activities
- CO3: Analyze the English speech sounds, stress, rhythm, intonation and syllable division for better listening and speaking comprehension.
- CO4: Evaluate and exhibit professionalism in participating in debates and group discussions.
- CO5: Develop the capacity to use various writing forms to achieve their professional needs.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 3    | -    | -    |
| CO2   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 3    | -    | -    |
| CO3   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 3    | -    | -    |
| CO4   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 3    | -    | -    |
| CO5   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 3    | -    | -    |

**List of Topics:**

1. City Living – Discuss living in cities, Changes to a home, write an email to complaint.
2. Dilemmas – Discuss personal finance, Moral dilemmas and crime, Be encouraging, Write a review.
3. Discoveries – Discuss new inventions, People's lives and achievements, Express uncertainty, Write an essay expressing a point of view.
4. Possibilities – Speculate about the past, Discuss life achievements, How you felt, Write a narrative.

**Suggested Software:**

- Cambridge Empower
- Young India Films
- Walden Infotech



**Text Books:**

1. Cambridge Empower – Second Edition B2 Level

**Reference Books:**

1. Raman Meenakshi, Sangeeta-Sharma. Technical Communication. Oxford University Press.2018.
2. Taylor Grant: English Conversation Practice, Tata McGraw-Hill Education India, 2016
3. Hewing's, Martin. Cambridge Academic English (B2). CUP, 2012.
4. J. Sethi & P.V. Dhamija. A Course in Phonetics and Spoken English, (2nd Ed), Kindle, 2013

**Web Links:****Spoken English:**

1. [www.cambridgeone.org](http://www.cambridgeone.org)
2. [www.englishinteractive.net](http://www.englishinteractive.net)
3. <https://www.britishcouncil.in/english/online>
4. <http://www.letstalkpodcast.com/>
5. <https://www.youtube.com/c/EnglishClass101/featured>

**Voice & Accent:**

1. [www.cambridgeone.org](http://www.cambridgeone.org)
2. <https://www.youtube.com/user/letstalkaccent/videos>
3. <https://www.youtube.com/c/EngLanguageClub/featured>
4. [https://www.youtube.com/channel/UC\\_OskgZBoS4dAnVUgJVexc](https://www.youtube.com/channel/UC_OskgZBoS4dAnVUgJVexc)

## MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS

IV Semester

Course Code: 31HS4T01

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Outcomes:

At the end of the Course, Student will be able to:

- CO1:** Explain the Managerial Economic concepts and Illustrate the law of demand forecasting methods..
- CO2:** Identify the production , cost behavior for managerial decision making and Break Even Point (BEP) of an enterprise.
- CO3:** Differentiate types of market structures, business organizations along with basic knowledge on business cycle.
- CO4:** Utilize various techniques on investment project proposals with the help of capital budgeting techniques for decision making.
- CO5:** Make use of the process & principles of accounting for the preparation of basic accounts.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | -    | -    | -    | -    | -    | -    | -    | -    | 2    | -     | -    | -    |
| CO2   | -    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -    | -    |
| CO3   | 1    | -    | -    | -    | -    | -    | -    | -    | -    | -     | 3    | -    |
| CO4   | -    | -    | -    | -    | -    | -    | -    | -    | 1    | 1     | -    | -    |
| CO5   | 1    | -    | -    | -    | -    | -    | -    | -    | 3    | 1     | 2    | -    |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | -    | -    |
| CO2    | -    | -    |
| CO3    | -    | -    |
| CO4    | -    | -    |
| CO5    | -    | -    |

### UNIT – I Managerial Economics:

Introduction - Nature, meaning, significance, functions, and advantages. Demand-Concept, Function, Law of Demand - Demand Elasticity- Types - Measurement. Demand Forecasting- Factors governing Forecasting, Methods. Managerial Economics and Financial Accounting and Management

**UNIT – II Production and Cost Analysis:**

Introduction Nature, meaning, significance, functions and advantages. Production Function- Least-cost combination- Short run and long run Production Function- Isoquants and Is costs, Cost & Break-Even Analysis - Cost concepts and Cost behaviour- Break-Even Analysis (BEA) - Determination of Break-Even Point (Simple Problems).

**UNIT – III Business Organizations and Markets:**

Introduction - Forms of Business Organizations- Sole Proprietary Partnership - Joint Stock Companies - Public Sector Enterprises. Types of Markets - Perfect and Imperfect Competition - Features of Perfect Competition Monopoly- Monopolistic Competition- Oligopoly-Price-Output Determination - Pricing Methods and Strategies

**UNIT – IV Capital Budgeting:**

Introduction Nature, meaning, significance. Types of Working Capital, Components, Sources of Short-term and Long-term Capital, Estimating Working capital requirements. Capital Budgeting- Features, Proposals, Methods and Evaluation. Projects - Pay Back Method, Accounting Rate of (IRR) Method (sample problems) Return (ARR) Net Present Value (NPV) Internal Rate Return

**UNIT – V Financial Accounting and Analysis:**

Introduction-Concepts and Conventions- Double-Entry Bookkeeping, Journal, Ledger, Trial Balance- Final Accounts (Trading Account, Profit and Loss Account and Balance Sheet with simple adjustments). Introduction to Financial Analysis - Analysis and Interpretation of Liquidity Ratios, Activity Ratios, and Capital structure Ratios and Profitability

**Text Books:**

1. Dr. A. R. Aryasri – Managerial Economics and Financial Analysis, TMH
2. Dr. N. Appa Rao, Dr. P. Vijay Kumar: ‘Managerial Economics and Financial Analysis’, Cengage Publications, New Delhi.

**Reference Books:**

1. V. Maheswari : Managerial Economics, Sultan Chand
2. Suma Damodaran : Managerial Economics, Oxford.

**Web Links:**

1. <https://www.coursera.org/specializations/accounting-fundamentals>
2. <https://archive.nptel.ac.in/courses/110/101/110101149/>

## ENGINEERING GEOLOGY

**IV Semester**

**L    T    P    C**  
**3    0    0    3**

**Course Code: 231ES4T01**

**Course Outcomes:**

**At the end of the Course, Student will be able to:**

**CO1:** Understand the significance of geological agents on Earth surface and its significance in Civil Engineering.

**CO2:** Identify and understand the properties of Minerals and Rocks.

**CO3:** Understand the concepts of Groundwater and its geophysical methods.

**CO4:** Classify and measure the Earthquake prone areas, Landslides and subsidence to practice the hazard zonation.

**CO5:** Investigate the project site for mega/mini civil engineering projects and site selection for mega engineering projects like Dams, Reservoirs and Tunnels.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| CO2   | 2    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 3    | 3    | 3    | 2    | 3    | -    | 2    | -    | -    | -     | 2     | 2     |
| CO5   | 3    | 3    | 2    | 2    | 3    | -    | 2    | -    | -    | -     | 2     | 2     |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | 2     | -     |
| CO 2   | 1     | -     |
| CO 3   | 1     | -     |
| CO 4   | 2     | 2     |
| CO 5   | 2     | 2     |

#### UNIT-I: Introduction:

Branches of Geology, Importance of Geology in Civil Engineering with case studies, Weathering of rocks, Geological agents, weathering process of Rock, Rivers and geological work of rivers.

#### UNIT-II Mineralogy and Petrology:

Definitions of mineral and rock-Different methods of study of mineral and rock. Physical properties of minerals and rocks for megascopic study for the following minerals and rocks. Common rock forming minerals: Feldspar, Quartz Group, Olivine, Augite, Hornblende, Mica Group, Asbestos, Talc, Chlorite, Kyanite, Garnet, Calcite and ore forming minerals are Pyrite, Hematite, Magnetite,

Chlorite, Galena, Pyrolusite, Graphite, Chromite, Magnetite and Bauxite. Classification, structures, textures and forms of Igneous rocks, Sedimentary rocks, Metamorphic rocks, and their megascopic study of granite

varieties, (pink, gray, green). Pegmatite, Dolerite, Basalt etc., Shale, Sand Stone, Lime Stone, Laterite, Quartzite, Gneiss, Schist, Marble, Khondalite and Slate.

### **UNIT-III Structural Geology:**

Strike , Dip and Outcrop study of common geological structures associating with the rocks such as Folds, Faults, Joints and Unconformities- parts, types, mechanism and their importance in Civil Engineering.

### **UNIT-IV Ground Water:**

Water table, Cone of depression, Geological controls of Ground Water Movement, Ground Water Exploration Techniques.

**Earthquakes and Land Slides:** Terminology, Classification, causes and effects, Shield areas and Seismic belts, Richter scale intensity, Precautions of building constructions in seismic areas. Classification of Landslides, Causes and Effects, measures to be taken prevent their occurrence at Landslides.

**Geophysics:** Importance of Geophysical methods, Classification, Principles of Geophysical study by Gravity method, Magnetic method, Electrical methods, Seismic methods, Radiometric method and Electrical resistivity, Seismic refraction methods and Engineering properties of rocks.

### **UNIT-V Geology of Dams, Reservoirs and Tunnels:**

Types and purpose of Dams, Geological considerations in the selection of a Dam site. Geology consideration for successful constructions of reservoirs, Life of Reservoirs. Purpose of Tunnelling, effects, Lining of Tunnels. Influence of Geology for successful Tunnelling.

### **Text Books:**

1. Engineering Geology by N. ChennaKesavulu, Laxmi Publications . 2<sup>nd</sup>Edn.
2. Engineering & General Geology by Parbin Singh Katson educational series 8<sup>th</sup> 2023

### **References:**

1. Engineering Geology by SubinoyGangopadhyay Oxford University press 1<sup>st</sup> edition.
2. Engineering Geology by D. Venkat Reddy, Vikas Publishing.

### **Weblinks:**

1. <http://nptel.iitm.ac.in/video.php?subjectId=105105106>
2. <http://nptel.iitm.ac.in/video.php?courseId=1055&p=1>
4. <http://nptel.iitm.ac.in/video.php?courseId=1055&p=3>
5. <http://nptel.iitm.ac.in/video.php?courseId=1055&p=4>

## CONCRETE TECHNOLOGY

**IV Semester**  
**Course Code: 231CE4T01**

**L T P C**  
**3 0 0 3**

### Course Outcomes:

**At the end of the course, the student will be able to**

- CO1** : Explain the properties of the constituent materials of concrete
- CO2** : Examine the properties of fresh concrete
- CO3** : Explain the properties of hardened concrete
- CO4** : Design a desired grade of concrete
- CO5** : Use special concrete(s) depending on the requirement.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO1</b> | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| <b>CO2</b> | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| <b>CO3</b> | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| <b>CO4</b> | 3    | 2    | 3    | -    | -    | -    | -    | 2    | -    | -     | -    | -    |
| <b>CO5</b> | 2    | 2    | -    | -    | -    | 2    | -    | -    | -    | -     | -    | -    |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | -     | 3     |
| <b>CO 2</b> | -     | 3     |
| <b>CO 3</b> | -     | 3     |
| <b>CO 4</b> | -     | 3     |
| <b>CO 5</b> | -     | 3     |

### UNIT - I Cement & Admixtures:

**Cements:** Portland cement – chemical composition – Hydration, Setting of cement – Structure of hydrated cement – Test on physical properties – Different grades of cement –Types of cement.

**Admixtures:** Admixtures –Mineral and chemical admixtures- Set controlling admixtures- surface acting admixtures.

### UNIT – II Aggregates & Fresh Concrete:

**Aggregates:** Classification of aggregates – Particle shape & texture – Bond, strength & other mechanical properties of aggregate – Specific gravity, Bulk density, porosity, adsorption & moisture content of aggregate – Bulking of sand – Deleterious substance in aggregate – Soundness of aggregate – Alkali aggregate reaction – Thermal properties – Sieve analysis – Fineness modulus – Grading curves – Grading of fine & coarse Aggregates – Gap graded aggregate – Maximum aggregate size.

**Fresh Concrete:** Workability – Factors affecting workability – Measurement of workability by different tests – Setting times of concrete – Effect of time and temperature on workability – Segregation & bleeding – Mixing and vibration of concrete – Steps in manufacture of concrete –Quality of mixing concrete – Ready

mix concrete.

**Unit – III Hardened Concrete & Testing of Hardened Concrete:**

Hardened Concrete: Water / Cement ratio – Abram’s Law – Gel space ratio – Nature of strength of concrete – Maturity concept – Strength in tension & compression – Factors affecting strength – Relation between compression & tensile strength – Curing of Concrete.

Testing Of Hardened Concrete: Compression tests – Tension tests – Factors affecting strength – Flexure test – Split tensile tests and Pull out test – Non-destructive testing methods – IS Code provisions for NDT AR20 AEC-CE 106

**UNIT – IV Elasticity, Creep & Shrinkage & Mix Design:**

Elasticity, Creep & Shrinkage: – Modulus of elasticity – Dynamic modulus of elasticity – Poisson’s ratio – Creep of concrete – Factors influencing creep – Relation between creep & time – Nature of creep – Effects of creep – Shrinkage – types of shrinkage. Durability of Concrete.

Mix Design: Factors in the choice of mix proportions – Quality Control of concrete – Statistical methods – Acceptance criteria – Proportioning of concrete mixes by BIS method.

**UNIT – V Special Concretes:**

Light weight aggregate concrete – Cellular concrete – No fines concrete – High density concrete – Fiber reinforced concrete – Polymer concrete – Types of Polymer concrete – Properties of polymer. concrete – High performance concrete – Self compacting concrete – Fly Ash Concrete.

**Textbooks:**

1. Concrete Technology: Theory and Practice, 8/e, M. S. Shetty & A K Jain, Publisher S.Chand, 2020.
2. Concrete Technology, Second Edition, Pearson, by A. M. Neville and J.J. Brooks, 2019.

**Reference Books:**

1. Concrete Technology, by S.S. Bhavikatti, Publisher: Dreamtech Press, Edition: 2019.
2. Concrete Technology, by Indrajeet M. Jain, Publisher: Tech-Neo Publications, LLP and Edition: 2019.

**Web Links:**

1. <https://nptel.ac.in/courses/105/102/105102012/>
2. <https://nptel.ac.in/courses/105/106/105106176/>

## STRUCTURAL ANALYSIS

**IV Semester**  
**Course Code: 231CE4T02**

**L T P C**  
**3 0 0 3**

### Course Outcomes:

**At the end of the course, the student will be able to**

- CO1** : Apply energy theorems to analyze trusses
- CO2** : Analyze indeterminate structures by using Castigliano's-II theorem
- CO3** : Analysis of fixed and continuous beams
- CO4** : Analyze continuous beams and portal frames by using slope-deflection method
- CO5** : Analyze continuous beams and portal frames by using Moment – distribution method

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO1</b> | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| <b>CO2</b> | 2    | 3    | 1    | 2    | -    | -    | -    | -    | -    | -     | -    | -    |
| <b>CO3</b> | 3    | 3    | 2    | 2    | -    | -    | -    | -    | -    | -     | -    | -    |
| <b>CO4</b> | 3    | 3    | 2    | 2    | -    | -    | -    | -    | -    | -     | -    | -    |
| <b>CO5</b> | 3    | 3    | 1    | 2    | -    | -    | -    | -    | -    | -     | -    | -    |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | -     | 3     |
| <b>CO 2</b> | -     | 3     |
| <b>CO 3</b> | -     | 3     |
| <b>CO 4</b> | -     | 3     |
| <b>CO 5</b> | -     | 3     |

### UNIT – I Energy Theorems:

Introduction-Strain energy in linear elastic system, expression of strain energy due to axial load, bending moment and shear forces – Castigliano's first theorem - Deflections of simple beams and pin jointed trusses.

### UNIT – II Analysis of Indeterminate Structures:

Indeterminate Structural Analysis – Determination of static and kinematic indeterminacies – Solution of trusses with upto two degrees of internal and external indeterminacies – Castigliano's-II theorem.

### UNIT - III Fixed Beams & Continuous Beams:

Introduction to statically indeterminate beams with uniformly distributed load, central point load, eccentric point load, number of pointloads, uniformly varying load, couple and combination of loads – Shear force and Bending moment diagrams – Deflection of fixed beams effect of sinking of support, effect of rotation of a support.



**UNIT - IV Slope-Deflection Method:**

Introduction-derivation of slope deflection equations- application to continuous beams with and without settlement of supports - Analysis of single bayportal frames without sway.

**UNIT - V Moment Distribution Method:**

Introduction to moment distribution method-Application to continuous beams with and without settlement of supports-Analysis of single bay storey portal frames without sway.

**Textbooks:**

1. Analysis of Structures – Vol-I&II by V.N.Vazirani & M.M.Ratwani, Khanna Publications, New Delhi.
2. Basic Structural Analysis by C.S.Reddy., Tata McGraw Hill Publishers. 3<sup>rd</sup> edition.

**Reference Books:**

1. Structural analysis by Aslam Kassimali Cengage publications 6<sup>th</sup> edition 2020.
2. Structural analysis Vol.I and II by Dr.R.Vaidyanathan and Dr.PPerumal– Laxmi publications.

**Web Links:**

1. <http://nptel.ac.in/courses/105101085/>
2. <https://lecturenotes.in/subject/154/structural-analysis-1>
3. <https://www.scribd.com/document/148330927/Unit-6-Theorem-of-Three-Moments>
4. <https://www.vidyarthiplus.com/vp/thread-35607.html#.Wsx43ohuZPY>

## HYDRAULICS AND HYRAULIC MACHINERY

**IV Semester**

**Course Code: 231CE4T03**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:**

**On Completion of the course, the students will be able to:**

- CO1 :** Examine the characteristics of laminar and turbulent flows.
- CO2 :** Apply the knowledge of fluid mechanics to address the uniform flow problems in open channels.
- CO3 :** Solve non-uniform flow problems and hydraulic jump phenomenon in open channel flows.
- CO4 :** Evaluate the performance of impact of jets on plates and design Pelton wheel, Francis and Kaplan turbine
- CO5 :** Examine the principles, losses and its efficiencies of centrifugal pumps

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 2    | 2    | -    | -    | -    | 1    | -    | -    | -    | -     | 1    | -    |
| CO2   | 2    | 2    | -    | -    | -    | 2    | -    | -    | -    | -     | 2    | -    |
| CO3   | 2    | 2    | -    | -    | -    | 2    | -    | -    | -    | -     | 2    | -    |
| CO4   | 2    | 2    | -    | -    | -    | 2    | -    | -    | -    | -     | 2    | -    |
| CO5   | 2    | 2    | -    | -    | -    | 2    | -    | -    | -    | -     | 1    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | 1     | -     |
| CO 2   | 1     | -     |
| CO 3   | 1     | -     |
| CO 4   | 1     | -     |
| CO 5   | 1     | -     |

**UNIT – I Laminar & Turbulent flow in pipes:**

Laminar Flow- Laminar flow through: circular pipes, annulus and parallel plates. Stoke's law, Measurement of viscosity. Reynolds experiment, Transition from laminar to turbulent flow. Resistance to flow of fluid in smooth and rough pipes-Moody's diagram – Introduction to boundary layer theory.

**UNIT – II Uniform flow in Open Channels:**

Open Channel Flow - Comparison between open channel flow and pipe flow, geometrical parameters of a channel, classification of open channels, classification of open channel flow, Velocity Distribution of channel section. Hydraulically efficient channel sections: Rectangular, trapezoidal and triangular channels, Energy and Momentum correction factors

**UNIT – III Non-Uniform flow in Open Channels:**

Specific energy, critical flow, discharge curve, Specific force, Specific depth, and Critical depth. Measurement of Discharge and Velocity – Gradually Varied Flow- Dynamic Equation of Gradually Varied Flow. Hydraulic Jump and classification - Elements and characteristics- Energy dissipation.

**UNIT – IV Impact of Jets:**

Hydrodynamic force of jets on stationary and moving flat, inclined and curved vanes - Velocity triangles at inlet and outlet - Work done and efficiency Hydraulic Turbines: Classification of turbines; pelton wheel and its design. Francis turbine and its design - efficiency - Draft tube: theory - characteristic curves of hydraulic turbines. Cavitation: causes and effects.

**UNIT – V pumps:**

Working principles of a centrifugal pump, work done by impeller; heads, losses and efficiencies; minimum starting speed; Priming; specific speed; limitation of suction lift, net positive suction head (NPSH); Performance and characteristic curves; Cavitation effects; Multistage centrifugal pumps; troubles and remedies

**Text books:**

1. P. M. Modi and S. M. Seth, Hydraulics and Fluid Mechanics, Standard Book House 22<sup>nd</sup>, 2019.
2. K. Subrahmanya, Theory and Applications of Fluid Mechanics, Tata McGraw Hill, 2<sup>nd</sup> edition 2023

**Reference Books:**

1. R. K. Bansal, A text of Fluid mechanics and hydraulic machines, Laxmi Publications (P)Ltd., New Delhi 11<sup>th</sup> edition, 2024.
2. Fluid Mechanics by Frank M. White, Henry Xue, Tata McGraw Hill, 9<sup>th</sup> edition , 2022.

**Weblinks:**

1. <https://nptel.ac.in/courses/105105203>
2. <https://archive.nptel.ac.in/courses/112/106/112106300/>
3. <https://archive.nptel.ac.in/courses/112/103/11210324/>

## CONCRETE TECHNOLOGY LABORATORY

**IV Semester**  
**Course Code: 231CE4L01**

|          |          |          |            |
|----------|----------|----------|------------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b>   |
| <b>0</b> | <b>0</b> | <b>3</b> | <b>1.5</b> |

### Course outcomes:

#### At the end of the Course, Student will be able to:

- CO1:** Determine the physical properties of cement.
- CO2:** Determine the physical properties of aggregates.
- CO3:** Determine the properties of fresh concrete.
- CO4:** Determine the mechanical properties of concrete.
- CO5:** Evaluate strength properties of concrete by non-destructive methods

#### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO1</b> | 2    | 2    | -    | 2    | 2    | -    | -    | 2    | 3    | 2     | -    | -    |
| <b>CO2</b> | 2    | 2    | -    | 2    | 2    | -    | -    | 2    | 3    | 2     | -    | -    |
| <b>CO3</b> | 2    | 2    | 2    | 2    | 2    | -    | -    | 2    | 3    | 2     | -    | -    |
| <b>CO4</b> | 2    | 2    | 2    | 2    | 2    | -    | -    | 2    | 3    | 2     | -    | -    |
| <b>CO5</b> | 2    | 1    | -    | 2    | 2    | -    | -    | 2    | 3    | 2     | -    | -    |

#### Mapping of Course Outcomes with Program Specific Outcomes

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | -     | 3     |
| <b>CO 2</b> | -     | 3     |
| <b>CO 3</b> | -     | 3     |
| <b>CO 4</b> | -     | 3     |
| <b>CO 5</b> | -     | 3     |

#### List of Experiments:

##### A. Tests on Cement

1. To test the normal consistency and fineness of cement.
2. To test the initial setting time and final setting time of cement.
3. To test the specific gravity and soundness of cement.
4. To test the compressive strength of cement.

##### B. Tests on Fine Aggregates

5. To determine the grading and fineness modulus of Fine aggregate by sieve analysis.
6. To test the specific gravity, water absorption and bulking of fine aggregate

**C. Tests on Coarse Aggregates**

7. To determine the grading of coarse aggregate by sieve analysis.
8. To test the specific gravity and water absorption of Coarse aggregates.

**D. Tests on fresh Concrete**

9. To determine the workability of concrete by compaction factor method
10. To determine the workability of concrete by slump test
11. To determine the workability of concrete by Vee-bee test.

**E. Tests on Hardened Concrete**

12. To determine the compressive strength of cement concrete

**List of Augmented Experiments (any two)**

1. To determine the Modulus of rupture Young's Modulus and Poisson's Ratio
2. To determine the split tensile strength of concrete.
3. To perform the Non-Destructive testing on concrete (for demonstration)

**Reference Books:**

1. Concrete Technology, M.S.Shetty, Chand Publication, 8<sup>th</sup> Edition, 2019
2. Properties of Concrete, A.M. Neville, Pearson.

**Web Links:**

1. [http://www.sgoinstitute.in/Downloads/Civil\\_Downloads/Manual\\_ConcreteTech.pdf](http://www.sgoinstitute.in/Downloads/Civil_Downloads/Manual_ConcreteTech.pdf)
2. <http://civil.gecgudlavalleru.ac.in/pdf/manuals/ConcreteTechnologyLabManual.pdf>
3. <http://www.atri.edu.in/images/pdf/departments/CT%20Lab%20Manual.pdf>
4. [http://jnec.org/Lab-manuals/CIVIL/LAB%20MANUAL%20\(CT\).pdf](http://jnec.org/Lab-manuals/CIVIL/LAB%20MANUAL%20(CT).pdf)

**ENGINEERING GEOLOGY LABORATORY****IV Semester****Course Code: 231CE4L02**

|          |          |          |            |
|----------|----------|----------|------------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b>   |
| <b>0</b> | <b>0</b> | <b>3</b> | <b>1.5</b> |

**Course Outcomes:****At the end of the Course, Student will be able to:**

- CO1** : Identify megascopic minerals & their properties.  
**CO2** : Identify megascopic rocks & their properties.  
**CO3** : Identify the site parameters such as contour, slope & aspect for topography.  
**CO4** : Know the occurrence of materials using the strike & dip problems.  
**CO5** : Analyse the surface and subsurface profile of earth.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 1    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO2   | 1    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO3   | 1    | 1    | 1    | -    | -    | -    | -    | -    | -    | 1     | 1    | -    |
| CO4   | 1    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO5   | 1    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | -     | -     |
| CO 2   | -     | -     |
| CO 3   | 1     | 1     |
| CO 4   | -     | -     |
| CO 5   | -     | -     |

**LIST OF EXPERIMENTS:**

1. Physical properties of minerals: Mega-scopic identification of
  - a. Rock forming minerals – Quartz group, Feldspar group, Garnet group, Micagroup & Talc, Chlorite, Olivine, Kyanite, Asbestos, Tourmelene, Calcite, Gypsum, etc...
  - b. Ore forming minerals– Magnetite, Hematite, Pyrite, Pyralusite, Graphite, Chromite, etc...
2. Megascopic description and identification of rocks.
  - a) Igneous rocks – Types of Granite, Pegmatite, Gabbro, Dolerite, Syenite, Granite Poryphery, Basalt, etc.

- b) Sedimentary rocks – Sand stone, Ferruginous sand stone, Lime stone, Shale, Laterite, Conglomerate, etc.
  - c) Metamorphic rocks – Biotite – Granite Gneiss, Slate, Muscovite & Biotite schist, Marble, Khondalite, etc.
- 3. Interpretation and drawing of sections for geological maps showing tilted beds, faults, unconformities etc.
  - 4. Simple Structural Geology problems.
  - 5. Bore hole data.
  - 6. Strength of the rock using laboratory tests.
  - 7. Field work – To identify Minerals, Rocks, Geomorphology & Structural Geology.

**Reference Books:**

- 1. 'Applied Engineering Geology Practicals' by M T Mauthesha Reddy, New Age International Publishers, 2<sup>nd</sup> Edition.
- 2. 'Foundations of Engineering Geology' by Tony Waltham, Spon Press, 3<sup>rd</sup> edition.

**Web Links:**

- 1. <https://nptel.ac.in/courses/105105106/>
- 2. <https://sites.google.com/site/3rdsemnotes/engineering-geology>
- 3. <https://www.vidyarthiplus.com/vp/thread-36461.html#.Wfrs14-CzIU>
- 4. [http://www.geology.cz/projekt681900/vyukove-materialy/Priloha%20JV\\_4.pdf](http://www.geology.cz/projekt681900/vyukove-materialy/Priloha%20JV_4.pdf)

## REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEMS

IV Semester

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>1</b> | <b>2</b> | <b>2</b> |

Course Code: 231CE4S01

### Course outcomes

**At the end of the course the student will be able to**

- CO 1 :** Acquire knowledge about concepts of remote sensing, sensors and their characteristics.
- CO2 :** Familiarize with data models and data structures to introduce various Raster and Vector Analysis capabilities in GIS.
- CO3 :** Digitize and create thematic map and extract important features to calculate geometry.
- CO4 :** Perform surface analysis over Contour to develop digital elevation model.
- CO5 :** Utilize GIS software to perform simple analysis in water resources and transportation engineering.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO1</b> | 2    | -    | 1    | 1    | -    | -    | 2    | -    | -    | -     | -    | 2    |
| <b>CO2</b> | 2    | -    | 1    | 1    | -    | -    | 2    | -    | -    | -     | -    | 2    |
| <b>CO3</b> | 1    | 1    | 1    | 1    | 2    | 1    | 3    | -    | 2    | 2     | 1    | 3    |
| <b>CO4</b> | 1    | 1    | 1    | 1    | 2    | 1    | 3    | -    | 2    | 2     | 1    | 3    |
| <b>CO5</b> | 1    | 1    | 1    | 1    | 2    | 2    | 3    | -    | 2    | 2     | 1    | 3    |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | 1     | -     |
| <b>CO 2</b> | 1     | -     |
| <b>CO 3</b> | 1     | -     |
| <b>CO 4</b> | 2     | -     |
| <b>CO 5</b> | 2     | -     |

### UNIT – I Introduction to Remote sensing:

History of Remote Sensing, Electromagnetic Radiation,

Electromagnetic Spectrum, Energy Interaction with Atmosphere, Energy Interaction with the Earth Surfaces - Characteristics of Remote Sensing Systems, Sensor Resolutions, Advantages & Limitations - Platforms: Types of Sensors, Airborne Remote Sensing, Spaceborne Remote Sensing - IRS, LANDSAT, SPOT & Recent satellite.



**UNIT – II Digital Image Analysis:**

Digital Image Characteristics, Digital Image Data Formats, Band Interleaved by Pixel (BIP), Band Interleaved by Line (BIL), Band Sequential (BSQ) - Visual Interpretation Elements, Preprocessing, Enhancement, Classification, Supervised classification, Unsupervised classification.

**UNIT – III Introduction to Geographic Information System:**

Principles, Components and Applications of GIS - Map projections, Spatial Data Structures, Raster and Vector Data Formats, Data Inputs, Data Manipulation, Data Retrieval, Data Analysis - Spatial data analysis: Overlay Function-Vector Overlay Operations, Raster Overlay Operations, Arithmetic Operators, Comparison and Logical Operators, Conditional Expressions - Network Analysis: Components of network, Transportation network - Optimum pathanalysis.

**List of Experiments:**

- 1 :Georeferencing a Toposheet or Map
- 2 :Digitization and Attribute table creation.
- 3 :Creation of Thematic Map
- 4 :Calculation of Feature geometry – Length, Area & Perimeter.
- 5 :Contour map – developing TIN & DEM from Contour.
- 6 :Stream network – Stream ordering map.
- 7 :Watershed - calculate Hydro-geomorphological parameters.
- 8 :Transportation Network Map – Route analysis.

**GIS SOFTWARE:** QGIS / ArcGIS

**Text books:**

1. BasudebBhatta. ‘Remote sensing and GIS’, 3<sup>rd</sup> edn., Oxford University Press.
2. S. Kumar, ‘Basics of Remote sensing & GIS’, Laxmi Publications.

**Reference Books:**

1. George Joseph, ‘Fundamentals of Remote Sensing’, Universities Press.
2. Burrough P A and R.A. McDonnell, ‘Principals of Geographical Information Systems’, Oxford University Press.

**Web links:**

1. <https://nptel.ac.in/courses/10510319>

## DESIGN THINKING & INNOVATION

**IV Semester**
**Course Code: 231ES4T04**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>1</b> | <b>0</b> | <b>2</b> | <b>2</b> |

**Course Outcomes: At the end of the course, student will be able to:**
**CO1:** Appreciate various design process procedure

**CO2:** Generate and develop design ideas through different technique

**CO3:** Identify the significance of reverse Engineering to understand products

**CO4:** Draw technical drawing for design ideas

**CO5:** Illustrate design teams to create feasible and user-focused solutions to complex problems in design.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | -    | -    | -    | -    | -    | -    | -    | 2    | 2    | -     | -     | -     |
| <b>CO2</b> | -    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| <b>CO3</b> | -    | -    | -    | -    | -    | -    | -    | -    | -    | 3     | -     | -     |
| <b>CO4</b> | -    | -    | -    | -    | -    | -    | -    | 1    | 1    | 2     | -     | -     |
| <b>CO5</b> | -    | -    | -    | -    | -    | -    | -    | -    | -    | 3     | -     | -     |

**UNIT – I**

**Process of Design Understanding Design thinking:** Shared model in team-based design – Theory and practice in Design thinking – Explore presentation signers across globe – MVP or Prototyping.

**UNIT – II**

**Tools for Design Thinking:** Real-Time design interaction capture and analysis – Enabling efficient collaboration in digital space – Empathy for design – Collaboration in distributed Design

**UNIT – III**

**Design Thinking in IT:** Design Thinking to Business Process modelling – Agile in Virtual collaboration environment – Scenario based Prototyping

**UNIT – IV**

**DT For strategic innovations:** Growth – Story telling representation – Strategic Foresight - Change – Sense Making - Maintenance Relevance – Value redefinition - Extreme Competition – experience design.

**UNIT – V**

**Design thinking workshop:** Design Thinking Work shop Empathize, Design, Ideate, Prototype and Test.

**Text Books:**

1. Engineering Design, John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, Cengage learning (International edition) 2<sup>nd</sup> Edition, ISBN 9788131530740
2. The Design of Business: Why Design Thinking is the Next Competitive Advantage, Roger Martin, Harvard Business Press, ISBN 9781422177808

**Reference Books:**

1. Engineering Design Process, Yousef Haik and Tamer M.Shahin, Cengage Learning, 2<sup>nd</sup> Edition, ISBN 9788131529041
2. Solving Problems with Design Thinking - Ten Stories of What Works, Jeanne Liedtka, Andrew King & Kevin Bennett (Columbia Business School Publishing) Hardcover, ISBN 978-0231163569

**Web Links:**

1. [www.tutor2u.net/business/presentations/. /Product lifecycle/default.html](http://www.tutor2u.net/business/presentations/. /Product lifecycle/default.html)
2. [https://docs.oracle.com/cd/E11108\\_02/otn/pdf/. /E11087\\_01.pdf](https://docs.oracle.com/cd/E11108_02/otn/pdf/. /E11087_01.pdf)

**Note:** The performance of the student is evaluated through Continuous Internal Evaluation (CIE) and Semester End Examinations (SEE) with a maximum of 100 marks.

**Evaluation procedure:**

**Project-Based Assessment (PBA): CIE (30 Marks):** Continuous assessment of a design thinking project throughout the semester can be done by each stage of Design Thinking (5 Stages)

- Empathize stage: 5 Marks
- Define & Problem Identification: 5 Marks
- Ideate stage: 5 Marks
- Prototype Development: 10 marks
- Testing & Feedback: 5 Marks

**Final Project Demo : SEE (70 Marks):** Team of students present their final demo and solution to a panel, followed by Q&A.

Presentation of idea and solution through: 50 Marks

Viva Voce: 20 Marks

## ESSENCES OF INDIAN TRADITIONAL KNOWLEDGE

**IV Semester**

**L   T   P   C**  
**2   0   0   0**

**Course Code: 231MC4T01**

**Course Outcomes:**

**At the end of the course the student will be able to**

- CO1:** Understand the fundamental principles and concepts of Indian Traditional Knowledge.
- CO2:** Analyze the significance and relevance of Indian Traditional Knowledge in modern times.
- CO3:** Apply the principles of Indian Traditional Knowledge to everyday life and professional practices.
- CO4:** Develop critical thinking and appreciation for the diversity of Indian Traditional Knowledge systems.
- CO5:** Communicate effectively about the importance and value of Indian Traditional Knowledge.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO1</b> | -    | -    | -    | -    | -    | 2    | 1    | 1    | -    | -     | -    | -    |
| <b>CO2</b> | -    | -    | -    | -    | -    | 2    | 1    | 1    | -    | -     | -    | -    |
| <b>CO3</b> | -    | -    | -    | -    | -    | 2    | 1    | 1    | -    | -     | -    | -    |
| <b>CO4</b> | -    | -    | -    | -    | -    | 2    | 1    | 1    | -    | -     | -    | -    |
| <b>CO5</b> | -    | -    | -    | -    | -    | 2    | 1    | 1    | -    | -     | -    | -    |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | -     | -     |
| <b>CO 2</b> | -     | -     |
| <b>CO 3</b> | -     | -     |
| <b>CO 4</b> | -     | -     |
| <b>CO 5</b> | -     | -     |

### UNIT - I Introduction to Traditional Knowledge:

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge vs western knowledge traditional knowledge.

**UNIT – II Protection of Traditional Knowledge:**

The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

**UNIT – III Legal Framework and TK:**

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.

**UNIT – IV Traditional Knowledge and Intellectual Property:**

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge

**UNIT – V Traditional Knowledge in Different Sectors:**

Traditional knowledge and engineering, Traditional medicine system, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

**Textbooks:**

1. Traditional Knowledge System in India, Amit Jha.

**Reference Books:**

1. Traditional Knowledge System in India, Amit Jha, Atlantic publishers.
2. Knowledge Traditions and Practices of India, Kapil Kapoor1, Michel Danino.

**Web Links:**

1. <https://www.youtube.com/watch?v=LZP1StpYEPM>
2. <http://nptel.ac.in/courses/121106003>

## DESIGN & DRAWING OF REINFORCED CONCRETE STRUCTURES

**V Semester**

**L T P C**

**Course Code: 231CE5T01**

**3 0 0 3**

**Course Outcomes: At the end of the course the student will be able to**

**CO1:** Explain design philosophies of reinforced concrete members and analyse beams under flexure

**CO2:** Design RC beams by limit state of flexure

**CO3:** Design RC beams subjected to shear, torsion, and bond.

**CO4:** Design various types of reinforced concrete compression members and footings

**CO5:** Design conventional slabs and waist slab staircase.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 2    | -    | 3    | -    | -    | 1    | -    | -    | -    | -     | -    | -    |
| CO2   | 2    | 1    | 3    | -    | -    | 1    | 2    | -    | -    | -     | -    | -    |
| CO3   | 2    | 1    | 3    | -    | -    | 1    | 2    | -    | -    | -     | -    | -    |
| CO4   | 2    | 1    | 3    | -    | -    | 1    | 2    | -    | -    | -     | -    | -    |
| CO5   | 2    | 1    | 3    | -    | -    | 1    | 2    | -    | -    | -     | -    | -    |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | 1     | -     |
| CO 2   | 3     | -     |
| CO 3   | 3     | -     |
| CO 4   | 3     | -     |
| CO 5   | 3     | -     |

## UNIT – I

**Working stress method:** Design codes and handbooks, loading standards – Dead, live, wind and earthquake loads, elastic theory, design constants, balanced, under-reinforced and over-reinforced sections.

### Limit State Design

Concepts of limit state design – Basic statistical principles – Characteristic loads – Characteristic strength – Partial load and safety factors – representative stress-strain curves for cold worked deformed bars and mild steel bars.

Assumptions in limit state design – stress – block parameters – limiting moment of Resistance.

**UNIT – II****Design for Flexure:**

Limit state analysis and design of singly reinforced sections- effective depth- Moment of Resistance- Doubly reinforced and flanged (T and L) beam sections- Minimum depth for a given capacity- Limiting Percentage of Steel- Minimum Tension Reinforcement-Maximum Flexural Steel.

**UNIT – III****Design for Shear, Torsion and Bond**

Limit state analysis and design of section for shear and torsion – concept of bond, anchorage and development length, I.S. code provisions. Design examples in simply supported and continuous beams, detailing and Limit state design for serviceability.

**UNIT-IV****Design of Compression members**

Effective length of a column, Design of short and long columns – under axial loads, uni- axial bending and biaxial bending – Braced and un-braced columns – I S Code provisions

**Footings**

Different types of footings – Design of isolated and footings – Square and rectangular footings subjected to axial loads, uniaxial bending moments.

**UNIT-V**

**Slabs:** Classification of slabs, design of one - way slabs, two - way slabs, and continuous slabs using IS Coefficients (conventional), design of waist-slab staircase.

**Textbooks:**

1. Reinforced Concrete Structures, S. Unnikrishna Pillai & Devdas Menon, Tata McGraw Hill, New Delhi, 2017.
2. Design of Reinforced Concrete Structures, N. Subrahmanyian, Oxford press publications, 2014

**Reference Books:**

1. Reinforced Concrete Structures, Park and Pauley, John Wiley, and Sons Publishers, 1975
2. Design of Reinforced Concrete Structures, Krishna Raju, New AgeInternational, 2015

**Web Links:**

1. <https://nptel.ac.in/courses/111/107/111107105/>
2. <https://nptel.ac.in/courses/111/105/111105041/>

## ENGINEERING HYDROLOGY

**V Semester**
**L T P C**
**Course Code: 231CE5T02**
**3 0 0 3**
**Course Outcomes: At the end of the course the student will be able to**

- CO1:** Explain the hydrologic cycle, sources of hydrological data, and analyze precipitation characteristics using IDF and DAD curves for design applications
- CO2:** Estimate losses due to evaporation, evapotranspiration, and infiltration, and apply various measurement and estimation techniques for hydrological abstractions.
- CO3:** Analyze runoff generation and perform hydrograph analysis using unit hydrograph concepts, including derivation, superposition, and synthetic methods.
- CO4:** Apply statistical methods for flood frequency analysis and evaluate flood control strategies using hydrologic routing techniques like Muskingum and Puls methods.
- CO5:** Interpret groundwater flow through aquifers using Darcy's and Dupuit's equations, and compute aquifer parameters and well yields for groundwater resource evaluation.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 3    | -    | -    | 2    | -    | 2    | -    | -    | -    | -     | -    | -    |
| CO2   | 3    | 1    | -    | 2    | -    | 2    | -    | -    | -    | -     | -    | -    |
| CO3   | 3    | 2    | 2    | 3    | -    | -    | -    | -    | -    | -     | -    | 1    |
| CO4   | 3    | 3    | 2    | 2    | -    | 2    | -    | -    | -    | -     | -    | 1    |
| CO5   | 3    | 2    | 2    | 2    | -    | 2    | -    | -    | -    | -     | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | -     | -     |
| CO 2   | -     | -     |
| CO 3   | -     | -     |
| CO 4   | -     | -     |
| CO 5   | -     | -     |

**UNIT – I**

**Introduction:** Engineering hydrology and its applications, Hydrologic cycle, hydrological data-sources of data.

**Precipitation:** Types and forms, measurement, introduction to radar measurement of rain fall, rain gauge network, presentation of rainfall data, average rainfall, continuity and consistency of rainfall data, frequency of rainfall, Intensity-Duration-Frequency (IDF) curves, Depth-Area-Duration (DAD) curves, Probable Maximum Precipitation (PMP), design storm



## UNIT – II

**Abstractions:** Initial abstractions, Evaporation: factors affecting, measurement, estimation, reduction, Evapotranspiration: factors affecting, measurement, estimation, control, Infiltration: factors affecting, Infiltration capacity curve, measurement, infiltration indices.

## UNIT – III

**Runoff: Factors** affecting runoff, components, empirical formulae, tables and curves, stream gauging, rating curve, flow mass curve and flow duration curve.

**Hydrograph analysis:** Components of hydrograph, separation of base flow, effective rainfall hyetograph and direct runoff hydrograph, unit hydrograph, assumptions, derivation of unit hydrograph, unit hydrographs of different durations, principle of superposition and S-hydrograph methods, limitations and applications of unit hydrograph, dimensionless unit hydrograph, synthetic unit hydrograph, introduction to IUH.

## UNIT-IV

**Floods:** Causes and effects, frequency analysis- Gumbel's and Log-Pearson type III distribution methods, Standard Project Flood (SPF) and Probable Maximum Flood (MPF), flood control methods and management.

**Flood Routing:** Hydrologic routing, channel and reservoir routing-Muskingum and Puls methods of routing.

## UNIT-V

**Groundwater:** Occurrence, types of aquifers, aquifer parameters, porosity, specific yield, permeability, transmissivity and storage coefficient, types of wells, Darcy's law, Dupuit's equation- steady radial flow to wells in confined and unconfined aquifers, yield of an open well-recuperation test.

### Textbooks:

1. 'Engineering Hydrology' by Subramanya, K, Tata McGraw-Hill Education Pvt Ltd, (2024), New Delhi.
2. 'Engineering Hydrology' by Jayarami Reddy, P, Laxmi Publications Pvt. Ltd., (2013), New Delhi

### Reference Books:

1. 'Water Resources Engineering', Mays L.W, Wiley India Pvt. Ltd, (2013).
2. Hydrology' by Raghunath. H.M., New Age International Publishers, (2010)

### Web Links:

1. <http://www.academicpub.org/jwrhe/>
2. <https://nptel.ac.in/downloads/105105110/>

## GEOTECHNICAL ENGINEERING– I

**V Semester**

**L T P C**

**Course Code: 231CE5T03**

**3 0 0 3**

**Course Outcomes: At the end of this course; the student will be able to**

**CO1:** Understand soil formation, its index properties and classification

**CO2:** Understand soil moisture and flow of water through soils and its effects

**CO3:** Understand stress distribution in soils.

**CO4:** Understand Compressibility characteristics under partially saturated and fully saturated conditions.

**CO5:** Understand shear strength of soil at different loading & drainage conditions for different soils.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 3    | 2    | 1    | 1    | 1    | 1    | -    | -    | -    | -     | -    | 1    |
| CO2   | 3    | 3    | 1    | 2    | 2    | -    | 1    | -    | -    | -     | -    | 1    |
| CO3   | 3    | 3    | 2    | 2    | 2    | -    | -    | -    | -    | -     | -    | 1    |
| CO4   | 3    | 3    | 2    | 2    | 1    | -    | 1    | -    | -    | -     | -    | 1    |
| CO5   | 3    | 3    | 2    | 2    | 2    | -    | 1    | -    | 1    | 1     | -    | 1    |

### Mapping of Course Outcomes with Program-Specific Outcomes

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | 3     | 2     |
| CO 2   | 3     | 3     |
| CO 3   | 3     | 3     |
| CO 4   | 3     | 3     |
| CO 5   | 3     | 3     |

## UNIT – I

**Introduction:** Soil formation – Structure of Soils – Texture of Soils – Three phase system and phase relationships.

**Index Properties and Classification Tests of Soils:** Index properties – Density Index - Grain size analysis – Sieve and Hydrometer methods – Consistency of Clay Soils – Activity of Clays – Thixotropy of clays - soil Classification – Unified soil classification and I.S. Soil classification.

## UNIT – II

**Soil moisture and Capillarity:** Soil moisture and modes of occurrence – Total, Neutral and Effective Pressures – Capillary Rise in soils.

**Permeability:** Flow of water through soils -- One dimensioned flow of water through soils – Darcy’s law- permeability – Factors affecting –laboratory determination of coefficient of permeability – Permeability of layered systems.

### UNIT –III

**Seepage and Flow Nets:** Flow net for one-dimensional flow – two-dimensional flow – Basic equation for Seepage – Flow nets & Characteristics and Uses – Quicksand condition –Seepage forces

**Stress Distribution in Soils:** Stresses induced by applied loads - Boussinesq’s and Westergaard’s theories for point loads and areas of different shapes– Newmark’s influence chart – 2:1 stress distribution method. - Pressure Blubs.

### UNIT – IV

**Compaction:** Mechanism of compaction – factors affecting – effects of compaction on soil properties - compaction control.

**Consolidation:** Compressibility of soils – e-p and e-log p curves – Stress history – Concept of consolidation - Spring Analogy - Terzaghi’s theory of one-dimensional Consolidation – Time rate of consolidation and degree of consolidation – Determination of coefficient of consolidation ( $c_v$ ) - Over consolidated and normally consolidated clays.

### UNIT - V

**Shear Strength of Soils:** Basic mechanism of shear strength - Mohr – Coulomb Failure theories – total and effective shear strength parameters – Stress-Strain behavior of Sands - Critical Void Ratio – Stress-Strain behavior of clays – Shear Strength determination- various drainage conditions – stress paths.

#### Text Books:

- 1 Soil Mechanics and Foundation Engineering by Dr. K.R. Arora, Standard Publishers and Distributors, New Delhi.
- 2 Basic and Applied Soil Mechanics’ by Gopal Ranjan and A.S.R.Rao, New Age International Publishers.

#### References:

- 1 Fundamentals of Soil Mechanics’ by D.W.Taylor., Wiley.
- 2 An introduction to Geotechnical Engineering’ by Holtz and Kovacs; Prentice Hall

#### Weblinks

1. <https://nptel.ac.in/courses/105103097>
2. <https://nptel.ac.in/courses/105106142/>

**ADVANCED STRUCTURAL ANALYSIS****(Professional Elective-I)****V Semester****L T P C****Course Code: 231CE5E01****3 0 0 3****Course Outcomes: At the end of this course; the student will be able to**

- CO1:** Understand strain energy concepts and apply Castigliano's theorems to determine deflections in beams/trusses and analyze indeterminate trusses
- CO2:** Analyze three-hinged and two-hinged arches for thrust, bending moment, and shear, considering temperature effects and support variations
- CO3:** Apply approximate methods (Portal, Cantilever, and Substitute Frame) to analyze building frames under gravity/lateral loads.
- CO4:** Analyze cable structures and suspension bridges under various loads, including temperature effects.
- CO5:** Analyze frames using Moment Distribution, Slope-Deflection, and Kani's methods, accounting for sway and support settlements.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 3    | 3    | -    | 1    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO2   | 3    | 3    | -    | 2    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO3   | 3    | 3    | -    | 2    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO4   | 3    | 3    | -    | 1    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO5   | 3    | 3    | -    | 2    | 3    | -    | -    | -    | -    | -     | -    | -    |

**Mapping of Course Outcomes with Program-Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | -     | -     |
| CO 2   | -     | -     |
| CO 3   | -     | -     |
| CO 4   | -     | -     |
| CO 5   | -     | -     |

**UNIT-I**

**Energy Theorems:** Introduction-Strain energy in linear elastic system, expression of strain energy due to axial load, bending moment and shear forces - Castigliano's first theorem-Deflections of simple beams and pin jointed plane trusses.

**Indeterminate Trusses:** Determination of static and kinematic indeterminacies – Analysis of trusses having single and two degrees of internal and external indeterminacies – Castigliano's second theorem.

## UNIT-II

**Two Hinged Arches:** Determination of horizontal thrust, bending moment, normal thrust and radial shear – Rib shortening and temperature stresses, Tied arches – Fixed arches – (No analytical question)

**Three Hinged Arches:** Elastic theory of arches – Eddy's theorem – Determination of horizontal thrust, bending moment, normal thrust and radial shear – effect of temperature. Hinges with supports at different levels.

## UNIT-III

**Approximate Methods of Analyses:** Application to building frames. (i) Portal Method (ii) Cantilever Method (iii) Substitute frame method for approximate analysis of multi-storey frames subjected to gravity loads and lateral loads. Shear force and bending moment diagrams - Elastic curve.

## UNIT – IV

**Cable Structures and Suspension Bridges:** Introduction, characteristics of cable, analysis of cables subjected to concentrated and uniformly distributed loads, anchor cable, temperature stresses, analysis of simple suspension bridge, three hinged and two hinged stiffening girder suspension bridges.

## UNIT – V

**Moment Distribution Method:** Analysis of Portal frames – including Sway- Substitute frame analysis by two cycle. Sloped deflection method: Analysis of Portal frames – including Sway. Analysis of inclined frames. Shear force and bending moment diagrams - Elastic curve.

**Kani's Method:** Analysis of continuous beams—including settlement of supports and single bay portal frames with and without side sway. Shear force and bending moment diagrams - Elastic curve.

### Text Books:

- 1 Structural Analysis by R.C. Hibbeler, Pearson, New Delhi.
- 2 Analysis of Structures- Vol. I and II, V. N. Vazirani and M. M. Ratwani, Khanna Publishers, New Delhi.

### References:

1. Mechanics of Structures Vol – II by H.J.Shah and S.B.Junnarkar, Charotar Publishing House Pvt. Ltd.
2. Structural Analysis by Devdas Menon, Narosa Publishing Housing Pvt. Ltd.

### Weblinks

1. <https://archive.nptel.ac.in/courses/105/106/105106050/>
2. [https://onlinecourses.nptel.ac.in/noc25\\_ce110/preview](https://onlinecourses.nptel.ac.in/noc25_ce110/preview)

## ARCHITECTURE AND TOWN PLANNING

### (Professional Elective-I)

**V Semester****L T P C****Course Code: 231CE5E02****3 0 0 3****Course Outcomes: At the end of the course the student will be able to**

- CO1:** Understand and distinguish between various architectural styles from Western
- CO2:** Apply fundamental principles of residential building planning such as site selection, orientation, grouping, and circulation.
- CO3:** Describe and compare ancient town planning practices in India and other historic cities like Harappa, Mohenjo-Daro, and Rome.
- CO4:** Analyze modern town planning concepts including zoning, housing, public utilities, neighborhood planning, and legal regulations.
- CO5:** Evaluate various town expansion models such as garden cities, satellite towns, skyscrapers, and apply basic landscaping principles.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 1    | -    | -    | -    | -    | -    | 1    | -    | -    | 1     | -    | -    |
| CO2   | 1    | 1    | 1    | -    | -    | -    | 1    | -    | -    | -     | -    | -    |
| CO3   | 1    | 1    | 1    | -    | -    | -    | 1    | 1    | -    | -     | -    | -    |
| CO4   | 1    | 1    | 1    | 1    | -    | -    | 1    | 1    | -    | -     | -    | -    |
| CO5   | 1    | 1    | 1    | 1    | -    | -    | 1    | 1    | -    | -     | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | -     | -     |
| CO 2   | 1     | -     |
| CO 3   | 1     | -     |
| CO 4   | 1     | -     |
| CO 5   | 1     | -     |

**UNIT-I**

History of Architecture: Western Architecture: Egyptian, Greek, Roman Architectures- Orders. Indian Architecture: Vedic age, Indus valley civilization. Temples of Religions: Buddhist period: Stambas, Stupas, Toranas, Chaityas, Viharas – Hindu temples: Dravidian and Indo Aryan Styles-Temple of Aihole, Madurai, Bhubaneshwar, Mount Abu. Indo Sarsanic (Islamic) Architecture: Mosque - Palace - Fort - Tomb.

**UNIT-II**

Principles of designing and Planning: Principles of planning a residence-site selection, site orientation-aspect, prospect, grouping, circulation, privacy, furniture requirements, services and other factors.

Post-classic Architecture: Introduction of post-classic architecture-contribution of eminent architects to modern period-Edward Lutyens, Le Corbusier, Frank Lloyd Wright, Walter Groping.

### **UNIT-III**

Historical Background of Town Planning: Town planning in India –Town plans of mythological Manasa-Town plans of ancient towns: Harappa, Mohenjo- Daro, Pataliputra, Delhi, Acropolis (Greece), Jerusalem, Mecca, Rome, London.

### **UNIT-IV**

Modern Town Planning: Zoning- Roads and road traffic- Housing- Slums, Parks, Play grounds- Public Utility Services- Surveys and maps for planning- Neighborhood Planning. Standards of Town planning: Planning new towns, planning standards and specifications, national and regional planning, town planning and legislation-planning regulations and limitations.

### **UNIT-V**

Land Scaping and Expansion of Towns: Land scaping for the towns, horizontal and vertical expansion of towns-garden cities, satellite towns-floating towns-skyscrapers-pyramidal cities.

#### **Textbooks:**

1. 'The great ages of World Architecture 'by G.K.Hiraskar.
2. 'Planning and Design of Buildings by Section of Architecture' by Y.S.Sane.

#### **References:**

1. 'Drafting and Design for Architecture'by Hepler, Cengage Learning
2. 'Architect's Portable Handbook' by John Patten Guthrie–McGraw Hill International Publications.

#### **Web Links:**

1. [NPTEL : NOC:Introduction to History of Architecture in India \(Architecture\)](#)
2. [NPTEL : Architecture \(34 Courses\)](#)

**Construction Technology and Management**  
**(Professional Elective-I)**

**V Semester****L T P C****Course Code: 231CE5E03****3 0 0 3****Course Outcomes: At the end of the course the student will be able to**

- CO1:** Understand and apply fundamental principles of project planning, scheduling, and monitoring using tools like bar charts, milestone charts, and CPM.
- CO2:** Analyze project timelines and optimize resources and costs using techniques like PERT, crashing, and construction management software such as Primavera.
- CO3:** Evaluate the productivity, functions, and economic considerations of various earthmoving and hoisting equipment such as trucks, cranes, and rollers.
- CO4:** Identify and utilize appropriate concreting equipment like batching plants and concrete mixers, and understand methods for placing, consolidating, and finishing concrete.
- CO5:** Gain practical knowledge of modern construction methods, including earthwork, piling, and formwork, while ensuring quality control, safety, and BIM integration.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 2    | 1    | 1    | -    | -    | -    | -    | 1    | 1    | -     | -    | -    |
| CO2   | 2    | 1    | 2    | 1    | -    | -    | -    | 1    | 1    | -     | -    | -    |
| CO3   | 2    | 1    | 2    | 1    | -    | -    | -    | 1    | 1    | -     | -    | -    |
| CO4   | 2    | 1    | 2    | -    | -    | -    | -    | 1    | 1    | -     | -    | -    |
| CO5   | 2    | 1    | 2    | 1    | -    | -    | -    | 1    | 1    | -     | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | 1     | -     |
| CO 2   | 1     | -     |
| CO 3   | 1     | -     |
| CO 4   | 1     | -     |
| CO 5   | 1     | -     |

**UNIT-I**

Construction project management and its relevance – qualities of a project manager – project planning – coordination –scheduling - monitoring – bar charts – milestone charts – critical path method

**UNIT-II**

Project evaluation and review technique–cost analysis updating crashing for optimum cost crashing for optimum resources–allocation of resources introduction to software's for construction management, project management using PRIMAVERA (or) equivalent.



**UNIT-III**

Construction equipment – economical considerations – earthwork equipment – Trucks and handling equipment – rear dump trucks – capacities of trucks and handling equipment – calculation of truck production – compaction equipment – types of compaction rollers Hoisting and earth work equipment– hoists–cranes–tractors–bulldozers–graders–scrapers draglines–clam shell buckets

**UNIT-IV**

Concreting equipment— concrete mixers– Batching plants, mobile using plants like “Ajax”etc. mixing and placing of concrete – consolidating and finishing.

**UNIT-V**

Construction methods – earthwork – piling – placing of concrete – form work – fabrication and erection – quality control and safety engineering. BIM for Civil Engineers (Building Information Modelling)

**Textbooks:**

1. ‘Construction Planning, Equipment and Methods’ by Peurifoy and Schexnayder, Shapira, Tata McGraw hill.
2. ‘Construction Project Management Theory and Practice’ by Kumar NeerajJha(2011), Pearson.

**References:**

1. ‘Construction Project Management-An Integrated Approach’by Peter Fewings,Taylor and Francis
2. ‘Construction Management Emerging Trends and Technologies’ by TreforWilliams , Cengage learning

**Web Links:**

1. [NPTEL :: Civil Engineering - NOC:Principles of Construction Management](#)
2. [NPTEL :: Civil Engineering - Construction Planning and Management](#)

## WASTE WATER MANAGEMENT (Open Elective-I)

V Semester

Course Code: 231CE5001

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Summarize the importance of sanitation and wastewater management.  
**CO2:** Estimation of sewage flow and storm water drainage.  
**CO3:** Identify the various characteristics of sewage and plan the treatment system.  
**CO4:** Examination of waste water characteristics  
**CO5:** Outline various waste water treatment technologies and effluent disposal methods

### Mapping of Course Outcomes with Program Outcomes:

| CO/PSO     | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|------|
| <b>CO1</b> | 2    | 1    | -    | -    | -    | 2    | -    | -    | -    | -     | -     | -    |
| <b>CO2</b> | 1    | 1    | 1    | -    | -    | 1    | -    | -    | -    | -     | -     | -    |
| <b>CO3</b> | 3    | 2    | 1    | -    | -    | 1    | -    | -    | -    | -     | -     | -    |
| <b>CO4</b> | 2    | 1    | -    | 2    | -    | 2    | -    | -    | -    | -     | -     | -    |
| <b>CO5</b> | 2    | 1    | -    | -    | -    | 2    | -    | -    | -    | -     | -     | -    |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | SO 2 |
|--------|------|------|
| CO1    | -    | -    |
| CO2    | -    | -    |
| CO3    | -    | -    |
| CO4    | -    | -    |
| CO5    | -    | -    |

### Unit - I

Introduction:

Introduction to sanitation–systems of sanitation–relative merits and demerits –need for waste water management–basic terminology in waste water–generation of waste water– types – collection and conveyance of waste water– classification of sewerage systems.

### Unit – II

Sewage Flow and Pumping:

Estimation of sewage flow and storm water drainage–fluctuations. Types of sewers– hydraulics of sewers– appurtenances in sewerage. Pumping of waste water: pumping stations–location– components– types of pumps and their suitability with regards to waste waters.

### Unit – III

Sewage Analysis and Treatment Sewage characteristics–sampling and analysis of waste water– physical, chemical, and biological examination– measurement of BOD, COD. Preliminary and primary treatment–screens–grit chambers–greasetraps–floatation– sedimentation.

**Unit – IV**

Secondary Treatment:

Aerobic and anaerobic treatment process-comparison.

Aerobic units:

Activated sludge process, principles, modifications of activated sludge processes Oxidation ponds– Trickling filters–Rotating biological contactors.

Anaerobic units: UASB Reactor, principle and working.

**Unit – V**

Tertiary Treatment and Disposal:

Removal of Nutrients–Nitrification and Denitrification–Ion exchange–membrane processes –MF, UF, NF, RO. Disposal of sewage–Methods of disposal–Effluent Standards. Need, Scope and demand for waste water recycling

**Text Books:**

1. Wastewater Engineering: Treatment and Resource Recovery, Metcalf & Eddy, 5th Edition, McGraw-Hill, New York, 2014.
2. Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, Tata McGraw-Hill edition, 2018.

**Reference Books:**

1. Environmental Engineering-II: Sewage disposal and Air pollution Engineering, Garg & S.K., Khanna Publications.
2. Environmental Engineering by D. Srinivasan, PHI Learning private Limited, New Delhi, 2011

**Web Links:**

1. [https://web.iitd.ac.in/~arunku/files/CVL100\\_Y16/LecSep1220.pdf](https://web.iitd.ac.in/~arunku/files/CVL100_Y16/LecSep1220.pdf)
2. <http://www.civil.iitm.ac.in/dwwm/sites/default/files/presentations>

**Construction Technology and Management**  
(Open Elective-I)

V Semester

L T P C

Course Code: 231CE5002

3 0 0 3

**Course Outcomes: At the end of the course the student will be able to**

- CO1:** Demonstrate understanding of project planning, scheduling, and monitoring techniques using tools like bar charts, milestone charts, and CPM.
- CO2:** Analyze and optimize project timelines and resources using PERT, crashing methods, and project management software like Primavera.
- CO3:** Evaluate the working, capacity, and productivity of earthwork and hoisting equipment such as dump trucks, cranes, bulldozers, and rollers.
- CO4:** Understand the usage and operation of concreting equipment including batching plants, mixers, and techniques for placing and finishing concrete.
- CO5:** Apply modern construction techniques involving formwork, piling, fabrication, quality control, safety practices, and integrate BIM in project planning.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 2    | 1    | 1    | -    | -    | -    | -    | 1    | 1    | -     | -    | -    |
| CO2   | 2    | 1    | 2    | 1    | -    | -    | -    | 1    | 1    | -     | -    | -    |
| CO3   | 2    | 1    | 2    | 1    | -    | -    | -    | 1    | 1    | -     | -    | -    |
| CO4   | 2    | 1    | 2    | -    | -    | -    | -    | 1    | 1    | -     | -    | -    |
| CO5   | 2    | 1    | 2    | 1    | -    | -    | -    | 1    | 1    | -     | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | -     | -     |
| CO 2   | -     | -     |
| CO 3   | -     | -     |
| CO 4   | -     | -     |
| CO 5   | -     | -     |

**UNIT – I**

Construction project management and its relevance – qualities of a project manager – project planning – coordination –scheduling - monitoring – bar charts – milestone charts – critical path method

**UNIT – II**

Project evaluation and review technique–cost analysis–updating–crashing for optimum cost crashing for optimum resources–allocation of resources introduction to software's for construction management, project management using PRIMAVERA (or) equivalent.

**UNIT – III**

Construction equipment – economical considerations – earthwork equipment – Trucks and handling equipment – rear dump trucks – capacities of trucks and handling equipment – calculation of truck production – compaction equipment – types of compaction rollers Hoisting and earth work equipment–hoists–cranes–tractors–bull dozers–graders–scrapers draglines clam shell buck

**UNIT-IV**

Concreting equipment— concrete mixers–Batching plants, mobile using plants like “Ajax” etc. mixing and placing of concrete – consolidating and finishing.

**UNIT-V**

Construction methods – earthwork – piling – placing of concrete – form work – fabrication and erection – quality control and safety engineering. BIM for Civil Engineers (Building Information Modelling)

**Textbooks:**

1. Construction Planning, Equipment and Methods' by Peurifoy and Schexnayder, Shapira, Tata McGraw hill.
2. Construction Project Management Theory and Practice' by Kumar NeerajJha (2011), Pearson.

**Reference Books:**

1. Construction Project Management-An Integrated Approach 'by Peter Fewings, Taylor and Francis
2. Construction Management Emerging Trends and Technologies' by Trefor Williams , Cengage learning

**Web Links:**

1. [NPTEL :: Civil Engineering - NOC:Principles of Construction Management](#)
2. [NPTEL :: Civil Engineering - Construction Planning and Management](#)

**GREEN BUILDINGS****(Open Elective-I)****V Semester****L T P C****Course Code:** 231CE5O03**3 0 0 3****Course Outcomes: At the end of the course the student will be able to**

- CO1:** Understand the fundamental concepts, benefits, and sustainable features of green buildings.
- CO2:** Describe and analyze green building rating systems and sustainability practices in construction.
- CO3:** Apply principles of energy-efficient green design and evaluate renewable energy integration.
- CO4:** Assess HVAC design strategies and energy modeling used in green building projects.
- CO5:** Evaluate indoor air quality measures, sustainable material use, and occupant well-being strategies.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 3    | -    | -    | 2    | -    | 2    | -    | -    | -    | -     | -    | -    |
| CO2   | 3    | 1    | -    | 2    | -    | 2    | -    | -    | -    | -     | -    | -    |
| CO3   | 3    | 2    | 2    | 3    | -    |      | -    | -    | -    | -     | 1    | -    |
| CO4   | 3    | 3    | 2    | 2    | -    | 2    | -    | -    | -    | -     | 1    | -    |
| CO5   | 3    | 2    | 2    | 2    | -    | 2    | -    | -    | -    | -     | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | -     | -     |
| CO 2   | -     | -     |
| CO 3   | -     | -     |
| CO 4   | -     | -     |
| CO 5   | -     | -     |

**UNIT – 1:****Introduction**

What is Green Building, Why to go for Green Building, Benefits of Green Buildings, Green Building Materials and Equipment in India, What are key Requisites for Constructing a Green Building, Important Sustainable features for Green Building,

**UNIT – 2:**

Green Building Concepts And Practices Indian Green Building Council, Green Building Moment in India, Benefits Experienced in Green Buildings, Launch of Green Building

Rating Systems, Residential Sector, Market Transformation; Green Building Opportunities And Benefits: Opportunities of Green Building, Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy Saving Approach in Buildings, LEED India Rating System and Energy Efficiency

### **UNIT-3:**

Green Building Design Introduction, Reduction in Energy Demand, Onsite Sources and Sinks, Maximise System Efficiency, Steps to Reduce Energy Demand and Use Onsite Sources and Sinks, Use of Renewable Energy Sources. Eco friendly captive power generation for factory, Building requirement,

### **UNIT- 4:**

Air Conditioning Introduction, CII Godrej Green business centre, Design philosophy, Design interventions, Energy modeling, HVAC System design, Chiller selection, pump selection, Selection of cooling towers, Selection of air handling units, Precooling of fresh air, Interior lighting system, Key feature of the building. Eco-friendly captive power generation for factory, Building requirement.

### **UNIT –5:**

Material Conservation Handling of non process waste, waste reduction during construction, materials with recycled content, local materials, material reuse, certified wood, Rapidly renewable building materials and furniture; Indoor Environment Quality And Occupational Health: Air conditioning, Indoor air quality, Sick building syndrome, Tobacco smoke control, Minimum fresh air requirements avoid use of asbestos in the building, improved fresh air ventilation, Measure of IAQ, Reasons for poor IAQ, Measures to achieve Acceptable IAQ levels,

### **Text Books:**

1. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.
2. Green Building Hand Book by Tom woolley and Samkimings, 2009. Recommended

### **Reference Books:**

1. Complete Guide to Green Buildings by Trish Riley, The Lyons Press, 2009.
2. Standard for the Design of High-Performance Green Buildings by Kent Peterson, ASHRAE, 2009.

### **Web Links:**

1. <https://nptel.ac.in/courses/105107213>
2. <https://nptel.ac.in/courses/105107212>

## RENEWABLE ENERGY SOURCES (OPEN ELECTIVE-I)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>Semester: V</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EE5001</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1** Analyse solar radiation data, extra-terrestrial radiation, radiation on earth's surface and solar Energy Storage.
- CO2** Illustrate the components of wind energy systems.
- CO3** Illustrate the working of biomass, hydel plants and Geothermal plants.
- CO4** Demonstrate the principle of Energy production from OTEC, Tidal and Waves.
- CO5** Evaluate the concept and working of Fuel cells & MHD power generation.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 2    | 2    | -    | 1    | -    | -    | -    | 1    | 1     | -     | -     |
| <b>CO2</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | 1    | 1     | -     | -     |
| <b>CO3</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | 1    | 1     | -     | -     |
| <b>CO4</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | 1    | 1     | -     | -     |
| <b>CO5</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | 1    | 1     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    | -    |
| <b>CO2</b> | 1    | -    |
| <b>CO3</b> | 1    | -    |
| <b>CO4</b> | 1    | -    |
| <b>CO5</b> | 1    | -    |

## UNIT – I

### Solar Energy

Introduction - Renewable Sources - prospects, solar radiation at the Earth Surface - Equivalent circuit of a Photovoltaic (PV) Cell - I-V & P-V Characteristics - Solar Energy Collectors: Flat plate Collectors, concentrating collectors - Solar Energy storage systems and Applications: Solar Pond - Solar water heating - Solar Green house.



**UNIT – II****Wind Energy**

Introduction - basic Principles of Wind Energy Conversion, the nature of Wind - the power in the wind - Wind Energy Conversion - Site selection considerations - basic components of Wind Energy Conversion Systems (WECS) - Classification - Applications.

**UNIT – III**

Biomass, Hydel and Geothermal Energy

Biomass: Introduction - Biomass conversion technologies- Photosynthesis. Factors affecting Bio digestion.

Hydro plants: Basic working principle – Classification of hydro systems: Large, small, micro hydel plants.

Geothermal Energy: Introduction, Geothermal Sources – Applications - operational and Environmental problems.

**UNIT – IV**

Energy From oceans, Waves & Tides:

Oceans: Introduction - Ocean Thermal Electric Conversion (OTEC) – methods - prospects of OTEC in India.

Waves: Introduction - Energy and Power from the waves - Wave Energy conversion devices.

Tides: Basic principle of Tide Energy -Components of Tidal Energy.

**UNIT – V**

Chemical Energy Sources:

Fuel Cells: Introduction - Fuel Cell Equivalent Circuit - operation of Fuel cell - types of Fuel Cells - Applications.

Hydrogen Energy: Introduction - Methods of Hydrogen production - Storage and Applications

Magneto Hydro Dynamic (MHD) Power generation: Principle of Operation - Types.

**Text Books:**

- 1 G.D.Rai, Non-Conventional Energy Sources, Khanna Publications, 2011.
- 2 John Twidell & Tony Weir, Renewable Energy Sources, Taylor & Francis, 2013.

**Reference Books:**

- 1 S.P.Sukhatme & J.K.Nayak, Solar Energy-Principles of Thermal Collection and Storage, TMH, 2011.

- 2 John Andrews & Nick Jelly, Energy Science- principles, Technologies and Impacts, Oxford, 2<sup>nd</sup> edition, 2013.
- 3 ShobaNath Singh, Non- Conventional Energy Resources, Pearson Publications, 2015.

**Web Links:**

- 1 <https://archive.nptel.ac.in/courses/103/103/103103206>
- 2 <https://archive.nptel.ac.in/courses/103/107/103107157>

## CONCEPTS OF ENERGY AUDITING & MANAGEMENT (OPEN ELECTIVE-I)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>Semester: V</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EE5002</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1** Understand the principles of energy audit along with various Energy related terminologies.
- CO2** Asses the role of Energy Manager and Energy Management program.
- CO3** Design a energy efficient motors and good lighting system.
- CO4** Analyse the methods to improve the power factor and identify the energy instruments for various real time applications.
- CO5** Evaluate the computational techniques with regard to economic aspects.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|------|
| <b>CO1</b> | 3    | 2    | 2    | -    | 1    | -    | -    | -    | 1    | 1     | -     | -    |
| <b>CO2</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | 1    | 1     | -     | -    |
| <b>CO3</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | 1    | 1     | -     | -    |
| <b>CO4</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | 1    | 1     | -     | -    |
| <b>CO5</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | 1    | 1     | -     | -    |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    | -    |
| <b>CO2</b> | 1    | -    |
| <b>CO3</b> | 1    | -    |
| <b>CO4</b> | 1    | -    |
| <b>CO5</b> | 1    | -    |

## UNIT – I

### Basic Principles of Energy Audit

Energy audit- definitions - concept - types of Energy audit - energy index - cost index - pie charts - Sankey diagrams and load profiles - Energy conservation schemes- Energy audit of industries- energy saving potential - energy audit of process industry, thermal power station - building energy audit - Conservation of Energy Building Codes (ECBC-2017)

**UNIT – II****Energy Management**

Principles of energy management - organizing energy management program - initiating - planning - controlling - promoting - monitoring - reporting. Energy manager - qualities and functions - language - Questionnaire – check list for top management.

**UNIT – III****Energy Efficient Motors and Lighting**

Energy efficient motors - factors affecting efficiency - loss distribution - constructional details - characteristics – variable speed - RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. lighting system design and practice - lighting control - lighting energy audit.

**UNIT – IV****Power Factor Improvement and Energy Instruments**

Power factor – methods of improvement - location of capacitors - Power factor with non-linear loads - effect of harmonics on power factor - power factor motor controllers – Energy Instruments- watt meter - data loggers - thermocouples - pyrometers - lux meters - tongue testers.

**UNIT – V****Economic Aspects and their Computation**

Economics Analysis depreciation Methods - time value of money - rate of return - present worth method - replacement analysis - lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method - net present value method- Power factor correction - lighting – Applications of life cycle costing analysis - return on investment.

**Text Books:**

- 1 Energy management by W.R.Murphy & G.Mckay Butter worth - Heinemann publications - 1982.
- 2 Energy management hand book by W.CTurner - John wiley and sons - 1982.

**Reference Books:**

- 1 Energy efficient electric motors by John.C.Andreas - Marcel Dekker Inc Ltd-2nd edition - 1995.
- 2 Energy management by Paul o' Callaghan - Mc-graw Hill Book company-1st edition - 1998.

**Web Links:**

- 1 <https://nptel.ac.in/courses/108106022>
- 2 <https://archive.nptel.ac.in/courses/108/106/108106022>

## SUSTAINABLE ENERGY TECHNOLOGIES

### (OPEN ELECTIVE-I)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>Semester: V</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231ME5O01</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Explain the importance of Sustainable energy Sources and Solar radiation.  
**CO2:** Explain working of Solar Energy collection and Storage.  
**CO3:** Discuss the Working of Solar PV module and Solar PV systems.  
**CO4:** Describe process of energy extraction from Wind and Biomass.  
**CO5:** Discuss process of energy extraction from Geothermal, Ocean and fuel cells.

#### Mapping of Course Outcomes with Program Outcomes:

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 2    | -    | -    | -    | -    | 3    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 2    | -    | -    | -    | -    | 3    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 2    | -    | -    | -    | -    | 3    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 2    | -    | -    | -    | -    | 3    | -    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 2    | -    | -    | -    | -    | 3    | -    | -    | -    | -     | -     | -     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | -    |
| <b>CO2:</b> | -    | -    |
| <b>CO3:</b> | -    | -    |
| <b>CO4:</b> | -    | -    |
| <b>CO5:</b> | -    | -    |

#### Unit – I

##### Sustainable Energy Sources

Types of Sustainable Energy sources, Importance, and limitations of Sustainable sources of energy, Sustainable Design and development, Present Indian and international energy scenario of conventional and non-conventional energy sources.

**Solar Radiation:** Role and potential of new and renewable sources, fundamentals of solar radiation, sun-earth relationships, coordinate systems and coordinates of the sun, solar radiation on tilted surface, instruments for measuring solar radiation and sun shine, solar radiation data.

#### Unit – II

**Solar Energy Collection:** Flat plate and concentrating collectors, classification of concentrating collectors, orientation.

**Solar Energy Storage and Applications:** Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

**Unit – III****Solar PV Modules and PV Systems:**

PV Module Circuit Design, Module Structure, Electrical and Mechanical Insulation, Lifetime of PV Modules, Degradation and Failure, PV Module Parameters, Efficiency of PV Module, Solar PV Systems-Design of Off Grid Solar Power Plant. Installation and Maintenance.

**Storage in PV Systems:**

Battery Operation, Types of Batteries, Battery Parameters, Application and Selection of Batteries for Solar PV System.

**Unit – IV**

**Wind Energy:** Sources and potentials, types of winds, horizontal and vertical axis windmills, performance characteristics, Betz criteria.

**Bio-Mass:** Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels.

**Unit – V**

**Geothermal Energy:** Origin, Applications, Types of Geothermal Resources, Relative Merits

**Ocean Energy:** Ocean Thermal Energy; Open Cycle & Closed Cycle OTEC Plants, Environmental Impacts, Challenges

**Fuel Cells:** Introduction, Applications, Classification, Different Types of Fuel Cells Such as Phosphoric Acid Fuel Cell, Alkaline Fuel Cell, PEM Fuel Cell, MC Fuel Cell.

**Text Books:**

- 1 Non-conventional energy source, B.H. Khan, McGraw Hill Education India Private Limited, 3<sup>rd</sup> edition, 2017
- 2 Renewable Energy Sources and Emerging Technologies, D.P. Kothari, K.C Singal, Rakesh Ranjan PHI Learning Pvt.Ltd, New Delhi, 3<sup>rd</sup> edition, 2021.

**Reference Books:**

- 1 Sustainable Energy, Richard A. Dunlap, Cengage Learning India Private Limited, Delhi, 2015
- 2 Renewable energy, Godfrey Boyle, Open University, Oxford University Press in association with the Open University, 2004
- 3 Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki , PHI Learning Private Limited, New Delhi, 2011
- 4 Photovoltaic Systems: Analysis and Design, A.K. Mukerjee and Nivedita Thakur, PHI Learning Private Limited, New Delhi, 2011

**Weblinks:**

- 1 <https://nptel.ac.in/courses/112105051>
- 2 <https://www.eia.gov/energyexplained/renewable-sources/>

**APPLIED OPERATIONS RESEARCH**  
**(OPEN ELECTIVE-I)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>Semester: V</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231ME5O02</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Formulate and solve real industrial problems using Graphical and Simplex methods  
**CO2:** Interpret Transportation and sequencing problems  
**CO3:** Solve replacement problems and analyze queuing models  
**CO4:** Solve game theory and deterministic inventory problems  
**CO5:** Interpret dynamic programming and simulation.

**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 2    | 1    | 1    | -    | -    | 2    | -    | -    | -    | -     | 1     | -     |
| <b>CO2:</b> | 1    | 1    | 1    | -    | -    | 1    | -    | -    | -    | -     | 1     | -     |
| <b>CO3:</b> | 3    | 2    | 1    | -    | -    | 1    | -    | -    | -    | -     | 1     | -     |
| <b>CO4:</b> | 2    | 1    | 1    | -    | -    | 2    | -    | -    | -    | -     | 1     | -     |
| <b>CO5:</b> | 2    | 1    | 1    | -    | -    | 2    | -    | -    | -    | -     | 1     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | 2    |
| <b>CO2:</b> | -    | 2    |
| <b>CO3:</b> | -    | 2    |
| <b>CO4:</b> | -    | 2    |
| <b>CO5:</b> | -    | 2    |

**Unit – I**

**INTRODUCTION** - definition– characteristics and phases – types of operation research models – applications.

Linear programming: Problem formulation – graphical solution – simplex method – artificial variables techniques -two–phase method, big-M method – duality principle.

**Unit – II**

**TRANSPORTATION PROBLEM:** Formulation – optimal solution, unbalanced transportation problem – degeneracy, assignment problem – formulation – optimal solution - variants of assignment problem- travelling salesman problem.

**SEQUENCING** – Introduction – flow –shop sequencing – n jobs through two machines – n jobs through three machines – job shop sequencing – two jobs through ‘m’ machines.

**Unit – III**

**REPLACEMENT THEORY:** Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.

**GAME THEORY: Introduction** – mini. max (max. mini) – criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points – 2 x 2 games – dominance principle – m x 2 & 2 x n games -graphical method.

**Unit – IV**

**WAITING LINES:** Introduction – single channel – poisson arrivals – exponential service times – with infinite population and finite population models– multichannel – poisson arrivals – exponential service times with infinite population single channel.

**PROJECT MANAGEMENT:** Basics for construction of network diagram, Program Evaluation and Review Technique (PERT), Critical Path Method (CPM) – PERT Vs. CPM, determination of floats- Project crashing and its procedure.

**Unit – V**

**DYNAMIC PROGRAMMING:** Introduction – Bellman's principle of optimality – applications of dynamic programming-shortest path problem – linear programming problem.

**SIMULATION:** Definition – types of simulation models – phases of simulation– applications of simulation – inventory and queuing problems – advantages and disadvantages

**Text Books:**

- 1 Operations Research-An Introduction/Hamdy A Taha/Pearson publishers
- 2 Operations Research –Theory & publications / S.D.Sharma Kedarnath/McMillan publishers India Ltd

**Reference Books:**

- 1 Introduction to O.R/Hiller & Libermann/TMH
- 2 Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.

**Web links:**

- 1 <https://ocw.mit.edu/courses/find-by-topic/#cat=engineering&subcat=operationsresearch>
- 2 <https://nptel.ac.in/courses/112/107/112107209/>



## NANO TECHNOLOGY

### (OPEN ELECTIVE-I)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>Semester: V</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231ME5003</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Understand the classification of Nano structured Materials
- CO2:** Explain the unique properties of Nano materials.
- CO3:** Explain the Synthesis Routes - Bottom up and Top down approaches
- CO4:** Analyse the tools to characterize Nano materials
- CO5:** Understand the applications of Nano materials

#### Mapping of Course Outcomes with Program Outcomes:

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 3    | -    | 2    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 3    | -    | -    | -    | -    | 1    | 1    | -    | -    | -     | -     | -     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | -    |
| <b>CO2:</b> | -    | -    |
| <b>CO3:</b> | -    | -    |
| <b>CO4:</b> | -    | -    |
| <b>CO5:</b> | -    | -    |

#### UNIT – 1

**INTRODUCTION:** History and Scope, Classification of Nano structured Materials, Fascinating Nanostructures, and applications of nano-materials, challenges and future prospects.

#### UNIT – 2

**UNIQUE PROPERTIES OF NANO MATERIALS:** Microstructure and Defects in Nano crystalline Materials: Dislocations, Twins, stacking faults and voids, Grain Boundaries, triple and disclinations. Effect of Nano-dimensions on Materials Behavior: Elastic properties, Melting Point, Diffusivity, Grain growth characteristics, enhanced solid solubility. Magnetic Properties: Soft magnetic nanocrystalline alloy, Permanent magnetic nanocrystalline materials, Giant Magnetic Resonance, Electrical Properties, Optical Properties, Thermal Properties and Mechanical Properties.

**UNIT – 3**

**SYNTHESIS ROUTES:** Bottom up approaches: Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method, Self-assembly. Top down approaches: Mechanical alloying, Nano-lithography. Consolidation of Nano powders: Shock wave consolidation, Hot iso-static pressing and Cold iso-static pressing, Spark plasma sintering.

**UNIT – 4**

**TOOLS TO CHARACTERIZE NANOMATERIALS:** X-Ray Diffraction (XRD), Small Angle X-ray scattering, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscope (STM), Field Ion Microscope (FEM), Three-dimensional Atom Probe (3DAP), Nano indentation.

**UNIT – 5**

**APPLICATIONS OF NANO MATERIALS:** Nano-electronics, Micro- and Nano-electromechanical systems (MEMS/NEMS), Nano sensors, Nano catalysts, Food and Agricultural Industry, Cosmetic and Consumer Goods, Structure and Engineering, Automotive Industry, Water- Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defense and Space Applications, Concerns and challenges of Nanotechnology

**TEXT BOOKS:**

1. Introduction to Nano Technology by Charles. P. Poole Jr & Frank J. Owens. Wiley India Pvt. Ltd.
2. Nano Materials- A.K. Bandyopadhyay/ New Age Publishers.
3. Nano Essentials- T. Pradeep/TMH

**REFERENCE BOOKS:**

1. Solid State physics by Pillai, Wiley Eastern Ltd.
2. Introduction to solid state physics 7th edition by Kittel. John Wiley & sons (Asia) Pvt Ltd.

**THERMAL MANAGEMENT OF ELECTRONIC SYSTEMS**  
**(OPEN ELECTIVE-I)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>Semester: V</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231ME5004</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** To understand the basics of heat transfer and analyze heat transfer through fins  
**CO2:** To acquire the knowledge on Free and forced convective systems  
**CO3:** To understand the air cooling and single phase liquid cooling systems with case studies.  
**CO4:** To demonstrate the concepts of two phase cooling and heat pipes.  
**CO5:** To understand thermoelectric coolers, mini and micro channels.

**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|------|
| <b>CO1:</b> | 3    | 2    | 2    | 1    | 3    | 2    | 3    | 2    | 2    | 3     | 1     | 1    |
| <b>CO2:</b> | 3    | 2    | 3    | 3    | 2    | 1    | 2    | 3    | 1    | 2     | 2     | 2    |
| <b>CO3:</b> | 3    | 2    | 2    | 2    | 1    | 3    | 1    | 2    | 2    | 2     | 3     | 3    |
| <b>CO4:</b> | 3    | 2    | 2    | 2    | 1    | 2    | 1    | 1    | 3    | 1     | 1     | 1    |
| <b>CO5:</b> | 3    | 2    | 1    | 2    | 1    | 1    | 1    | 1    | 2    | 2     | 1     | 1    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | -    |
| <b>CO2:</b> | -    | -    |
| <b>CO3:</b> | -    | -    |
| <b>CO4:</b> | -    | -    |
| <b>CO5:</b> | -    | -    |

**Unit - I**

Introduction of Heat Transfer: Modes – Conduction, Convection and Radiation – Basic Laws – Applications of Heat Transfer.

Basics of Conduction –Conduction equation – Thermal analogy – Lumped heat capacity analysis  
 - Heat conduction with phase change - Thermal Resistance – Extended Surfaces – Uniform cross section fins – Fin efficiency – Selection and design of fins

**Unit -II**

Forced and Free Convection – Heat transfer coefficient - Parameters effecting heat transfer – Thermal Properties of fluids - Combined Modes.

Radiation – Stefan- Boltzmann Law – Kirchoff's law and Emissivity – Radiation between Black Isothermal Surfaces – Radiation between Grey Isothermal Surfaces – Extreme Climatic conditions - Radiation at normal ambient Temperature measurement and its Instrumentation.

### Unit - III

Printed Circuit boards – Chip packaging – thermal Resistance – Board Cooling methods – Board thermal Analysis – Equivalent thermal Conductivity.

Air Cooling – Fans – Heat transfer Enhancement – Air handling systems - Blowers

Single Phase Cooling – Coolant Selection – Natural Convection – Forced Convection - Air Cooling - Convective cooling in Small systems – Forced cooling in medium and large systems – Liquid cooling in high power modules – Case Studies.

### Unit - IV

Two Phase Cooling – Direct Immersion Cooling – Basics of Pool Boiling – Enhancement of Pool Boiling – Flow Boiling.

Heat Pipes – Operation Principles – Useful Characteristics – Operating Limits and Temperatures – Operation Methods – Applications – Micro Heat Pipes.

### Unit – V

Thermoelectric coolers: Basics theories – Thermoelectric effect – Operation Principles.

Phase change materials, Thermal Interface materials, Heat Spreaders and Heat Sinks – Working Principles Mini and Micro Channels. Use of nano fluids in electronic cooling.

### Text Books:

- 1 Thermal Analysis and Control of Electronic Equipment – Allan D. Kraus and Avram BarCohen, McGraw Hill, New York, NY, 1983.
- 2 Fundamentals of Microelectronics Packaging – Ed: Rao Tummala, McGraw Hill, New York, NY, 2001.1.
- 3 Packaging of Electronic Systems – James W. Dally, McGraw Hill, New York, NY, 1990

### Reference Books:

- 1 Fundamentals of Microelectronics Packaging – Edited by Rao Tummala, McGraw Hill, New York, NY, 2001.
- 2 Heat Transfer: Thermal Management of Electronics – Younes Shabany, CRC Press, 2009
- 3 HoSung Lee, Thermal Design: Heat Sinks, Thermoelectrics, Heat Pipes, Compact Heat Exchangers, and Solar Cells, 2011 John Wiley & Sons, Inc.

### Weblinks:

- 1 <https://nptel.ac.in/courses/108108110>
- 2 [https://ocw.mit.edu/courses/6-622-power-electronics-spring-2023/resources/mit6\\_622s23\\_lecture\\_01\\_mp4/](https://ocw.mit.edu/courses/6-622-power-electronics-spring-2023/resources/mit6_622s23_lecture_01_mp4/)
- 3 <https://www.coursera.org/courses?query=electronics>

## ENTREPRENEURSHIP

### (Open Elective-I)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>Semester: V</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231ME5O05</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Identify the core characteristics, knowledge, and skills of successful entrepreneurs.
- CO2:** Explain the influence of family and societal structures on entrepreneurial initiatives.
- CO3:** Explain the fundamentals of international business, including schemes and policies.
- CO4:** Develop a comprehensive business model using the Business Model Canvas framework.
- CO5:** Develop a comprehensive small business plan.

#### Mapping of Course Outcomes with Program Outcomes:

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|------|
| <b>CO1:</b> | 2    | -    | -    | -    | -    | 1    | -    | -    | 1    | -     | -     | 2    |
| <b>CO2:</b> | 2    | -    | -    | -    | -    | 1    | 2    | -    | 1    | -     | -     | -    |
| <b>CO3:</b> | 2    | -    | -    | -    | -    | 1    | -    | -    | 1    | -     | -     | 1    |
| <b>CO4:</b> | 2    | -    | -    | -    | -    | 1    | -    | -    | 1    | -     | -     | 1    |
| <b>CO5:</b> | 2    | -    | -    | -    | -    | 1    | -    | -    | 1    | -     | -     | 2    |

#### Mapping of Course Outcomes with Program Specific Outcomes:

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | -    |
| <b>CO2:</b> | -    | -    |
| <b>CO3:</b> | -    | -    |
| <b>CO4:</b> | -    | -    |
| <b>CO5:</b> | -    | -    |

#### Unit - I

##### ENTREPRENEURIAL COMPETENCE :

Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial Personality - Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur. - Features - Types - Functions - Entrepreneurship - Characteristics - Role of entrepreneurship in economic development.

#### Unit -II

##### ENTREPRENEURIAL ENVIRONMENT

Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organisational Services

**Unit - III****INDUSTRIAL POLICIES**

Central and State Government Industrial Policies and Regulations -Schemes- International Business.

**Unit - IV****BUSINESS PLAN PREPARATION**

Sources of Product for Business -Business model canvas-Business model generation-Prefeasibility Study - Criteria for Selection of Product - Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.

**Unit – V****LAUNCHING OF SMALL BUSINESS**

Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching – Incubation, Venture capital, IT startups.

Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business.

**Text Books:**

- 1 Robert D Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2013.
- 2 Dr. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 2001

**Reference Books:**

- 1 Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 1996..
- 2 Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra ,2nd Edition ,2005
- 3 P.Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai -1997.
- 4 Arya Kumar. Entrepreneurship. Pearson. 2012

**Weblinks:**

- 1 <https://www.nptel.ac.in/courses/127105007>
- 2 <https://www.youtube.com/watch?v=7NI5P4KqrAs&t=1s>

## Entrepreneurship Development & Venture Creation (Open Elective – I)

Semester: V

L T P C

Course Code: 231ME5006

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Develop an entrepreneurial mindset and appreciate the concepts of entrepreneurship, cultivate essential attributes to become an entrepreneur or Intrapreneur and demonstrate skills such as problem solving, team building, creativity and leadership
- CO2:** Comprehend the process of problem-opportunity identification through design thinking, identify market potential and customers while developing a compelling value proposition solution
- CO3:** Analyse and refine business models to ensure sustainability and profitability
- CO4:** Build Prototype for Proof of Concept and validate MVP of their practice venture idea
- CO5:** Create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture
- CO6:** Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

### Mapping of Course Outcomes with Program Outcomes:

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|------|
| <b>CO1:</b> |      |      |      |      |      |      |      |      |      |       |       |      |
| <b>CO2:</b> |      |      |      |      |      |      |      |      |      |       |       |      |
| <b>CO3:</b> |      |      |      |      |      |      |      |      |      |       |       |      |
| <b>CO4:</b> |      |      |      |      |      |      |      |      |      |       |       |      |
| <b>CO5:</b> |      |      |      |      |      |      |      |      |      |       |       |      |

### Unit I: Entrepreneurship Fundamentals & Context

Meaning and concept, attributes and mindset of entrepreneurial and intrapreneurial leadership, role models in each and their role in economic development. An understanding of how to build entrepreneurial mindset, skillsets, attributes and networks while on campus.

Core Teaching Tool: Simulation, Game, Industry Case Studies (Personalized for students – 16 industries to choose from), Venture Activity

### Unit II: Problem & Customer Identification

Understanding and analysing the macro-Problem and Industry perspective, technological, socio economic and urbanization trends and their implication on new opportunities. Identifying passion, identifying and defining problem using Design thinking principles. Analysing problem and validating with the potential customer. Iterating problem-customer fit. Understanding customer segmentation, creating and validating customer personas. Competition and Industry trends mapping and assessing initial opportunity.

Core Teaching Tool: Several types of activities including Class, game, Gen AI, 'Get out of the Building' and Venture Activity.

### Unit III: Solution design, Prototyping & Opportunity Assessment and Sizing

Understanding Customer Jobs-to-be-done and crafting innovative solution design to map to customer's needs and create a strong value proposition. Developing Problem-solution fit in an iterative manner. Understanding prototyping and MVP. Developing a feasibility prototype with differentiating value, features and benefits. Initial testing for proof-of-concept and iterate on the prototype. Assess relative market position via competition analysis, sizing the market and assess

scope and potential scale of the opportunity. Core Teaching Tool: Venture Activity, no-code Innovation tools, Class activity

#### **Unit IV: Business & Financial Model, Go-to-Market Plan**

Introduction to Business model and types, Lean approach, 9 block lean canvas model, riskiest assumptions to Business models. Importance of Build - Measure – Lean approach.

**Business planning:** components of Business plan- Sales plan, People plan and financial plan. Financial Planning: Types of costs, preparing a financial plan for profitability using financial template, understanding basics of Unit economics and analysing financial performance.

Introduction to Marketing and Sales, Selecting the Right Channel, creating digital presence, building customer acquisition strategy.

Choosing a form of business organization specific to your venture, identifying sources of funds: Debt & Equity, Map the Start-up Lifecycle to Funding Options.

Core Teaching Tool: Founder Case Studies – Sama and SecurelyShare; Class activity and discussions; Venture Activities.

#### **Unit V: Scale Outlook and Venture Pitch readiness**

Understand and identify potential and aspiration for scale vis a vis your venture idea. Persuasive Storytelling and its key components. Build an Investor ready pitch deck.

Core Teaching Tool: Expert talks; Cases; Class activity and discussions; Venture Activities.

#### **Text Books:**

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition.
2. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business

#### **Reference Books:**

1. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons.
2. Simon Sinek (2011) Start with Why, Penguin Books limited
3. Brown Tim (2019) Change by Design Revised & Updated: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business
4. Namita Thapar (2022) The Dolphin and the Shark: Stories on Entrepreneurship, Penguin Books Limited
5. Saras D. Sarasvathy, (2008) Effectuation: Elements of Entrepreneurial Expertise, Elgar Publishing Ltd

#### **Web Resources**

- Learning resource- Ignite 5.0 Course Wadhvani platform (Includes 200+ components of custom created modular content + 500+ components of the most relevant curated content)



## PRINCIPLES OF SIGNALS & SYSTEMS (Open Elective-I)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>Semester: V</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EC5001</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1** Outline the signal representation using fourier series.
- CO2** Interpret the signals in frequency domain using fourier transform.
- CO3** Infer LTI system characteristics.
- CO4** Compare sampling methods
- CO5** Apply Z-transform techniques for the analysis of discrete-time signals and Systems.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

### Unit - I

Signals: Classification of Signals, Different deterministic signals: impulse, step, ramp, gate, signum, sinc, sinusoidal, exponential, complex exponential, operations on signals. Fourier Series: Representation of Fourier series for continuous time periodic signals, Trigonometric Fourier series and Exponential Fourier series.

### Unit – II

Fourier Transform: Deriving Fourier Transform (FT) from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms, Fourier transforms involving impulse function and Signum function, Applications of Fourier Transforms

**Unit – III**

Signal Transmission Through LTI Systems: Classification of Systems, Impulse response and step response of LTI systems, Transfer function of a LTI system. Filter characteristics of LTI systems. Distortion less transmission through a system, Ideal LPF, HPF and BPF characteristics, Causality and Paley-Wiener criterion for physical realization, Signal bandwidth, system bandwidth.

**Unit – IV**

Sampling: Sampling, Sampling theorem – Graphical and analytical proof for Band Limited Signals, Nyquist rate, Nyquist duration, Impulse sampling, Natural sampling and Flat top Sampling, Reconstruction of signal from its samples, Effect of under sampling – Aliasing,

**Unit – V**

Z-Transforms: Z-Transform of a discrete time signal, Distinction between Laplace, Fourier and Z-transforms, Region of convergence in Z-Transform, constraints on ROC for various classes of discrete signals, Properties of Z-transforms, Inverse Z-transform.

**Text Books:**

1. Signals and Systems - A.V. Oppenheim, A.S. Willsky, and S.H. Nawab, PHI, 2nd Edition, 2016.
2. Signals, Systems & Communications - B.P. Lathi, BS Publications, 2003.
3. Signals and Systems – A. Anand Kumar, PHI, 4th Edition, 2017.

**Reference Books:**

1. Signals & Systems - Simon Haykin and Van Veen, Wiley, 2nd Edition

**Web Links:**

1. <https://freevideolectures.com/course/3540/signals-and-systems-i>(Signals and Systems I by Prof. K.S.Venktesh IIT Kanpur )
2. <https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/>
3. <https://nptel.ac.in/courses/108104100>(Principles of Signals and Systems, Video course, Coordinator by Prof. Aditya, K. Jagannatham, IIT Kanpur )

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## INTRODUCTION TO INTERNET OF THINGS (Open Elective-I)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| V Semester                    | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EC5002</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO 1:** Interpret the evolution of different internet technologies and need for IOT.

**CO 2:** Identify different networking components in IOT with respect to OSI.

**CO 3:** Infer the need of sensors and actuators used in IOT.

**CO 4:** Outline the terminologies and technologies associated with IOT connectivity.

**CO 5:** Summarize IOT applications for societal needs.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 3    | 2    | 1    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

### Unit - I

Introduction to IOT: Introduction, Evolution of IOT, IOT and M2M, IOT -CPS, IOT-WoT, Various enablers of IOT and Complex interdependence technologies, Networking components of IOT.

### Unit – II

Networking Components in IOT: Introduction, Network types, Network reachability, OSI model, Internet Protocol suite, Data link layer addressing, Network layer addressing, TCP/IP transport layer.

### Unit – III

IOT sensors and actuators: Introduction, Sensors and its characteristics, types of sensing, sensing considerations, Actuators, characteristics of actuators, types of actuators.

**Unit – IV**

IOT software and Protocols: Introduction, data protocols, MQTT, MQTT-SN, CoAP, XMPP, HTTP, Web Socket, Identification protocols, EPC, u Code.

**Unit – V**

Connectivity Technologies in IOT: Introduction, IEEE 802 15 4, Zigbee, Communication topologies in Zigbee, Wireless HART network architecture, RFID, Lora, WI-Fi, Bluetooth. IOT Applications: IOT in agriculture, Smart irrigation Management system, IOT in health care systems.

**Text Books:**

1. Internet of Things- A Hands-on Approach, Arshdeep Bahgaand Vijay Madiseti, Universities Press, 2015, ISBN:9788173719547
2. Getting Started with RaspberryPi, Matt Richardson & Shawn Wallace, O'Reilly(SPD), 2014, ISBN:9789350239759.
3. Misra,S.,Mukherjee,A.,&Roy,A.(2021).Introduction to IoT. Cambridge:Cambridge University Press. doi:10.1017/9781108913560.

**Reference Books:**

1. Adrian McEwen, Hakim Cassimally “Designing the Internet of Things”, John Wiley & Sons, 2014.
2. Peter Friess,’ Internet of Things—From Research and Innovation to Market Deployment’, River Publishers, 2014

**Web Links:**

1. <https://onlinecourses.nptel.ac.in/noc2lee85/course>
2. <https://onlinecourses.nptel.ac.in/noc2lcs17/preview>
3. <https://nptel.ac.in/courses/106/105/106105166/>

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## DIGITAL ELECTRONICS AND LOGIC DESIGN (Open Elective-I)

V Semester

L T P C

Course Code: 231EC5003

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1** Interpret number representation in different code formats.

**CO2** Illustrate the functionality of logic gates

**CO3** Realize logic minimization using suitable techniques.

**CO4** Construct combinational logic circuits for desired functionality.

**CO5** Realize Boolean functions using PLDs.

**CO6** Interpret the functionality of flip flops.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO6   | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |
| CO6    | -     | -     |

### Unit - I

**Number Systems:** Representation of numbers of different radix, conversion from one radix to another radix,  $r-1$ 's compliments and  $r$ 's compliments of signed numbers, problem solving.

**Binary Codes:** 4 bit codes, BCD, Excess-3, 2421, 84-2-1 9's complement code etc. Error detection & correction codes, Gray code, error detection, error correction codes.

**Logic Gates:** Basic logic operations: NOT, OR, AND, Universal building blocks, EXOR, EX-NOR Gates.

**Unit – II**

**Boolean Algebra & Minimization Techniques:** Boolean theorems, principle of complementation & duality, De-Morgan theorems, minimization of logic functions using Boolean theorems, minimization of switching functions using K-Map up to 4 variables, tabular minimization.

**Unit – III**

**Combinational Logic Circuits:** Design of Half adder, full adder, half sub-tractor, full sub-tractor, applications of full adders, 4-bit binary adder-sub-tractor circuit, BCD adder circuit, look-a-head adder circuit, Design of decoder, de-multiplexer, 7 segment decoder, higher order de-multiplexing, encoder, multiplexer, higher order multiplexing, realization of Boolean functions using decoders & multiplexers.

**Unit – IV**

**Programmable Logic Devices:** Introduction to PLD's: PROM, PAL, PLA-Basics structures, realization of Boolean function with PLDs, programming tables of PLDs, merits & demerits of PROM, PAL, PLA comparison, realization of Boolean functions using PROM, PAL, PLA, programming tables of PROM, PAL, PLA.

**Unit – V**

**Sequential Circuits:** Classification of sequential circuits (synchronous and asynchronous) basic flip-flops, truth tables and excitation tables (NAND RS latch, NOR RS latch, RS flip-flop, JK flip-flop, T-flip-flop, D- flip-flop with reset and clear terminals). Conversion from one flip-flop to another flip-flop.

**Text Books:**

1. Digital Design, Morris Mano, Pearson, 3rd Edition, 2002.
2. Fundamentals of Logic Design, Charles H. Roth Jr., Jaico Publishers, 2004.
3. Switching Theory and Logic Design, A. Anand Kumar, Pearson, 3rd Edition, 2013.

**Reference Books:**

1. Modern Digital Electronics, RP Jain, Tata Mc Graw Hill, 4th Edition, 2010.
2. Introduction to Switching Theory and Logic Design, Fredriac J. Hill, Gerald R. Peterson, 3rd Edition, John Wiley & Sons Inc., 1982.
3. Switching and Finite Automata Theory, ZviKohavi&NirajK.Jha, 3rd Edition 2010.

**Web Links:**

1. <http://nptel.ac.in/courses/117/106/117106086/> (By Prof. Goutam Saha, Electronics & Electrical Communication Engineering Dept, IIT Kharagpur).
2. <https://www.nptelvideos.in/2012/12/digital-circuits-and-systems.html> (By Prof. Santanu Chattopadhyay, Electronics & Electrical Communication Engineering Dept, IIT Kharagpur).
3. <https://www.smartzworld.com/notes/switching-theory-and-logic-design-stld/>.

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**DATA BASE MANAGEMENT SYSTEMS****(Open Elective-I)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>V Semester</b>             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CS5001</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Summarize the database characteristics and identify various database architectures.

**CO2:** Interpret relational database using SQL

**CO3:** Examine issues in data storage and query processing for appropriate

**CO4:** Make use of normalization techniques for database design

**CO5:** Illustrate the mechanisms of transaction management.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|------|
| CO1   | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | 1    |
| CO2   | 1    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 2    |
| CO3   | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | 1    |
| CO4   | 2    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 2    |
| CO5   | 3    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | 2    |

**Mapping Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

**Unit – I**

Introduction: Database system, Characteristics (Database Vs File System), Database Users(Actors on Scene, Workers behind the scene), Advantages of Database systems, Database applications. Brief introduction of different Data Models; Concepts of Schema, Instance and data independence; Three tier schema architecture for data independence; Database system structure, environment, Centralized and Client Server architecture for the database.

**Unit – II**

Relational Model: Introduction to relational model, concepts of domain, attribute, tuple, relation, importance of null values, constraints (Domain, Key constraints, integrity constraints) and their importance

**Unit – III**

Entity Relationship Model: Introduction, Representation of entities, attributes, entity set, relationship, relationship set, constraints, sub classes, super class, inheritance, specialization, generalization using ER Diagrams.

**Unit – IV**

Schema Refinement (Normalization): Purpose of Normalization or schema refinement, concept of functional dependency, normal forms based on functional dependency(1NF, 2NF and 3 NF), concept of surrogate key, Boyce-codd normal form(BCNF), Lossless join and dependency preserving decomposition, Fourth normal form(4NF), Fifth Normal Form (5NF).

**Unit – V**

Transaction Concept: Transaction State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability, Recoverability, Implementation of Isolation, Testing for Serializability, Failure Classification, Storage, Recovery and Atomicity, Recovery algorithm.

**Textbooks:**

1. Database Management Systems, 3/e, Raghurama Krishnan, Johannes Gehrke, TMH
2. Database System Concepts, 5/e, Silberschatz, Korth, TMH

**Reference Books:**

1. Introduction to Database Systems, 8/e C J Date, PEA.
2. Database Management System, 6/e Ramez Elmasri, Shamkant B. Navathe, PEA
3. Database Principles Fundamentals of Design Implementation and Management, Corlos Coronel, Steven Morris, Peter Robb, Cengage Learning.

**Web Links:**

1. <https://nptel.ac.in/courses/106/105/106105175/>
2. <https://www.geeksforgeeks.org/introduction-to-nosql/>
3. <https://www.youtube.com/watch?v=wkOD6mbXc2M>
4. <https://beginnersbook.com/2015/05/normalization-in-dbms/>

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## PYTHON PROGRAMMING (Open Elective-I)

V Semester

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|----------|----------|----------|----------|

Course Code: 231DS5O01

|   |   |   |   |
|---|---|---|---|
| 3 | 0 | 0 | 3 |
|---|---|---|---|

**Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Develop programs using fundamentals of python**CO2:** Make use of control statements and strings for developing applications**CO3:** Develop applications using data structures and functions**CO4:** Apply OOPs concepts and files for developing programs**CO5:** Illustrate Exception Handling to handle runtime errors.**CO6:** Build applications using GUI.**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO11 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 1   | 2   | 3   | -   | 1   | -   | -   | -   | -   | -    | -    | 2    |
| CO2   | 2   | 2   | 3   | -   | 1   | -   | -   | -   | -   | -    | -    | 2    |
| CO3   | 2   | 2   | 2   | -   | 1   | -   | -   | -   | -   | -    | -    | 2    |
| CO4   | 2   | 2   | 2   | -   | 1   | -   | -   | -   | -   | -    | -    | 2    |
| CO5   | 2   | 1   | 2   | -   | 1   | -   | -   | -   | -   | -    | -    | 2    |
| CO6   | 2   | 1   | 3   | -   | 1   | -   | -   | -   | -   | -    | -    | 2    |

**Mapping Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

**Unit - I**

Programming: Introduction to Programming Concepts with Scratch Introduction: Introduction to Python, Program Development Cycle, Input, Processing, and Output, Displaying Output with the Print Function, Comments, Variables, Reading Input from the Keyboard, Performing Calculations, Operators. Type conversions, Expressions, More about Data Output. Data Types Expression: Strings Assignment, and Comment, Numeric Data Types and Character Sets, Using functions and Modules. Decision Structures and Boolean Logic: if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators, Boolean Variables. Repetition Structures: Introduction, while loop, for loop, Calculating a Running Total, Input Validation Loops, Nested

## **Unit – II**

Control Statement: Definite iteration for Loop Formatting Text for output, Selection if and if else Statement Conditional Iteration The While Loop Strings and Text Files: Accessing Character and Substring in Strings, Data Encryption, Strings and Number Systems, String Methods Text Files

## **Unit – III**

List and Dictionaries: Lists, Defining Simple Functions, Dictionaries Design with Function: Functions as Abstraction Mechanisms, Problem Solving with Top Down Design, Design with Recursive Functions, Case Study Gathering Information from a File System, Managing a Program's Namespace, Higher Order Function. Modules: Modules, Standard Modules, Packages

## **Unit – IV**

Object Oriented Programming: Concept of class, object and instances, Constructor, class attributes and destructors, Real time use of class in live projects, Inheritance , overlapping and overloading operators, Adding and retrieving dynamic attributes of classes, Programming using OOPS support Design with Classes: Objects and Classes, Data modeling Examples, Case Study An ATM, Structuring Classes with Inheritance and Polymorphism File Operations: Reading config files in python, Writing log files in python, Understanding read functions, read(), readline() and readlines(), Understanding write functions, write() and writelines(), Manipulating file pointer using seek, Programming using file operations

## **Unit – V**

Errors and Exceptions: Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, User-defined Exceptions, Defining Clean-up Actions, Redefined Clean up Actions. Graphical User Interfaces: The Behavior of Terminal Based Programs and GUI - Based, Programs, Coding Simple GUI-Based Programs, Other Useful GUI Resources.

### **Text Books:**

1. Fundamentals of Python First Programs, Kenneth. A. Lambert, Cengage, 2018
2. Beginning Python: from Novice to Professional, Lie Hetland, Magnus, 2nd Edition, 2005

### **Reference Books:**

1. Introduction to Python Programming, Gowrishankar.S, Veena A, CRC Press
2. Introduction to Programming Using Python, Y. Daniel Liang, Pearson, 2017.
3. Think Python, Allen Downey, Green Tea Press, 2012 .
4. Python for Everybody Exploring Data in Python 3, Charles Russell Severance, Sue Blumenberg.

### **Web Links:**

1. <https://www.python.org/>
2. <https://www.coursera.org/courses?query=Python%20programming>
3. <https://www.learnpython.org/>
4. [https://www.tutorialspoint.com/python3/python\\_tutorial.pdf](https://www.tutorialspoint.com/python3/python_tutorial.pdf)

## COMPUTER ORGANIZATION (Open Elective-I)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| V Semester                    | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231IT5001</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Describe the basic structure of a computer system, various number systems and arithmetic operations.
- CO2:** Explain the Operation of CPUs including RTL, ALU, Instruction Cycle and Buses
- CO3:** Demonstrate the architecture and functionality of central processing unit
- CO4:** Illustrate the I/O and memory organization in an efficient way.
- CO5:** Make use of multi processors and pipelining to improve the efficiency of computer system.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 2   | 2   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO2</b> | 3   | 1   | 1   | 2   | -   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO3</b> | 2   | 2   | 2   | 3   | -   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO4</b> | 2   | 1   | 3   | 2   | -   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO5</b> | 2   | 3   | 1   | 1   | -   | -   | -   | -   | -   | -    | -    | -    |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | -    |
| <b>CO2</b> | -    | -    |
| <b>CO3</b> | -    | -    |
| <b>CO4</b> | -    | -    |
| <b>CO5</b> | -    | -    |

### Unit – I

Basic Structure of Computers: Basic Organization of Computers, Historical Perspective, Bus Structures. Data Representation: Data types, Complements, Fixed Point Representation. Floating – Point Representation. Other Binary Codes, Error Detection Codes. Computer Arithmetic: Addition and Subtraction, Multiplication Algorithms, Division Algorithms.

### Unit – II

Register Transfer Language and Microoperations: Register Transfer language. Register Transfer Bus and Memory Transfers, Arithmetic Micro operations, Logic Micro Operations, Shift Micro Operations, Arithmetic Logic Shift Unit. Basic Computer Organization and Design: Instruction Codes, Computer Register, Computer Instructions, Instruction Cycle, Memory – Reference Instructions. Input – Output and Interrupt, Complete Computer Description,

**Unit – III**

Central Processing Unit: General Register Organization, STACK Organization. Instruction Formats, Addressing Modes, Data Transfer and Manipulation, Program Control, Reduced Instruction Set Computer.

Microprogrammed Control: Control Memory, Address Sequencing, Micro Program example, Design of Control Unit.

**Unit – IV**

Memory Organization: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory.

Input-Output Organization: Peripheral Devices, Input-Output Interface, Asynchronous data transfer, Modes of Transfer, Priority Interrupts, Direct Memory Access.

**Unit – V**

Multi Processors: Introduction, Characteristics of Multiprocessors, Interconnection Structures, Inter Processor Arbitration.

Pipeline: Parallel Processing, Pipelining, Instruction Pipeline, RISC Pipeline, Array Processor.

**Text Books:**

1. Computer System Architecture, M. Morris Mano, Third Edition, Pearson, 2008.
2. Computer Organization, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, 5/e, McGraw Hill, 2002.

**Reference Books:**

1. Computer Organization and Architecture, William Stallings, 6/e, Pearson, 2006.
2. Structured Computer Organization, Andrew S. Tanenbaum, 4/e, Pearson, 2005.
3. Fundamentals of Computer Organization and Design, Sivarama P. Dandamudi, Springer, 2006

**Web Links:**

1. <https://nptel.ac.in/courses/106/105/106105163/>
2. <https://nptel.ac.in/courses/106/106/106106092/>
3. <https://www.udemy.com/course/computer-architecture-computer-organization-course/>
4. <http://www.cuc.ucc.ie/CS1101/David%20Tarnoff.pdf>

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### Object Oriented Programming Through Java (Open Elective-I)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>V Semester:</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231AM5001</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Create Well-Structured Java Programs Using Object-Oriented Programming Principles  
**CO2:** Create and implement Java classes, objects, and methods.  
**CO3:** Analyze and utilize arrays and inheritance in Java programs.  
**CO4:** Integrate packages, libraries, and exception handling in Java applications.  
**CO5:** Design and construct advanced Java applications with strings, multithreading, JDBC, and Java FX.

#### Mapping of Course Outcomes with Program Outcomes:

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|------|
| <b>CO1</b> | 3    | -    | -    | -    | 3    | -    | -    | -    | -    | -     | -     | -    |
| <b>CO2</b> | 3    | -    | 3    | -    | 3    | -    | -    | -    | -    | -     | -     | -    |
| <b>CO3</b> | 2    | 3    | 2    | -    | 3    | -    | -    | -    | -    | -     | -     | -    |
| <b>CO4</b> | 3    | 2    | 3    | -    | 3    | -    | -    | -    | -    | -     | -     | -    |
| <b>CO5</b> | 3    | 3    | 3    | -    | 3    | -    | -    | -    | -    | -     | -     | -    |

#### Mapping of Course Outcomes with Program Specific Outcomes:

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 1    |
| <b>CO2</b> | -    | 1    |
| <b>CO3</b> | -    | 1    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 3    |

#### UNIT – I

**Object Oriented Programming:** Basic concepts, Principles, Program Structure in Java: Introduction, Writing Simple Java Programs, Elements or Tokens in Java Programs, Java Statements, Command Line Arguments, User Input to Programs, Escape Sequences Comments, Programming Style.

**Data Types, Variables, and Operators :** Introduction, Data Types in Java, Declaration of Variables, Data Types, Type Casting, Scope of Variable Identifier, Literal Constants, Symbolic Constants, Formatted Output with printf() Method, Static Variables and Methods, Attribute Final, Introduction to Operators, Precedence and Associativity of Operators, Assignment Operator, Basic Arithmetic Operators, Increment and Decrement Operators, Ternary Operator, Relational Operators, Boolean Logical Operators, Bitwise Logical Operators.

**Control Statements:** Introduction, if Expression, Nested if Expressions, if–else Expressions, Ternary Operator, Switch Statement, Iteration Statements, while Expression, do–while Loop, for Loop, Nested for Loop, For–Each for Loop, Break Statement, Continue Statement.

## UNIT – II

**Classes and Objects:** Introduction, Class Declaration and Modifiers, Class Members, Declaration of Class Objects, Assigning One Object to Another, Access Control for Class Members, Accessing Private Members of Class, Constructor Methods for Class, Overloaded Constructor Methods, Nested Classes, Final Class and Methods, Passing Arguments by Value and by Reference, Keyword this.

**Methods:** Introduction, Defining Methods, Overloaded Methods, Overloaded Constructor Methods, Class Objects as Parameters in Methods, Access Control, Recursive Methods, Nesting of Methods, Overriding Methods, Attributes Final and Static

## UNIT – III

**Arrays:** Introduction, Declaration and Initialization of Arrays, Storage of Array in Computer Memory, Accessing Elements of Arrays, Operations on Array Elements, Assigning Array to Another Array, Dynamic Change of Array Size, Sorting of Arrays, Search for Values in Arrays, Class Arrays, Twodimensional Arrays, Arrays of Varying Lengths, Three dimensional Arrays, Arrays as Vectors.

**Inheritance:** Introduction, Process of Inheritance, Types of Inheritances, Universal Super ClassObject Class, Inhibiting Inheritance of Class Using Final, Access Control and Inheritance, Multilevel Inheritance, Application of Keyword Super, Constructor Method and Inheritance, Method Overriding, Dynamic Method Dispatch, Abstract Classes, Interfaces and Inheritance.

**Interfaces:** Introduction, Declaration of Interface, Implementation of Interface, Multiple Interfaces, Nested Interfaces, Inheritance of Interfaces, Default Methods in Interfaces, Static Methods in Interface, Functional Interfaces, Annotations.

## UNIT – IV

### **Packages and Java Library:**

Introduction, Defining Package, Importing Packages and Classes into Programs, Path and Class Path, Access Control, Packages in Java SE, Java.lang Package and its Classes, Class Object, Enumeration, class Math, Wrapper Classes, Auto boxing and Autounboxing, Java util Classes and Interfaces, Formatter Class, Random Class, Time Package, Class Instant (java.time.Instant), Formatting for Date/Time in Java, Temporal Adjusters Class, Temporal Adjusters Class.

**Exception Handling:** Introduction, Hierarchy of Standard Exception Classes, Keywords throws and throw, try, catch, and finally Blocks, Multiple Catch Clauses, Class Throwable, Unchecked Exceptions, Checked Exceptions.

**Java I/O and File:** Java I/O API, standard I/O streams, types, Byte streams, Character streams, Scanner class, Files in Java(Text Book 2)

## UNIT – V

**String Handling in Java:** Introduction, Interface Char Sequence, Class String, Methods for Extracting Characters from Strings, Comparison, Modifying, Searching; Class String Buffer.

**Multithreaded Programming:** Introduction, Need for Multiple Threads Multithreaded Programming for Multicore Processor, Thread Class, Main ThreadCreation of New Threads, Thread States, Thread PrioritySynchronization, Deadlock and Race Situations, Interthread Communication Suspending, Resuming, and Stopping of Threads.

**Textbooks:**

- 1 JAVA one step ahead, Anitha Seth, B.L.Juneja, Oxford.
- 2 Joy with JAVA, Fundamentals of Object Oriented Programming, DebasisSamanta, MonalisaSarma, Cambridge, 2023.
- 3 JAVA 9 for Programmers, Paul Deitel, Harvey Deitel, 4th Edition, Pearson.

**Reference Books:**

- 1 The complete Reference Java, 11th edition, Herbert Schildt, TMH
- 2 Introduction to Java programming, 7th Edition, Y Daniel Liang, Pearson

**Web Links:**

- 1 <https://nptel.ac.in/courses/106/105/106105191/>  
[https://infyspringboard.onwingspan.com/web/en/app/toc/lex\\_auth\\_012880464547618](https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012880464547618816347_shared/overview)
- 2 816347\_shared/overview

**Java Database Connectivity:** Introduction, JDBC Architecture, Installing MySQL and MySQL Connector/J, JDBC Environment Setup, Establishing JDBC Database Connections, ResultSet Interface

**Java FX GUI:** Java FX Scene Builder, Java FX App Window Structure, displaying text and image, event handling, laying out nodes in scene graph, mouse events (Text Book 3)

## INTRODUCTION TO UNDERGROUND MINING (OPEN ELECTIVE – I)

V Semester

L T P C

Course Code: 231MI5001

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Outline coal mining industry trends and modes of mine entry.
- CO2** Describe bord and pillar mining operations with safety measures.
- CO3** Explain longwall mining methods and their applicability.
- CO4** Analyze thick and deep seam mining methods and challenges.
- CO5** Summarize modern underground mining techniques and innovations.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PO | PSO1 | PSO2 |
|-------|------|------|
| CO1   | -    | -    |
| CO2   | -    | -    |
| CO3   | -    | -    |
| CO4   | -    | -    |
| CO5   | -    | -    |

**UNIT-I**

Introduction: Present situation and future growth of coal mining industry in India and world, different coal mining industries in India, factors effecting selection of mode of entry and different types of mode entry: incline, shaft, inclined shaft, coal mine development and its scenario, different terminology used in coal mine development, different coal mining methods, factors influencing choice of coal mining methods. Software application in coal mines for development and depillaring operations.

**UNIT-II**

Bord and Pillar Mining: applicability, limitations, advantages and disadvantages of Bord and pillar mining method, development and depillaring sequence operations in Bord and Pillar mining, and its related calculations, local fall, main fall, airblast. Dangers associated with B& Pmethod and precautions. Case study with layout.



**UNIT–III**

Longwall Mining: Applicability, limitations, merits and demerits, different long wall mining methods, factors influencing selection of long wall method, method of development and depillaring and its related calculations. Thin seam and thick seam mining with long wall mining method, Case study with layout.

**UNIT-IV**

Thick Seam and deep seam Mining: Problems associated with thick and deep seam Mining, selection of mining method, caving and stowing methods, limitations and applicability: different slicing methods- (inclined Slicing, Horizontal Slicing, Diagonal Slicing, Transversely Inclined Slicing), and Caving methods (Sublevel Caving) Working Steep and Moderately Thick Seams: Blasting Gallery Method, room and pillar method,

**UNIT– V**

Modern coal mining methods: applicability, limitations, merits and demerits of Inseam Mining and Horizon Mining, Hydraulic Mining, plough methods, working underneath surface features, extraction of multi seams, problems and issues:

Future Innovations: blind long hole pre-shattering methods, scientific mining approach, application of mining software for mine development and extraction and production planning and design of workings, Size and grade control by CSP and CWP, case study.

**Textbooks:**

1. Principles and Practices of Modern Coal Mining–R.D. Singh, New Age International, 1997.
2. Modern Coal Mining Technology–S.K.Das, 2<sup>nd</sup> edition, Lovely Prakashan Publishers, 1994.

**Reference books:**

1. Under ground Coal Mining Methods–J.G.Singh, Braj Kalpa Publishers, Varnasi, 2000.
2. Coal Mining – I.C.F. Statham, Vol. I, II, III and Vol. III. The Caxton Publishing Company Ltd. Inc. 1958.

**Web Links:**

1. <https://arlweb.msha.gov/Fatals/AccidentClassifications.asp>
2. [http://www.hsa.ie/eng/Topics/Managing\\_Health\\_and\\_Safety/Safety\\_Statement](http://www.hsa.ie/eng/Topics/Managing_Health_and_Safety/Safety_Statement)

## INTRODUCTION TO SURFACE MINING (OPEN ELECTIVE – I)

V Semester

L T P C

Course Code: 231MI5002

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Describe the applicability and limitations of opencast mining.
- CO 2:** Design open pit layouts considering bench parameters and slope stability.
- CO 3:** Explain drilling and blasting techniques with design considerations.
- CO 4:** Differentiate between surface mining methods and excavation equipment.
- CO 5:** Select appropriate transportation systems and equipment for surface mines.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PO | PSO1 | PSO2 |
|-------|------|------|
| CO1   | 3    | -    |
| CO2   | 3    | -    |
| CO3   | 3    | -    |
| CO4   | 3    | -    |
| CO5   | 3    | -    |

### UNIT-I:

**Introduction:** General consideration for the applicability of open cast mining, limits of opencast mining and its advantages and disadvantages. Method of opening box cut, selection of site for boxcut.

### UNIT-II:

**Open Pit Layout and Design:** Planning the layout and open pit mine with special reference to large mechanized mines. Optimum dimensions of open pit mines. Removal of over burden and disposal, open cast bench-number, height, width and slope angle of the bench. Factors affecting the stability of the slope. Various types of slope failures, problems on slope failures. Ground water control.

**UNIT-III:**

**Drilling and Blasting:** Drill ability, mechanics of drilling, major types of drilling machines, basics of mechanics of blasting, principles of fragmentation.

**Design of blasting:** with special reference to heavy blasting, air blasting, ground vibrations, fly rocks novel methods of drilling, smooth blasting and pre-splitting.

**UNIT-IV:**

**Surface Mining Methods:** Casting, strip, quarrying and Placer Mining, and Modern Methods Excavation and loading: Shovels, Dragline, Front-end loader, Stackers, Graders. Non-Cyclic Surface Mining: Bucket Wheel Excavators and Continuous surfaceminers.

**UNIT-V:**

**Transport Equipment:** Dumpers, Aerial ropeways-monocable and bicable types and their constructional details. Shovel – dumper combination, high angle conveyor and in-pit crusher. Selection of equipment.

**Text books:**

1. Surface Mining Technology by S.K.Das, Lovely Prakashan, Dhanbad,1994.
2. Surface Mining by G.B. Mishra, Dhanbad Publishers,1978.

**Reference books:**

1. Elements of Mining Technology, Vol.–I, D.J.Deshmukh, 6thEdition, Central Techno Publications,Nagpur,1998.
2. Opencast Mining–R.T.Deshmukh, M.Publications, Nagpur,1996.
3. Latest Development of Heavy Earth Moving Machinery Amithosh De, Annapurna Publishers, Dhanbad,1995.
4. Rock Slope Engineering, Hoek and Bray, theInstitutionofMiningandMetallurgy,1981.
5. Introductory Mining Engineering, Hartman, John Wiley and Sons,1987.

**Web Links:**

1. <https://arlweb.msha.gov/Fatals/AccidentClassifications.asp>
2. [http://www.hsa.ie/eng/Topics/Managing\\_Health\\_and\\_Safety/Safety\\_Statement\\_and\\_](http://www.hsa.ie/eng/Topics/Managing_Health_and_Safety/Safety_Statement_and_)
3. <http://www.sciencedirect.com/topics/earth-and-planetary-sciences/rock-mechanics>

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## TUNNELLING & UNDERGROUND SPACE DESIGN (OPEN ELECTIVE – I)

V Semester

L T P C

Course Code: 231MI5O03

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Explain the role of underground space in urban infrastructure and evaluate parameters influencing tunnel location and design.
- CO 2:** Compare different tunnelling methods for soft and hard ground conditions with supporting techniques.
- CO 3:** Analyze tunnel excavation through drilling and blasting, including blast design and equipment selection.
- CO 4:** Evaluate mechanized tunnelling methods including TBMs, road headers, and impact hammers.
- CO 5:** Design tunnels using field data, numerical modelling, and monitoring systems for stability assessment.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PO | PSO1 | PSO2 |
|-------|------|------|
| CO1   | -    | -    |
| CO2   | -    | -    |
| CO3   | -    | -    |
| CO4   | -    | -    |
| CO5   | -    | -    |

**UNIT I**

**INTRODUCTION:** Congestion in cities and its impact on development of social infrastructure for transport, water and power supply, separation of pedestrian and motorized vehicles and its movements, storage of materials, defense facilities including civil shelters. Parameters influencing location, shape and size; geological aspects; planning and site investigations. Tunnels for various purposes like road, rail, hydropower tunnels and caverns, Underground storage applications.

**UNIT II**

**TUNNELLING METHODS:** Types and purpose of tunnels; factors affecting choice of excavation techniques; soil and rock sampling and testing, Methods - soft ground tunneling, hard rock tunneling, shallow tunneling, deep tunneling; Shallow tunnels – cut and cover, cover and cut, pipe jacking, jacked

box excavation techniques, methods of muck disposal, supporting, problems encountered and remedial measures.

### UNIT III

**TUNNELLING BY DRILLING AND BLASTING:** Unit operations in conventional tunneling; Drilling - drilling principles, drilling equipment, drilling tools, drill selection, specific drilling, rock drillability factors; Blasting - explosives, initiators, blasting mechanics, blast holes nomenclature; types of cuts - fan, wedge and others; 21 blast design, tunnel blast performance - powder factor, parameters influencing, models for prediction; mucking and transportation equipment selection.

### UNIT IV

**MECHANIZED TUNNELLING:** Cutting principles, method of excavation, selection, performance, limitations and problems. Boring principles, method of excavation, selection, performance, limitations and problems; Road headers, Impact Hammers, Tunnel Boring Machines and applications.

### UNIT V

**TUNNEL DESIGN:** Planning and design, Assessment of behavior of tunneling media, deformation modulus and rock pressure assessment; determination of appropriate size and shape; Design of openings in rocks with the help of field data; Instrumentation and monitoring; Numerical modeling to assess the stability.

### TEXT BOOKS:

- 1) Hudson, J.A., Rock Engineering Systems Theory and Practice, Ellis Horwood, England.
- 2) Clark G.B., (1987), Principles of Rock Fragmentation, John Wiley and Sons, New York.

### REFERENCES:

- 1) Lohanson, John and Mathiesen, C.F., Modern trends in Tunnelling and Blast Design, AA Balkima, 154 P, 2000.
- 2) Bickel J.O., Kuesel T.R. and King E.H., Tunnel Engineering Hand Book, Chapmen & Hill Inc., New York and CBS Publishers, New Delhi 2nd addition.

### Web Links:

1. <https://arlweb.msha.gov/Fatals/AccidentClassifications.asp>
2. [http://www.hsa.ie/eng/Topics/Managing\\_Health\\_and\\_Safety/Safety\\_Statement\\_and\\_](http://www.hsa.ie/eng/Topics/Managing_Health_and_Safety/Safety_Statement_and_)
3. <http://www.sciencedirect.com/topics/earth-and-planetary-sciences/rock-mechanics>

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## INTRODUCTION TO MINE ENVIRONMENT (OPEN ELECTIVE – I)

V Semester

L T P C

Course Code: 231MI5004

3 0 0 3

Course Outcomes: At the end of the Course, Student will be able to:

- CO 1:** Explain the causes and control measures of spontaneous heating in underground and surface coal mines.
- CO 2:** Analyze fire hazards in mines and outline methods for fire prevention, control, and firefighting in different mining environments.
- CO 3:** Evaluate causes and preventive strategies for firedamp and coal dust explosions, including explosion investigations.
- CO 4:** Design preventive and recovery systems for mine inundation and plan approaches to old workings.
- CO 5:** Describe rescue and recovery operations in mine emergencies and the role of rescue equipment and stations.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PO | PSO1 | PSO2 |
|-------|------|------|
| CO1   | 3    | -    |
| CO2   | 3    | -    |
| CO3   | 3    | -    |
| CO4   | 3    | -    |
| CO5   | 3    | -    |

### UNIT 1:

**SPONTANEOUS HEATING** Causes, detection and preventive measures in underground and surface coal mines, control of spontaneous heating in stacks and dumps..

### UNIT 2:

**MINE FIRES** Mine fires, control of fires and fires extinguishers, study of atmosphere behind sealed off areas, fire stopping and sealing off an area, pressure balancing, conditions and procedure of reopening a sealed off area, firefighting organization. Fires in opencast mines and surface storage systems, emergency organization in mines.

**UNIT 3:**

**EXPLOSION** Fire damp and coal dust explosions, their causes and prevention, stone dust and water barriers, investigations of explosion.

**UNIT 4:**

**MINE INNUNDATION** Causes and precautionary measures, bulk head doors, barriers, dams, their design, precautions to be taken while approaching old workings, burnside drilling apparatus, recovery of flooded mines and de watering of old workings.

**UNIT 5:**

**RESCUE AND RECOVERY** Types of rescue equipment and their use, features of rescue stations and rescue rooms, first aid appliances, training of personnel, and organization of rescue and recovery work during mine fires, explosion, inundation.

**Text Books:**

- 1) Mine Environment By G.B. Mishra
- 2) Elements of Mining Tech. Vol.2 by D. J. Deshmukh
- 3) Subsurface Mine Ventilation. by Mcpherson

**Reference Books:**

- 1) Mine fires by Dr. Ramlu
- 2) Underground Mine Environment, M. Mcpherson
- 3) Subsurface Mine Ventilation, H.L. Hartman

**Web Links:**

1. <https://arlweb.msha.gov/Fatals/AccidentClassifications.asp>
2. [http://www.hsa.ie/eng/Topics/Managing\\_Health\\_and\\_Safety/Safety\\_Statement\\_and\\_](http://www.hsa.ie/eng/Topics/Managing_Health_and_Safety/Safety_Statement_and_)
3. <http://www.sciencedirect.com/topics/earth-and-planetary-sciences/rock-mechanics>

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**BASIC CROP PRODUCTION PRACTICES**  
**(Open Elective-I)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>V Semester</b>             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231AG5001</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO 1:** Explain factors affecting on crop growth and production.

**CO 2:** Explain crop selection and establishment of an adequate crop stand and ground cover.

**CO 3:** Explain crop water management using integrated water management methods.

**CO 4:** Apply agriculture crops production practices in field.

**CO 5:** Apply the horticulture crops production practices in field.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO 1  | 1    | 1    | -    | -    | 1    | -    | -    | -    | -    | -     | -     | 2     |
| CO 2  | 1    | -    | -    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |
| CO 3  | 1    | 1    | -    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |
| CO 4  | 1    | -    | 1    | 1    | 3    | -    | -    | -    | -    | -     | -     | -     |
| CO 5  | 1    | -    | 1    | 1    | 3    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

**Unit - I**

Agriculture and Crop Production: Introduction to agriculture and its crop production sub-sectors– field crop production and horticulture; Factors affecting crop growth and production: genetic (internal) and environmental (external) factors; Crop management through environmental modification and adaptation of crops to the existing environment through crop cultural practices.

**Unit – II**

Crop Selection and Establishment: Regional and seasonal selection of crops; Systems of crop production; Competition among crop plants; Spacing and arrangement of crop plants; Field preparation



for crops including systems of tillage; Establishment of an adequate crop stand and ground cover, including selection and treatment of seed, and nursery growing

### Unit – III

Crop Management: Crop water Management; a Crop nutrition management – need for supplementation to soil supplied nutrients, sources, generalized recommendations, methods and timing of application of supplemental nutrients including fertigation scheduling; Crop protection including management of weeds, pests and pathogens; Integrated methods of managing water, nutrients and plant protection; Types and methods of harvest.

### Unit – IV

Production Practices of Agricultural Crops: Generalized management and cultivation practices for important groups of field crops in Andhra Pradesh: cereal crops, grain legumes, oil seed crops, sugarcane, and fiber crops, and special purpose crops such as those grown for green manure and fodder.

### Unit – V

Production Practices of Horticultural Crops: Important basic groups of horticultural crops in A.P such as vegetable crops, fruit crops, flower crops; Cultivation practices of major fruits, major vegetables and major flowers of each group; Special features of production of horticultural crops – greenhouse cultivation, Organic farming, Zero budget farming, Vertical gardening and Kitchen farming.

### Text Books:

1. Rajendra Prasad, Text Book of Field Crop Production. Directorate of Information and Publication, Krishi Anusandhan Bhavan, Pusa, New Delhi, 2015.
2. Reddy T. Sankara G.H. Yellamanda Reddi, Principles of Agronomy, Kalyani Publishers, New Delhi, 2005.
3. Handbook of Agriculture. ICAR Publications, New Delhi, 2011.

### Reference Books:

1. Bose T. K. and L.P.Yadav. Commercial Flowers, Naya Prakash, Calcutta.1989.
2. Crop Production Guide, Tamil Nadu Agricultural University Publication, Coimbatore. 2005.
3. Kumar, N., Abdul Khader, M. Rangaswami, P. and Irulappan, I. Introduction to spices, plantation crops, medicinal and aromatic plants. Rajalakshmi Publications, Nagercoil. 1993.
4. Kumar, N., "Introduction to Horticulture", Rajalakshmi Publications. Nagercoil, 7th edition, 2015.
5. Shanmugavel, K.G. Production Technology of Vegetable Crops. Oxford India Publications, New Delhi. 1989.

### Web Links:

1. <https://www.carerlauncher.com/cbse-ncert/class-8/Science/CBSE-CropProduction and Management- Notes.html#:~:text=%E2%80%A2%20Basic%20Practices%20of%20Crop,is%20called%20ploughing%20or%20tilling.>
2. [https://www.edubeans.com/Class\\_VIII\\_Science\\_Crop-Production-and-Management.php](https://www.edubeans.com/Class_VIII_Science_Crop-Production-and-Management.php)
3. <https://byjus.com/biology/basic-practices-of-crop-production/>
4. <http://www.apagrisnet.gov.in/pdf/farmerbook.pdf>

**GROUNDWATER, WELLS AND PUMPS****(Open Elective-I)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>V Semester</b>             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231AG5O02</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1** Explain scenario, types and properties of various water bearing formations.
- CO 2** Select appropriate method for exploration and replenishment of groundwater.
- CO 3** Explain design, development and construction of wells.
- CO 4** Determine the aquifer properties under unsteady state and steady state subsurface flow conditions.
- CO 5** Explain the types, working principles with components and diagram of various water lifting devices and pumps.
- CO 6** Select the pump for irrigation by considering performance characteristics, installation and troubleshooting.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | -    | 2    | -    | -    | 3    | -    | 1    | -    | -    | -     | -     | -     |
| CO3   | -    | -    | 3    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 1    | -    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 1    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO6   | -    | 3    | 1    | -    | 3    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |
| CO6    | -     | -     |

**Unit - I**

Occurrence and movement of ground water; aquifer and its types & properties; classification of wells, fully penetrating tube wells and open wells, familiarization of various types of bore wells.

**Unit – II**

Groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; design of open wells; design of tube well and gravel pack, installation of well screen, completion and development of well.

**Unit – III**

Groundwater hydraulics- determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; well interference, multiple well systems, estimation of ground water potential, quality of ground water; artificial groundwater recharge techniques.

**Unit – IV**

Pumping systems: water lifting devices; different types of pumps, classification of pumps, component parts of centrifugal pumps, priming, pump selection, installation and troubleshooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics.

**Unit – V**

Propeller pumps; Mixed flow pumps and their performance characteristics; Vertical turbine pump- construction, installation, operation, maintenance and troubleshooting; and submersible pump- construction, installation, operation, maintenance and troubleshooting; hydraulic ram- principal of operation; Economics of pumping.

**Text Books:**

1. Water Well and Pumps, Michael AM, Khepar SD. and SK Sondhi, 2nd Edition, Tata Mc-Graw Hill, 2008.
2. Irrigation-Theory and Practice, Michael AM., 2nd Edition. Vikas Publishing House Pvt. Ltd, 2018.
3. Principles of Agricultural Engineering Vol-II, Michael A.M. and Ojha T.P. 5th Edition. Jain Brothers Publication, New Delhi, 2014.

**Reference Books:**

1. Land and Water Management Engineering, Murthy, V.V.N and Jha, M.K. Sixth Edition, Kalyani Publishers, Ludhiana, 2011.
2. Ground Water, Third Edition, New Age International, Raghunath, H.M. Publishers, New Delhi, 2007.
3. Groundwater Development and Management, Sarma, P.B.S., Allied Publishers Pvt. Ltd., New Delhi, 2009.
4. Ground Water Hydrology, Todd, D.K. John Wiley & Sons, New York, 2004.

**Web Links:**

1. <http://ecoursesonline.iasri.res.in/course/view.php?id=513>
2. <https://nptel.ac.in/courses/105/105/105105042/>

## INTRODUCTION TO PETROLEUM ENGINEERING (OPEN ELECTIVE-I)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>V Semester</b>             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231PT5O01</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Differentiate between Upstream, Mid-stream and Downstream processes
- CO 2:** Explain the concept of Hydrocarbon Phase diagrams and Reservoir Drives
- CO 3:** Demonstrate the production system and subsea wells
- CO 4:** Explain about production separators and transportation process.
- CO 5:** Discuss about refinery products and safety in refinery operations.

### Mapping of Course Outcomes with Program Outcomes

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | 3     | -     |
| CO2      | 3     | -     |
| CO3      | 3     | -     |
| CO4      | 3     | -     |
| CO5      | 3     | -     |

### UNIT-I

**Introduction:** What is Petroleum Engineering and its Significance? Introduction to Petroleum Industry- Upstream Sector – Midstream Processing-Downstream Processing- Indian and World Scenario of Petroleum and Natural Gas- Petroleum Trade- Geopolitics.

### UNIT II

**Upstream Sector-1:** Exploration & Production – Indian and World Scenario of Petroleum and Natural Gas Resources.

The Reservoir –Reservoir fluids- Hydrocarbon Phase diagrams- Onshore and Offshore Reservoirs – Reservoir Drives.

**UNIT III**

**Upstream Sector-2:** Drilling Rigs- Rig Components-Drill and drill bits- Drilling Fluids- Well Completions.

**Production System:** Sketches of Well - Well head- Christmas tree and Casing and various other parts- Cementing-Safety Systems.

**Subsea Wells:** Drilling & Completion and Production.

**Artificial Lift:** Principles and operation of Rod Pumps –Gas Lift –Electrical submersible pumps.

**Well Workover and Intervention- Well Stimulation:** Basic concepts in Matrix Acidizing and Hydro-fracturing.

**UNIT IV**

**Gathering of Oil & Gas and Storage:**

Well Tubing- Separation of Reservoir Fluids- Manifolds and Gathering – Production Separators – Gas Treatment and Compression - Oil & Gas Storage, Metering and Export.

**Midstream processing:** Transportation of Crude Oil & its Products and Natural Gas - World and Indian pipeline scenario- Design of Oil and Gas pipelines - Safety aspects of pipelines- Environmental issues.

**UNIT V**

**Downstream Processing:**

Crude Oil Refining: Classification and Composition – Constituents - Products and their specifications– Pre-treatment of crude oil- Refinery distillation- Safety in refinery operations.

**Text Books:**

1. Oil and Gas Production Handbook: An Introduction to Oil & Gas Production, Havard Devold, ABB ATPA Oil and Gas, 2006.
2. Introduction to Petroleum Engineering, John R. Fanchi and Christiansen, R.L., John Wiley & Sons, 2017.

**Reference Books:**

1. Petroleum engineering handbook: Howard.B. Bradley,SPE,1987
2. Petroleum engineering hand book: Larry .W.lake, SPE, volume II, 2006.
3. Petroleum engineering handbook: Production operations engineering, volume IV, Joe Dunn Clegg, 2009.

**Weblinks**

1. <https://www.drillopedia.com/direction-drilling-applications>
2. [https://www.academia.edu/17285077/Well\\_Control\\_Manual](https://www.academia.edu/17285077/Well_Control_Manual)

## INTRODUCTION TO PETROLEUM GEOLOGY

### (OPEN ELECTIVE-I)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>V Semester</b>             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231PT5O02</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Apply the concepts of igneous, sedimentary, metamorphic rocks to evaluate drilling operations
- CO 2:** Identify different source rocks from which hydrocarbons are generated.
- CO 3:** Classify the sources of reservoir rocks, pore space, porosity and permeability
- CO 4:** Classify and evaluate the sedimentary basins in India.
- CO5:** Gain knowledge of fluid hydrocarbons migration

#### Mapping of Course Outcomes with Program Outcomes

| CO/<br>PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO12 |
|-----------|------|------|------|------|------|------|------|------|------|-------|-------|------|
| CO1       | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2    |
| CO2       | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2    |
| CO3       | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2    |
| CO4       | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2    |
| CO5       | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2    |

#### Mapping of Course Outcomes with Program Specific Outcomes

| CO /<br>PSO | PSO 1 | PSO 2 |
|-------------|-------|-------|
| CO1         | 3     | -     |
| CO2         | 3     | -     |
| CO3         | 3     | -     |
| CO4         | 3     | -     |
| CO5         | 3     | -     |

#### UNIT-I:

Dimensions of earth, structure, composition and origin of earth-envelops of the Earth-crust, mantle, core. Internal dynamic process- Plate tectonics- continental drift, Earthquake and volcanoes. External dynamic process- weathering, erosion and deposition.

Origin of igneous, sedimentary and metamorphic rocks. Sedimentary structures- petrographic character of conglomerate, sandstone, shale, limestone.

#### **UNIT-II:**

Source rocks- Definition of source rocks, organic source rocks, nature and types of source rocks.

The process of diagenesis, catagenesis and metagenesis in the formation of source rocks, Kerogen- types, thermal maturation, sub-surface pressure temperature conditions for the generation of oil and gas from the source sediments – oil window.

#### **UNIT-III:**

Characteristics of Reservoir rocks: Classification and nomenclature: Clastic Reservoir Rocks, Carbonate Reservoir Rocks, Unconventional, Fractured and Miscellaneous reservoir rocks, Marine and non-marine reservoir rocks.

#### **UNIT-IV:**

Reservoir Properties and Cap Rocks: Reservoir pore space, porosity- primary and secondary porosity, effective porosity, fracture porosity – permeability, saturation-effective and relative permeability relationship between porosity, permeability. Cap rocks: Definition and characteristics of cap rocks.

Introduction to sedimentary basins and deltaic systems. Topographic maps, thematic maps, Topographic and thematic profiles.

#### **UNIT-V:**

Hydrocarbon migration: Geological framework of migration and accumulation, the concept of hydrocarbon migration from source beds to the carrier beds, carrier beds to the reservoir.

Classification and types of traps, Structural, stratigraphic and combination type of traps, Traps associated with salt domes.

Sedimentary Basins: Introduction to sedimentary basins.

Tectonic classification, stratigraphic evolution and hydrocarbon accumulations of the following basins: Krishna-Godavari basin, Assam Arakan basin, Cambay basin and Mumbai off-shore.

#### **Text Books:**

1. Bell, F.G., Engineering Geology, 2nd Edition, Butterworth-Heimann, 2007.
2. Mukharje, P.K., Text book of Geology, P.K The World Press Pvt Ltd., 2005.

**Reference Books:**

1. Gribble, C. D., Rutley's Elements of Mineralogy, 27th Edition. CBS Publishers, 2005.
2. David Duff, Homes' Principles of Physical Geology, Nelson Thornes Ltd; 4th Revised edition, 1992.

**Weblinks**

1. <https://www.drillopedia.com/direction-drilling-applications>
2. [https://www.academia.edu/17285077/Well Control Manual](https://www.academia.edu/17285077/Well_Control_Manual)



## INTRODUCTION TO WELL LOGGING

### (OPEN ELECTIVE-I)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>V Semester</b>             | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231PT5O03</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO 1:** Discuss about Classification of well logging methods.

**CO 2:** Identify different types of logging methods.

**CO 3:** Different ion between cased hole logging and production logging.

**CO 4:** List out the various advances in well logging.

**CO 5:** Estimate the hydrocarbon reserves with the help of well logging tools.

#### Mapping of Course Outcomes with Program Outcomes

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |

#### Mapping of Course Outcomes with Program Specific Outcomes

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | 3     | -     |
| CO2      | 3     | -     |
| CO3      | 3     | -     |
| CO4      | 3     | -     |
| CO5      | 3     | -     |

#### UNIT-I:

Direct Methods: Mud logging- coring – conventional and sidewall coring - Core analysis.

Concepts of well logging: What is well logging? - Logging Terminology-Borehole environment Borehole temperature and pressure-Log header and depth scale-Major components of well Logging unit and logging setup- Classification of well logging methods-Log presentation- Log quality control.

**UNIT-II:**

Open hole logging: SP Logging- Origin of SP, uses of SP log-Calculation of salinity of formation water- Shaliness-Factors influence SP log.

Resistivity log: Single point resistance log (SPR)- Conventional resistivity logs- Response of potential and gradient logs over thin and thick conductive and resistive formations-Limitations of conventional resistivity tools, Focused resistivity log- Advantages of focused resistivity tools over conventional resistivity tools.

Micro resistivity log: Conventional and focused micro resistivity logs and their application.

Induction log: Principle of induction tool and the advantages. Criteria for selection of induction and lateral logging tool. Determination of true resistivity ( $R_t$ ) of the formation-Resistivity index Archie's equation.

**UNIT III:**

Cased hole logging: Gamma ray spectral log-Neutron decay time log-Determination of fluid saturation behind casing-Cement bond log- Casing collar log-Depth control- Perforation technique- Free point locator and Plug setting-Casing inspection logs.

Production logging: Solving production problems with the help of Fluid Density log Temperature log and Flow meter logs.

**UNIT IV:**

Advances in Well logging: Dip meter log-Formation tester-Cased hole resistivity logs –Nuclear magnetic resonance log & Scanner logs ( Sonic scanner, MR scanner  $R_t$  scanner).Study on confirmation of log interpretation, and also recording resistivity in cased holes.

**UNIT V:**

Interpretation: Quick look interpretation- Cross plots. Neutron- Density, Sonic-Density, SonicNeutron cross plots-Hingle plot-Mid plot –Correlation- Hydrocarbon reserve estimate.

**TEXT BOOKS:**

1. Formation evaluation, Edward J. Lynch, Harper & Row, 1962.
2. Well logging and formation evaluation, Toby Darling, Elsevier, New York, 2005.
3. Well Logging & Reservoir Evaluation, Oberto Serra, Editions Technip, 2007.

**Reference books:**

1. Hydrocarbon well logging recommended practice, Society of professional well log analysts.
2. Open – Hole log analysis and formation evaluation, Richard M. Batemans, International Human Resources Development Corporation, Bostan, 1985.

**Weblinks**

1. <https://www.drillopedia.com/direction-drilling-applications>
2. [https://www.academia.edu/17285077/Well Control Manual](https://www.academia.edu/17285077/Well_Control_Manual)

**GEOTECHNICAL ENGINEERING LAB****V Semester****L T P C****Course Code: 231CE5L01****0 0 3 1.5****Course Outcomes: At the end of the course, the student will be able to**

**CO1:** Determine index properties of soils (specific gravity, consistency limits, grain size distribution, and differential free swell).

**CO2:** Evaluate permeability and understand water flow through soils using laboratory methods.

**CO3:** Estimate field and compaction characteristics such as field unit weight and optimum moisture content.

**CO4:** Assess shear strength parameters using various shear tests including Direct Shear, UCC, Vane Shear, and Triaxial tests.

**CO5:** Understand soil consolidation and bearing capacity through demonstration-based experiments like the Oedometer test, Plate Load test, and Field CBR test.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 3    | 3    | 2    | 3    | 2    | -    | -    | -    | -    | 1     | -    | 1    |
| CO2   | 3    | 3    | 2    | 3    | 2    | -    | 1    | -    | -    | 1     | -    | 1    |
| CO3   | 3    | 3    | 2    | 3    | 2    | -    | 1    | -    | -    | 1     | -    | 1    |
| CO4   | 3    | 3    | 3    | 3    | 3    | -    | 1    | 1    | 1    | 2     | -    | 2    |
| CO5   | 3    | 2    | 2    | 2    | 2    | 1    | 2    | 1    | -    | 1     | -    | 2    |

**Mapping of Course Outcomes with Program-Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | 3     | 2     |
| CO 2   | 3     | 3     |
| CO 3   | 3     | 3     |
| CO 4   | 3     | 3     |
| CO 5   | 3     | 3     |

**LIST OF EXPERIMENTS**

1. Determination of Specific Gravity using a Density Bottle and Pycnometer.
2. Determination of Consistency Limits – (i) Liquid Limit (ii) Plastic Limit and (iii) Shrinkage Limit.
3. Determination of Grain Size Distribution using Dry Sieve Analysis
4. Determination of differential free swell
5. Determination of Permeability using (i) Constant Head Method and (ii) Falling Head Method.
6. Determination of Field Unit Weight using Core Cutter and Sand Replacement Method
7. Determination of maximum dry density and optimum moisture content using the Standard Proctor Compaction test.
8. Determination of shear strength parameters using the Direct Shear test.

9. Determination of shear strength parameters using Unconfined Compression test.
10. Determination of shear strength parameters using the Vane Shear test.
11. Determination of shear strength parameters using Triaxial test.
12. Determination of Consolidation Co-efficient using Oedometer (Demo)
13. Demonstration of Field Plate Load Test
14. Demonstration of Field CBR Test

**Note:** Atleast Eight experiments shall be conducted.

**Textbooks:**

1. Soil Mechanics and Foundation Engineering by Dr. K.R. Arora, Standard Publishers and Distributors, New Delhi.
2. Basic and Applied Soil Mechanics' by Gopal Ranjan and A.S.R.Rao, New Age International Publishers.

**Reference Books**

1. Determination of Soil Properties, J. E. Bowles, McGraw Hill Book Company

**Weblinks:**

1. <https://nptel.ac.in/courses/105101160>
2. <https://smfe-iiith.vlabs.ac.in/>

## FLUID MECHANICS AND HYDRAULIC MACHINES LAB

**V Semester**

**L      T      P      C**

**Course Code: 231CE5L02**

**0      0      3      1.5**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Examine the calibration of different flowmeters.
- CO 2:** Illustrate flow measuring devices used in pipes, channels, and tanks
- CO 3:** Determine major and minor losses in pipes
- CO 4:** Analyze energy equation for problems on flow through pipes
- CO 5:** Identify the flow behavior in open channels.
- CO 6:** Examine the performance characteristics of turbines and pumps

**Mapping of Course Outcomes with Program Outcomes:**

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | 2    | -    | -    | 2    | 3    | 2    | -     | -     | -     |
| <b>CO2</b> | 2    | -    | -    | 3    | -    | -    | -    | 3    | 2    | -     | -     | -     |
| <b>CO3</b> | 3    | 2    | 2    | 2    | -    | 2    | -    | 3    | 2    | -     | -     | -     |
| <b>CO4</b> | 3    | 2    | 2    | 2    | -    | 2    | -    | 3    | 2    | -     | -     | -     |
| <b>CO5</b> | 3    | 2    | -    | 1    | -    | -    | -    | 3    | 2    | -     | -     | -     |
| <b>CO6</b> | 3    | 2    | 2    | 2    | 2    | -    | 2    | 3    | 2    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 3    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 3    | -    |
| <b>CO4</b> | 3    | -    |
| <b>CO5</b> | 2    | -    |
| <b>CO6</b> | 3    | -    |

**List of Experiments:**

1. Calibration of Venturimeter & Orifice meter.
2. Determine the Coefficient of discharge for a small orifice by a constant head method.
3. Calibration of contracted Rectangular Notch and /or Triangular Notch.
4. Determine the Coefficient of loss of head in a sudden contraction and friction factor.
5. Verify the Bernoulli's equation.
6. Study the impact of jet on various vanes.
7. Determine the height of jump and head loss in hydraulic jump.
8. Performance test on Pelton wheel turbine.
9. Performance test on Francis turbine.
10. Conduct efficiency test on centrifugal pump.
11. Conduct efficiency test on reciprocating pump.
12. Performance test on Kaplan turbine

**Reference Books:**

1. Fluid Flow in Pipes and Channels, G.L.Asawa,CBS,2015.
2. Open Channel flow, K.Subramanya, TataMcGrawHill Publishers, 2015.
3. Fluid Mechanics and Machinery, Md.Kaleem Khan, Oxford Higher Education, 2015.
4. A text book of Fluid mechanics and hydraulic machines, R.K.Bansal, Laxmi Publications NewDelhi, 2018.

**Web Links:**

1. <http://nptel.ac.in/courses/105106114>
2. [http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/Course\\_home-1.htm](http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/Course_home-1.htm)
3. [http://web.itu.edu.tr/~bulu/hydraulics\\_files/lecture\\_notes\\_05.pdf](http://web.itu.edu.tr/~bulu/hydraulics_files/lecture_notes_05.pdf)
4. <https://lecturenotes.in/subject/95/fluid-mechanics-and-hydraulic-machines>

## ESTIMATION, SPECIFICATION AND CONTRACTS

**V Semester**

**L T P C**

**Course Code: 231CE5S01**

**0 1 2 2**

**Course Outcomes: At the end of the course the student will be able to**

**CO1:** Apply principles of estimation for the valuation of buildings

**CO2:** Outline the preparation of both approximate, detailed estimates for buildings and rate analysis for various items.

**CO3:** Estimate the earth work quantities for roads and canals.

**CO4:** Prepare a bar bending schedule for different RCC elements.

**CO5:** Apply the appropriate method to estimate different items in buildings

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO1</b> | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | 2     | -    | -    |
| <b>CO2</b> | 1    | 1    | -    | -    | -    | -    | -    | 2    | -    | 1     | -    | -    |
| <b>CO3</b> | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | 2     | -    | -    |
| <b>CO4</b> | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | 2     | -    | -    |
| <b>CO5</b> | 3    | 3    | 1    | -    | -    | -    | -    | -    | -    | 2     | -    | -    |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | 1     | -     |
| <b>CO 2</b> | -     | -     |
| <b>CO 3</b> | 1     | -     |
| <b>CO 4</b> | 1     | -     |
| <b>CO 5</b> | 1     | -     |

### UNIT – I

**Contracts:** Types of contracts–Contract Documents–Conditions of contract,  
**Valuation of buildings:** concepts of e-procurement and reverse auctions. Standard specifications for different items of building construction.

### UNIT – II

**General items of work in Building:** Standard Units, Principles of working out quantities for detailed and abstract estimates –Approximate method of Estimating.

**Rate Analysis:** Working out data for various items of work, overhead and contingent charges.



**UNIT – III**

**Earth Works:** Estimation of earth work of road from longitudinal sections –Earthwork in canals – different cases–Estimation of earthwork in irrigation channels.

**UNIT-IV**

**Bar Bending Schedules and Estimation of RCC Works:** Quantity estimation and bar bending schedule for RCC roof slab – Quantity estimation and bar bending schedule for RCC beam –Quantity estimation and bar bending schedule for RCC Column with foundation footing

**UNIT-V**

**Estimation of Buildings:** Detailed Estimation of Buildings using individual wall method and centre line method for single, double and four-roomed buildings. Standard software like building estimator etc.

**Textbooks:**

1. A Textbook of Estimating and Costing for Civil Engineering, G.S. Birdie, Dhanpat Rai Publishing Company, 2014.
2. Estimating and Costing, B.N. Dutta, UBS publishers, 2018.

**Reference Books:**

1. Estimation, Costing and Specifications, M. Chakraborty, Laxmi Publications, 2006.
2. Civil Engineering Contracts and Estimates, B. S. Patil, Universities Press (India) Pvt. Ltd., Hyd, 2006.

**Web Links:**

1. <https://theconstructor.org/construction/methods-of-estimation-of-building/>
2. <https://nptel.ac.in/courses/105103093/15>

**TINKERING LAB: STRUCTURES IN SCALE****V Semester****L T P C****Course Code: 231CE5L03****0 0 2 1****Course Outcomes: At the end of the course the student will be able to****CO1:** To develop advanced prototyping and model-making skills relevant to civil engineering applications.**CO2:** To encourage innovation in sustainable construction, smart infrastructure, and digital tools.**CO3:** To enable students to conceptualize, design, and demonstrate functional working models addressing real-world civil engineering challenges.**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 2    | -    | 2    | -    | 3    | -    | -    | -    | 2    | -     | -    | -    |
| CO2   | 2    | 2    | 3    | -    | 3    | -    | 3    | -    | -    | -     | -    | -    |
| CO3   | 3    | 2    | 3    | 2    | 3    | -    | 2    | -    | 3    | 2     | 2    | 2    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | 1     | 3     |
| CO 2   | 3     | 1     |
| CO 3   | 32    | 2     |

**Module 1: Model Making Techniques and Prototyping Basics**

Fundamentals of scaled model making for civil engineering - Use of workshop tools and safety measures - Material selection for models: Thermocol, Foam board, Acrylic sheets, Popsicle sticks - Introduction to 3D printing for architectural and structural components

**Module 2: Structural Engineering Prototypes**

Concept of load paths and failure in structures - Design of bridges, trusses, domes, and shells – scaled models - Demonstration of earthquake-resistant building techniques (Shake Table concepts) - Retrofitting and strengthening methods – prototype demonstrations

**Module 3: Sustainable Construction and Environmental Models**

Use of sustainable and recycled materials in model making - Design of Rainwater Harvesting and Wastewater Treatment Plant Models - Demonstration of Green Building Concepts (insulation, ventilation, daylighting)

**Module 4: Smart Infrastructure Prototypes**

Introduction to IoT-based monitoring in Civil Engineering - Crack detection, water level indication.

**Module 5: Capstone Project and Innovation Showcase**

Idea generation techniques for real-life problem-solving - Planning and execution of group projects - Fabrication of final working prototype models - Exhibition of student projects with peer/faculty/expert review

| Module   | Activity                                                                                              |
|----------|-------------------------------------------------------------------------------------------------------|
| Module 1 | Build a scaled prototype of a two-storey building or simple truss bridge                              |
| Module 2 | Shake table demonstration with earthquake-resistant model                                             |
| Module 3 | Working prototype of rainwater harvesting or bio-filtration plant model                               |
| Module 4 | IoT-based water tank level indicator or crack detection demo                                          |
| Module 5 | Capstone Project: Develop and present an innovative prototype addressing civil engineering challenges |

**Textbooks:**

1. Model Making for Architects, Nick Dunn, Laurence King Pub, 2014.
2. Basic Civil Engineering, S.S. Bhavikatti, BNEWA; 3rd edition (19 April 2022).

**Web Links:**

1. <https://www.tinkercad.com/>
2. <https://www.instructables.com/>

**SUMMER INTERNSHIP-I**

**V Semester**  
**Course Code: 231CE5P01**

**L**     **T**     **P**     **C**  
**0**     **0**     **0**     **2**

**Guidelines:**

1. The internship is a team activity comprises of 3-4 students.
2. The internship mainly focuses on the field-oriented experience and also software related any civil engineering projects.
3. The internship relates to Surveying, Engineering materials, Structural, Transportation, Environmental and Water Resources Engineering.
4. Internship should cater to a small system required in laboratory or real life.
5. Artwork and Layout should be made using Auto-CAD software. Based on the project the advanced softwares like STAAD.pro, Sap 2000, Primevera, Sketchup, ETABS, REVIT, Arc.GIS etc., can be used for effective completion of the project.
6. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of mini project.
7. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.
8. The student is expected to exert on design, development and testing of the proposed work as per the schedule.

**Course Outcomes:** At the end of the Course, Student will be able to:

**CO1:** Conduct a technical survey to identify a real world engineering problem.

**CO2:** Analyze the industrial plant layout using technical expertise.

**CO3:** Compare theoretical and real work environments in technical perspective.

**CO4:** Identify the challenges in the execution of operations.

**CO5:** Execute the operations and report the results of assigned tasks using modern tools adhering to professional ethics.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | 2    | 2    | -    | -    | -    | 2    | 3    | 2    | 2     | 1     | 1     |
| CO2   | 2    | 2    | 2    | -    | -    | -    | 2    | 3    | 2    | 2     | 1     | 1     |
| CO3   | 2    | 2    | 2    | -    | -    | -    | 2    | 3    | 2    | 2     | 1     | 1     |
| CO4   | 2    | 2    | 2    | -    | -    | -    | 2    | 3    | 2    | 2     | 1     | 1     |
| CO5   | 2    | 2    | 2    | -    | 2    | -    | 2    | 3    | 2    | 2     | 1     | 1     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 2    | -    |
| CO2    | 2    | -    |
| CO3    | 2    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

## PROFESSIONAL ETHICS AND HUMAN VALUES (Common to all branches)

|                        |   |   |   |   |
|------------------------|---|---|---|---|
| V Semester             | L | T | P | C |
| Course Code: 231MC5T01 | 2 | 0 | 0 | 0 |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Make use of values, morals and ethics in their day-to-day life.

**CO2:** Identify what is right and wrong through moral ethics.

**CO3:** Analyze experimental learning while developing the society with ethics.

**CO4:** Apply ethical principles to resolve the problems that arise in workplace.

**CO5:** Apply adequate knowledge of the global code of conduct.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | -   | -   | -   | -   | -   | -   | -   | 3   | -   | 2    | -    | 1    |
| CO2   | -   | -   | -   | -   | -   | -   | -   | 3   | 2   | -    | -    | 1    |
| CO3   | -   | -   | -   | -   | -   | -   | -   | 3   | -   | 2    | -    | 1    |
| CO4   | -   | -   | -   | -   | -   | -   | -   | 3   | -   | 2    | -    | 1    |
| CO5   | -   | -   | -   | -   | -   | -   | -   | 3   | 2   | -    | -    | 1    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | -    | -    |
| CO2    | -    | -    |
| CO3    | -    | -    |
| CO4    | -    | -    |
| CO5    | -    | -    |

### Unit – I

Human Values: Morals, Values and Ethics – Integrity – Trustworthiness - Work Ethics – Service Learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty – Courage – Value Time – Co-operation – Commitment – Empathy – Self confidence – Spirituality- Character

### Unit – II

Principles for Harmony: Truthfulness – Customs and Traditions -Value Education – Human Dignity – Human Rights – Fundamental Duties - Aspirations and Harmony (I, We & Nature) – Gender Bias - Emotional Intelligence – Salovey – Mayer Model – Emotional Competencies – Conscientiousness.

### Unit – III

Engineering Ethics and Social Experimentation: History of Ethics - Need of Engineering Ethics - Senses of Engineering Ethics- Profession and Professionalism —Self Interest - Moral

Autonomy – Utilitarianism – Virtue Theory - Uses of Ethical Theories - Deontology- Types of Inquiry –Kohlberg’s Theory - Gilligan’s Argument –Heinz’s Dilemma - Comparison with Standard Experiments — Learning from the Past –Engineers as Managers – Consultants and Leaders – Balanced Outlook on Law - Role of Codes – Codes and Experimental Nature of Engineering

#### **Unit – IV**

Engineers’ Responsibilities towards Safety and Risk: Concept of Safety - Safety and Risk – Types of Risks – Voluntary v/sInvoluntary Risk – Consequences - Risk Assessment – Accountability – Liability - Reversible Effects - Threshold Levels of Risk - Delayed v/s Immediate Risk - Safety and the Engineer – Designing for Safety – Risk-Benefit Analysis Accidents.

#### **Unit – V**

Engineers’ Duties and Rights: Concept of Duty - Professional Duties – Collegiality - Techniques for Achieving Collegiality – Senses of Loyalty - Consensus and Controversy - Professional and Individual Rights – Confidential and Proprietary Information - Conflict of Interest-Ethical egoism - Collective Bargaining – Confidentiality - Gifts and Bribes - Problem solving- Occupational Crimes- Industrial Espionage- Price Fixing- Whistle Blowing Globalization and MNCs –Cross Culture Issues.

#### **Text Books:**

- 1.A Text Book On Professional Ethics And Human – R.S.Naagarazan.
2. Professional Ethics And Human Values By – M.P.Raghavan’s – Scitech Publications (Indian Pvt., 2013).

#### **Reference Books:**

1. Engineering Ethics & Human Values By M.Govindarajan, S.Natarajan And V.S.Senthil Kumar-PHI Learning Pvt. Ltd – 2009.
2. Human Values And Professional Ethics By Jayshree Suresh And B. S. Raghavan, S.Chand Publications
3. Professional Ethics And Human Values By Prof.D.R.Kiran-Tata Mcgraw-Hill – 2014
4. Engineering Ethics By Harris, Pritchard And Rabins, Cengage Learning, New Delhi.

#### **Web Links:**

- 1.<https://nptel.ac.in/courses/109104068>
- 2.<https://www.reelnreel.com/roles-and-responsibilities-of-a-typical-video-engineer/>
- 3.<http://nptel.ac.in/courses/109104068/30>
- 4.[http://nptel.ac.in/courses/122106031/Pdfs/2\\_1.pdf](http://nptel.ac.in/courses/122106031/Pdfs/2_1.pdf)

**DESIGN AND DRAWING OF STEEL STRUCTURES****VI Semester****L T P C****Course Code:** 231CE6T01**3 0 0 3****Course Outcomes: At the end of the course the student will be able to****CO1:** Analyze and design steel structural members with relevant IS codes**CO2:** Carryout analysis and design of flexural members and detailing**CO3:** Design of tension and compression members of different types with connection detailing**CO4:** Design slab base and gusset base for column**CO5:** Design Welded Plate Girder and Gantry Girder**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 2    | -    | 3    | -    | -    | 1    | -    | -    | -    | -     | -    | -    |
| CO2   | 2    | 1    | 3    | -    | -    | 2    | -    | -    | -    | -     | -    | -    |
| CO3   | 2    | 1    | 3    | -    | -    | 2    | -    | -    | -    | -     | -    | -    |
| CO4   | 2    | 1    | 3    | -    | -    | 2    | -    | -    | -    | -     | -    | -    |
| CO5   | 2    | 1    | 3    | -    | -    | 2    | -    | -    | -    | -     | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | 3     | -     |
| CO 2   | 3     | -     |
| CO 3   | 3     | -     |
| CO 4   | 3     | -     |
| CO 5   | 3     | -     |

**UNIT – I**

**Connections:** Riveted connections – definition, rivet strength and capacity, Welded connections: Introduction, Advantages and disadvantages of welding- Strength of welds-Butt and fillet welds: Permissible stresses – IS Code requirements. Design of fillet weld subjected to moment acting in the plane and at right angles to the plane of the joints.

**UNIT – II**

**Beams:** Allowable stresses, design requirements as per IS Code-Design of simple and compound beams-Curtailment of flange plates, Beam to beam connection, check for deflection, shear, buckling, check for bearing, laterally unsupported beams.

**UNIT – III**

**Tension Members and compression members:** Introduction to different modes of failures - Design of Tension Member - Effective length of members, slenderness ratio-permissible stresses. Design compression members subjected to axial and eccentric loading.

**UNIT-IV**

**Design of Columns:** Built up compression members – Design of lacings and battens. Design Principles of Eccentrically loaded columns, Splicing of columns.

**Design of Column Foundations:** Design of slab base and gusseted base. Column bases subjected to moment.

**UNIT-V**

**Design of Plate Girder:** Design consideration – IS Code Recommendations Design of plate girder-Welded – Curtailment of flange plates, stiffeners – splicing and connections.

**Design of Gantry Girder:** impact factors - longitudinal forces, Design of Gantry girders.

**FINAL EXAMINATION PATTERN:**

The end examination paper should consist of Part A and Part B. part A consist of two questions in Design and Drawing out of which one question is to be answered. Part B should consist of five questions and design out of which three are to be answered. Weightage for Part – A is 40% and Part-B is 60%.

**Textbooks:**

1. ‘Steel Structures Design and Practice’ by N.Subramanian, Oxford University Press.
2. ‘Design of Steel Structures’ by Ramachandra, Vol – 1, Universities Press.
3. ‘Design of steel structures’ by S.K. Duggal, Tata Mcgraw Hill, and New Delhi

**Reference Books:**

1. ‘Structural Design in Steel’ by SarwarAlamRaz, New Age International Publishers, New Delhi
2. ‘Design of Steel Structures’ by P. Dayaratnam; S. Chand Publishers

**Web Links:**

1. <https://nptel.ac.in/courses/105106112/>
2. <https://law.resource.org/pub/in/bis/S03/is.sp.6.6.1972.pdf>



## ENVIRONMENTAL ENGINEERING

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VI Semester</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE6T03</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Apply basic principles of protected water supply system for a town or city
- CO2** Illustrate multiple treatment methods based on characteristics of raw water and distribution of treated water.
- CO3** Interpret different treatment technologies of wastewater based on characteristics of sewage
- CO4** Identify an appropriate secondary and tertiary treatment method of sewage
- CO5** Demonstrate the concepts of sludge management, disposal methods and recycling treated water

**Mapping of Course Outcomes with Program Outcomes:**

|            | <b>PO 1</b> | <b>PO 2</b> | <b>PO 3</b> | <b>PO 4</b> | <b>PO 5</b> | <b>PO 6</b> | <b>PO 7</b> | <b>PO 8</b> | <b>PO 9</b> | <b>PO 10</b> | <b>PO 11</b> | <b>PO 12</b> |
|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|
| <b>CO1</b> | 3           | -           | 1           | -           | -           | 2           | 2           | -           | -           | -            | -            | 1            |
| <b>CO2</b> | 2           | 2           | 2           | 1           | -           | 2           | 2           | -           | -           | -            | -            | -            |
| <b>CO3</b> | 2           | 2           | 1           | 1           | -           | 2           | 3           | -           | -           | -            | -            | -            |
| <b>CO4</b> | 2           | 2           | 2           | 1           | -           | 2           | 2           | -           | -           | -            | -            | -            |
| <b>CO5</b> | 2           | -           | 3           | -           | -           | 2           | 3           | -           | -           | -            | -            | -            |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|            | <b>PSO1</b> | <b>PSO2</b> |
|------------|-------------|-------------|
| <b>CO1</b> | 1           | 2           |
| <b>CO2</b> | -           | 1           |
| <b>CO3</b> | -           | 3           |
| <b>CO4</b> | -           | 1           |
| <b>CO5</b> | 3           | 1           |

### Unit - I

#### **Introduction to protected water supply system:**

Importance and Necessity of Protected Water Supply systems, Water borne diseases, Flow chart of public water supply system, Estimation of water demand for a town or city, Per capita Demand and factors influencing it - Types of water demands and its variations factors affecting water demand, Design Period, population forecast, Sources of water, Intakes, conveyance of raw water.

### Unit – II

#### **Raw water treatment and Distribution:**

Raw water quality and characteristics, I.S. Drinking water quality standards - 2012 and WHO guidelines for drinking water, Water Quality Index – Calculation - Flowchart of water treatment plant, Treatment methods, Theory and Design of Sedimentation, Coagulation, Filtration, Theory of disinfection, Chlorination and other Disinfection methods, Methods of Distribution system, Layouts of Distribution networks, Analysis of Distribution networks, Components of Distribution system, Laying and testing of pipelines.

### **Unit – III**

#### **Sewage characteristics and treatment methods:**

Systems of sanitation, relative merits & demerits, collection and conveyance of waste water, Classification of sewerage systems, Estimation of sewage flow and storm water drainage, fluctuations, Types of sewers, Hydraulics of sewers and storm drains, Design of sewers, appurtenances in sewerage, Types of pumps and their suitability with regard to wastewaters, Sampling of wastewater, Physical, Chemical and Biological Examination of sewage, Primary treatment, Screens, grit chambers, Floatation, design of preliminary and primary treatment units.

### **Unit – IV**

#### **Secondary and Tertiary treatment methods:**

Aerobic and anaerobic treatment process comparison, Activated Sludge Process, principles, designs, and operational problems, Oxidation ponds, Trickling Filters– mechanism of impurities removal, classification, design, operation and maintenance problems, RBCs, Fluidized bed reactors, Removal of Nitrogen and Phosphorus, Septic Tanks and Imhoff tanks

### **Unit – V**

#### **Sludge management and recycling of treated water:**

Characteristics of sludge, handling and treatment of sludge-thickening, anaerobic digestion of sludge, Sludge drying beds, Methods of disposal, Disposal into water bodies, Oxygen Sag Curve, disposal into sea, disposal on land, sewage sickness, Importance of Recycling, Indirect and Direct methods of recycling, Guidelines of reuse of treated water, recent trends in recycling.

#### **Text Books:**

1. Water Supply Engineering, B. C. Punmia, Laxmi Publications, 2016
2. Wastewater Engineering, B. C. Punmia, Laxmi Publications, 2016

#### **Reference Books:**

1. Elements of Environmental Engineering, K. N. Duggal, S. Chand & Company Ltd., New Delhi, 2016
2. Environmental Engineering Vol 1 Water supply Engineering, S.K. Garg, Khanna Publications, 2017

#### **Web Links:**

1. [www.nptel.ac.in/courses/105104102](http://www.nptel.ac.in/courses/105104102)
2. <https://www.un-ihe.org/specialization/water-supply-engineering>

## HIGHWAY ENGINEERING

**VI Semester**
**L T P C**
**Course Code: 231CE6T02**
**3 0 0 3**
**Course Outcomes: At the end of the course the student will be able to**
**CO1:** Plan highway network for a given area

**CO2:** Determine Highway alignment and design highway geometrics.

**CO3:** Design Intersections and prepare traffic management plans.

**CO4:** Judge suitability of pavement materials.

**CO5:** Design of flexible and rigid pavements.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 1    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO2   | 3    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO3   | 2    | 2    | 2    | -    | -    | -    | -    | 1    | -    | -     | -    | -    |
| CO4   | 1    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO5   | 3    | 2    | 3    | -    | -    | -    | -    | 1    | -    | -     | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | 1     | -     |
| CO 2   | 3     | -     |
| CO 3   | 2     | -     |
| CO 4   | 1     | -     |
| CO 5   | 3     | -     |

### UNIT – I

**Highway Planning and Alignment:** Highway development in India; Classification of Roads; Road Network Patterns; Necessity for Highway Planning; Different Road Development Plans–First, second, third road development plans, road development vision 2021, Rural Road Development Plan – Vision 2025; Planning Surveys; Highway Alignment- Factors affecting Alignment-Engineering Surveys.

### UNIT – II

Highway Geometric Design: Importance of Geometric Design- Design controls and Criteria- Highway Cross Section Elements- Sight Distance Elements- Stopping Sight Distance, Overtaking Sight Distance and Intermediate Sight Distance- Design of Horizontal Alignment- Design of Super

elevation and Extra widening- Design of Transition Curves, Design of Vertical Alignment- Gradients - Vertical curves.

### UNIT – III

**Traffic Engineering:** Basic Parameters of Traffic-Volume, Speed and Density. Traffic Volume Studies; Speed studies – spot speed; Parking Studies. Capacity of Highways – Factors Affecting; LOS Concepts; Road Traffic Signs; Road markings; Types of Intersections; At- Grade Intersections – Design of Plain, Flared, Rotary and Channelized Intersections; Design of Traffic Signals – Webster Method – IRC Method.

### UNIT-IV

**Highway Materials:** Sub grade soil: classification – Group Index– Subgrade soil strength – California Bearing Ratio–Modulus of Subgrade Reaction. Stone aggregates: Desirable properties– Tests for Road Aggregates– Bituminous Materials: Types–Desirable properties— Tests on Bitumen -Bituminous paving mixes: Requirements – Marshall Method of Mix Design.

### UNIT-V

**Design of Pavements:** Types of pavements; Functions and requirements of different components of pavements; Design Factors.

**Flexible Pavements:** Design factors– Flexible Pavement Design Methods– CBR method– IRC method– Burmister method– Mechanistic method–IRC Method for Low volume Flexible pavements.

**Rigid Pavements:** Design Considerations– wheel load stresses – Temperature stresses – Frictional stresses– Combination of stresses– Design of slabs– Design of Joints– IRC method – Rigid pavements for low volume roads.

### Textbooks:

1. Highway Engineering, Khanna S. K., Justo C.E.G and Veeraragavan A. Nem Chand Bros., Roorkee.
2. Traffic Engineering and Transportation Planning, Kadiyali. L. R, Khanna Publishers, New Delhi.

### Reference Books:

1. Principles of Highway Engineering, Kadiyali. L. R, Khanna Publishers, New Delhi.
2. Principles of Transportation Engineering, Partha Chakraborty and Animesh Das, PHI Learning Private Limited, Delhi.

### Web Links:

1. <https://archive.nptel.ac.in/courses/105/101/105101087/>
2. [https://onlinecourses.nptel.ac.in/noc22\\_ce94/preview](https://onlinecourses.nptel.ac.in/noc22_ce94/preview)

**GEOTECHNICAL ENGINEERING – II**  
**(Professional Elective-II)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VI Semester</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE6E01</b> | 3        | 0        | 0        | 3        |

**Course Outcomes: At the end of the Course, Students will be able to:**

- CO1** Prepare the soil investigation report based on the suitable soil exploration method
- CO2** Determine the allowable bearing capacity for various types of shallow foundation
- CO3** Determine the allowable bearing pressure and settlement for various types of shallow foundation
- CO4** Calculate the load-carrying capacity of piles and well foundations
- CO5** Analyze various types of stability failures in earth-retaining structures

**Mapping of Course Outcomes with Program Outcomes:**

|             | <b>PO 1</b> | <b>PO 2</b> | <b>PO 3</b> | <b>PO 4</b> | <b>PO 5</b> | <b>PO 6</b> | <b>PO 7</b> | <b>PO 8</b> | <b>PO 9</b> | <b>PO 10</b> | <b>PO 11</b> | <b>PO 12</b> |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|
| <b>CO 1</b> | 3           | 3           | 3           | 3           | 2           | 3           | 1           | 1           | 2           | 1            | 2            | 2            |
| <b>CO 2</b> | 3           | 3           | 3           | 3           | 2           | 3           | 1           | 1           | 2           | 1            | 2            | 2            |
| <b>CO 3</b> | 3           | 3           | 3           | 3           | 2           | 3           | 1           | 1           | 2           | 1            | 2            | 2            |
| <b>CO 4</b> | 3           | 3           | 3           | 3           | 2           | 3           | 1           | 1           | 2           | 1            | 2            | 2            |
| <b>CO 5</b> | 3           | 3           | 3           | 3           | 3           | 3           | 1           | 1           | 3           | 1            | 2            | 2            |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | <b>PSO1</b> | <b>PSO2</b> |
|-------------|-------------|-------------|
| <b>CO 1</b> | 3           | 3           |
| <b>CO 2</b> | 2           | 2           |
| <b>CO 3</b> | 2           | 2           |
| <b>CO 4</b> | 3           | 2           |
| <b>CO 5</b> | 3           | 3           |

**Unit - I**

**Soil Exploration:**

Need – Methods and depth of soil exploration – Factors affecting the depth and location of foundation - Boring and Sampling methods – Field tests – Penetration tests – Pressure meter – Planning of program and preparation of soil investigation report.

**Unit – II**

**Shallow Foundations – Bearing Capacity Criteria:**

Types of foundations and factors to be considered in their location – Bearing capacity – Types of bearing capacity of shallow foundation - factors influencing bearing capacity – analytical methods to determine bearing capacity – Terzaghi's theory – IS Methods.

### **Unit – III**

#### **Shallow Foundations – Settlement Criteria:**

Safe bearing pressure based on N-value – Allowable bearing pressure – Safe bearing capacity and settlement from plate load test – Types of foundation settlements and their determination – Allowable settlements of structures – Raft foundation in sand and clay

### **Unit – IV**

#### **Pile Foundations and Well Foundations**

Types of piles – Load carrying capacity of piles based on static pile formulae – Dynamic pile formulae – Pile capacity based on empirical relations – Pile load tests – Load carrying capacity of pile groups in sands and clays  
– Settlement of pile groups. Types – Different shapes of well – Components of well – Functions – Forces acting on well foundations – Construction and sinking of wells – Tilt and shift.

### **Unit – V**

#### **Earth Retaining Structures and Slope Stability:**

Types of retaining walls - Rankine's and Coulomb's theory of Earth pressure – Culmann's graphical method for active earth pressure. Infinite and finite earth slopes in purely cohesionless and cohesive soil – Types and causes of slope failures – Factor of safety – Stability analysis by method of slices – Friction circle method – Taylor's method.

#### **Textbooks:**

1. Basic and Applied Soil Mechanics, Gopal Ranjan and A.S.R.Rao, New Age International Publishers, 2016
2. A Textbook of Soil Mechanics and Foundation Engineering by K.R.Arora, Standard Publishers & Distributors, 2020

#### **Reference Books:**

1. A Textbook of Soil Mechanics and Foundations B.C.Punmia, Laxmi Publications, 2017
2. Foundation Analysis & Design by Bowles & J.E, McGraw-Hill, 2001

#### **Web Links:**

1. <https://nptel.ac.in/courses/105/105/105105176/>
2. <https://nptel.ac.in/courses/105/101/105101083/>

## REPAIR AND REHABILITATION OF STRUCTURES (Professional Elective-II)

VI Semester

L T P C

Course Code: 231CE6E02

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Recognize the mechanisms of degradation of concrete structures and to design durable Concrete structures.

**CO2:** Conduct field monitoring and non-destructive evaluation of concrete structures

**CO3:** Design and suggest repair strategies for deteriorated concrete structures, including the use of composites for repair.

**CO4:** Understand the strengthening methods for concrete structures.

**CO5:** Assessment of the serviceability and residual life span of concrete structures by visual inspection and in situ tests.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | 1    |      | 1    | -    | 2    | 3    | -    | 1    | -     | -     | -     |
| CO2   | 2    | 1    |      | 2    | -    | 2    | 2    | -    | 2    | -     | -     | -     |
| CO3   | 2    | 2    | 3    | 2    | -    | 2    | 2    | -    | 2    | -     | -     | -     |
| CO4   | 2    | 2    |      | 2    | -    | 2    | 2    | -    | 2    | -     | -     | -     |
| CO5   | 2    | 2    |      | 2    | -    | 2    | 2    | -    | 2    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO2 |
|--------|-------|------|
| CO1    | 3     | -    |
| CO2    | 3     | -    |
| CO3    | 3     | -    |
| CO4    | 3     | -    |
| CO5    | 3     | -    |

### UNIT: I

Materials for repair and rehabilitation- Admixtures- Types of admixtures- Purposes of using admixtures, chemical composition, Natural admixtures and Carbon fiber wraps, Steel Plates, Nondestructive evaluation: Importance-Concrete behavior under corrosion, disintegrated mechanisms- moisture effects and thermal effects –Visual investigation- Acoustical emission methods-Corrosion activity measurement- chloride content–Depth of carbonation-Impact echo methods-Ultra sound pulse velocity methods- pull out tests.

**UNIT:II**

Strengthening and stabilisation- Techniques- design considerations shear capacity strengthening- Shear Transfer strengthening-stress reduction techniques- Column strengthening-flexural strengthening-Connection stabilization and strengthening, Crack stabilization.

**UNIT: III**

Bonded installation techniques-Externally bonded FRP-Wetlay upsheets, bolted plate, near surface mounted FRP, fundamental debonding mechanisms-intermediate crack debonding-CDC debonding-plate end debonding-strengthening of floor of structures post grout tests. Introduction to Liquefaction & its effects & applications.

**UNIT: IV**

Fiber reinforced concrete-Properties of constituent materials-Mix proportions, mixing and casting methods-Mechanical properties of fiber reinforced concrete-applications of fiber reinforced concretes-Lightweight concrete-properties of light weight concrete-No fines concrete-design of light weight concrete-Fly ash concrete-Introduction-classification of fly ash-properties and reaction mechanism of fly ash-Properties of fly ash concrete in fresh state and hardened state-Durability of fly ash concretes.

**UNIT:V**

High performance concretes-Introduction-Development of high performance concretes- Materials of high performance concretes-Properties of high performance concretes-Self Consolidating concrete-properties-qualifications.

**TEXT BOOKS**

1. Maintenance Repair Rehabilitation & Minor works of Buildings -P.C.Varghese, PHI Publications
2. Repair and Rehabilitation of Concrete Structures–P.I.Modi,C.N.Patel,PHI Publications

**REFERENCE:**

1. Concrete Technology Theory and Practice-M.S.Shetty,SChandand Company
2. Concrete Repair and Maintenance illustrated-PeterHEmmons

**WEB LINKS:**

- 1.[https://www.academia.edu/30633495/Repair\\_and\\_Rehabilitation\\_of\\_Structures](https://www.academia.edu/30633495/Repair_and_Rehabilitation_of_Structures)
- 2.<https://www.vidyarthiplus.com/vp/Thread-CE2071-Repair-and-Rehabilitation-of-Structures-Lecture-Notes>



## VALUATION AND QUANTITY SURVEY

### (Professional Elective-II)

**VI Semester****L T P C****Course Code:** 231CE6E03**3 0 0 3****Course Outcomes: At the end of the course the student will be able to**

- CO1:** Interpret the item of work from drawings and explain its general specification and unit of measurement.
- CO2:** Make use of given data from CPWDDAR/DSR for calculating the unit rate of different items of work associated with building Construction.
- CO3:** Develop detailed measurement (including BBS) and BoQ of various work like buildings, earth work for road, sanitary and water supply work.
- CO4:** Explain various basic terms related to the valuation of land and buildings.
- CO5:** Develop valuation of buildings using different methods of valuation.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | 2     | -    | -    |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | 2     | -    | -    |
| CO3   | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | 2     | -    | -    |
| CO4   | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | 2     | -    | -    |
| CO5   | 3    | 3    | 1    | -    | -    | -    | -    | -    | -    | 2     | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | 1     | -     |
| CO 2   | 1     | -     |
| CO 3   | 1     | -     |
| CO 4   | 1     | -     |
| CO 5   | 1     | -     |

**UNIT – I**

Introduction- Quantity Surveying- Basic principles, Role/responsibility of Quantity surveyor at various stages of construction. Estimate-Details required, Type of estimate, purposes. Contingencies, Work-charge establishment, Tools and Plant, centage charge, Day work, Prime cost, Provisional sum & provisional Quantity, Overhead charges, Cost index, Contract documents (Brief description only) Bill of Quantity-Typical format-use Item of works Identify various item of work from the drawings – units of measurement of various materials and works (focus may give to RCC residential building) General rule & method of measurement with reference to Indian Standard Specifications- IS1200.

**UNIT – II**

Introduction to the use of CPWD schedule of rates as per latest DSR and Analysis of rate as per latest DAR. Specifications – General specifications of all items of a residential building. Detailed specification (CPWD specifications) of major item of work like Earth work excavation in foundation, masonry, Reinforced cement concrete, finishing of building work Analysis of rates for Earth work in excavation for foundation, mortars, reinforced cement concrete Works, finishing work, masonry work, stone works, flooring with reference to latest DSR and latest DAR (Data should be given).

**UNIT – III**

Detailed Estimate- Preparation of detailed measurement using Centre line method & Short wall long wall (separate wall) method for RCC single storied building (Flat roof) including stair cabin- Residential/office/school building. BOQ preparation of a single storied RCC building work. Material quantity calculation of the items of work (Rubble, Brick work, Concrete work, Plastering) in detailed estimate prepared for building work. (Data for unit quantity should be provided from DAR)

**UNIT-IV**

Bar Bending Schedule- Preparation of BBS of RCC beams, slabs, Column footings, retaining wall. Road estimation – Estimation of earthwork from longitudinal section - metalled road. Estimation of sanitary and water supply work -Water tank, Septic tank, Manhole (No Detailed estimate needed- concept of item of work, its general specification and unit of measurement).(Valuation – purpose, factors affecting, introduction to terms - Value, Cost, Price, kinds of values Income Gross income, net income, outgoings, annuity, sinking fund, Year's purchase, Depreciation, obsolescence -Free hold and leasehold properties.)

**UNIT-V**

Methods of calculating depreciation – straight line method – constant percentage method, sinking fund method and quantity survey method. Methods of valuation–rental method, direct comparison of capital cost, valuation based on profit, depreciation method. Various method of valuation of land (Brief description only)

**Textbooks:**

1. Rangwala, Estimation Costing and Valuation, Charotar publishing house pvt.ltd
2. Estimating and Costing, B.N. Dutta, UBS publishers, 2018.

**Reference Books:**

1. Estimation, Costing and Specifications, M. Chakraborty, Laxmi Publications, 2006.
2. Civil Engineering Contracts and Estimates, B. S. Patil, Universities Press (India) Pvt. Ltd., Hyd, 2006.

**Web Links:**

1. [CPWDDAR2018andDSR2018orlatest](#)
2. [CPWDSpecificationsVol1&2\(2019orlatestedition\)](#)

## FINITE ELEMENT METHOD

### (Professional Elective-III)

**VI Semester****L T P C****Course Code:** 231CE6E04**3 0 0 3****Course Outcomes: At the end of the course, the student will be able to**

- CO1:** Apply energy principles and variational methods (Rayleigh-Ritz, weighted residuals) for approximate solutions in structural mechanics.
- CO2:** Formulate and analyze truss structures using FEM, including stiffness matrices, transformation, and stress computation.
- CO3:** Develop and solve beam and frame problems using finite element methods, including stiffness assembly and support conditions k.
- CO4:** Analyze plane stress, plane strain, and axisymmetric problems using CST/LST elements, evaluating convergence and stress interpretation
- CO5:** Implement isoparametric formulation for 2D elements, including shape functions, Gauss quadrature, and patch test validation.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 3    | 3    |      | 1    | 3    |      |      |      |      |       |      |      |
| CO2   | 3    | 3    |      | 2    | 3    |      |      |      |      |       |      |      |
| CO3   | 3    | 3    |      | 2    | 3    |      |      |      |      |       |      |      |
| CO4   | 3    | 3    |      | 1    | 3    |      |      |      |      |       |      |      |
| CO5   | 3    | 3    |      | 2    | 3    |      |      |      |      |       |      |      |

**Mapping of Course Outcomes with Program-Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | -     | -     |
| CO 2   | -     | -     |
| CO 3   | -     | -     |
| CO 4   | -     | -     |
| CO 5   | -     | -     |

**UNIT I**

Introduction: Review of stiffness method-Principle of Stationary potential energy-Potential energy of anelastic body-Rayleigh-Ritz method of functional approximation-variational approaches- weighted residual methods

**UNIT II**

Finite Element formulation of truss element: Stiffness matrix-properties of stiffness matrix –Selection of approximate displacement functions-solution of a planetruss-transformation matrix and stiffness matrix for a 3-D truss- Inclined and skewed supports-Galerkin's methodfor1-Dtruss– Computation of stress in a truss element.

**UNIT III**

Finite element formulation of Beam elements: Beam stiffness-assembly of beam stiffness matrix- Examples of beam analysis for concentrated and distributed loading-Galerkin's method – 2 Arbitrarily oriented beam element–inclined and skewed supports–rigid plane frame examples

**UNIT IV**

Finite element formulation for plane stress, plane strain and axisymmetric problems-Derivation of CST and LST stiffness matrix and equations-treatment of body and surface forces-Finite Element solution for plane stress and axisymmetric problems-comparison of CST and LST elements– convergence of solution-interpretation of stresses

**UNIT V**

Iso-parametric Formulation: Iso-parametric bar element- plane bilinear Iso-parametric element – quadratic plane element-shape functions, evaluation of stiffness matrix, consistent nodal load vector- Gauss quadrature-appropriate order of quadrature–element and mesh instabilities– spurious zero energy modes, stress computation-patch test.

**Textbooks**

1. A first course in the Finite Element Method–Daryl L. Logan, Thomson Publications.
2. Concepts and applications of Finite Element Analysis–Robert D.Cook, Michael E.Plesha, John Wiley & Sons Publications

**References:**

1. Introduction to Finite Elements in Engineering-Tirupati R.Chandrupatla, Ashok D. Belgunda, PHI publications.
2. Finite Element Methods (For Structural Engineers) Wail N Rifaie, Ashok K Govil, New Age International(P) Limited

**Web Links:**

1. <https://archive.nptel.ac.in/courses/112/105/112105308/>
2. <https://archive.nptel.ac.in/courses/112/104/112104193/>

**BRIDGE ENGINEERING****(Professional Elective-III)****VI Semester****L T P C****Course Code:** 231CE6E05**3 0 0 3****Course Outcomes: At the end of the course the student will be able to****CO1:** Explain different types of Bridges with diagrams and Loading standards**CO2:** Analyze and design various Slab bridges**CO3:** Analyze and design T Beam bridges, Box culvers and suggest structural detailing**CO4:** Analyze and design the Plate girder bridges**CO5:** Organize for attending inspections and maintenance of bridges and prepare reports.**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO1</b> | 3    | 1    | 1    | 2    | -    | -    | -    | -    | -    | -     | -    | -    |
| <b>CO2</b> | 2    | 3    | 3    | 1    | -    | -    | -    | -    | -    | -     | -    | -    |
| <b>CO3</b> | 2    | 3    | 3    | 1    | -    | -    | -    | -    | -    | -     | -    | 1    |
| <b>CO4</b> | 2    | 3    | 3    | 1    | -    | -    | -    | -    | -    | -     | -    | 1    |
| <b>CO5</b> | 3    | 1    | 1    | 2    | -    | -    | -    | -    | -    | -     | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | 2     | -     |
| <b>CO 2</b> | 3     | -     |
| <b>CO 3</b> | 3     | -     |
| <b>CO 4</b> | 3     | -     |
| <b>CO 5</b> | 2     | -     |

**UNIT – I**

**Introduction:** General Introduction to types of Bridges- (Slab bridges, TBeam, Arch bridges, Cable Stayed bridges, pre stressed concrete bridges, Truss Bridges, Culverts) - Nomenclature- Selection of Bridge Site- Economical span- Abutments pier and end connections- types of foundations- Open, Pile, Well Foundations, Bearings – Types- Introduction to Loading standards- Railway and IRC Loading

**UNIT – II**

**Types of Slab Bridges:** Slab bridges- Wheel load on slab- effective width method- slabs supported on two edges- cantilever slabs-dispersion length-Design of interior panel of slab-Guyon's– Massonet Method–Hendry-Jaegar Methods- Courbon's theory- Pigeaud's method

**UNIT – III**

**T-Beam bridges:** Analysis and design of various elements of bridge–Design of deck slab, longitudinal girders, Secondary beams- Reinforcement detailing

**Box Culverts:** Loading–Analysis and Design-Reinforcement detailing.

**UNIT-IV**

**Plate Girder Bridges:** Elements of plate girder and their design-web- flange- intermediate stiffener- vertical stiffeners- bearing stiffener- Splices, Design problem with detailing.

**UNIT-V**

**Inspection and Maintenance of Bridges:** Procedures and methods for inspection–Testing of bridges- Maintenance of Sub Structures and Super structures-Maintenance of bearings- Maintenance Schedules.

**Textbooks:**

1. ‘Essentials of Bridge Engineering ’by Johnson Victor D
2. ‘Design of Bridge Structures’ by T.R. Jagadeesh, M.A. Jayaram, PHI
3. ‘Design of RC Structures’ by B. C.Punmai, Jain & Jain, Lakshmi Publications

**Reference Books:**

1. ‘Design of Concrete Bridges’ by Aswini, Vazirani,Ratwani
2. ‘Design of Steel Structures’ by B.C.Punmai, Jain & Jain, Lakshmi Publications
3. ‘Design of Bridges’ by Krishna Raju

**Web Links:**

1. <https://archive.nptel.ac.in/courses/105/105/105105216/>
2. [https://onlinecourses.nptel.ac.in/noc21\\_ce43/](https://onlinecourses.nptel.ac.in/noc21_ce43/)

**Water Resources Engineering**  
**(Professional Elective-III)**

**VI Semester****L T P C****Course Code:** 231CE6E06**3 0 0 3****Course Outcomes: At the end of the course the student will be able to**

- CO1:** Explain the necessity and methods of irrigation, classify principal crops and seasons, and analyze soil-water-plant relationships and irrigation efficiencies.
- CO2:** Design non-erodible and erodible canals using economic and empirical methods like Kennedy's and Lacey's theories.
- CO3:** Describe the types and functions of canal structures, regulators, cross drainage works, outlets, and river training works.
- CO4:** Classify diversion head works and analyze the causes of failure of weirs on permeable foundations using Bligh's and Khosla's theories
- CO5:** Apply design principles for gravity dams, earth dams, spillways, and their components

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO1   | 3    | 2    | 1    | -    | -    | 2    | -    | -    | 1    | -     | -    | 1    |
| CO2   | 3    | 3    | 3    | 2    | 2    | -    | -    | -    | 1    | -     | -    | 1    |
| CO3   | 2    | 2    | 1    | -    | -    | 1    | -    | -    | 1    | -     | -    | 1    |
| CO4   | 3    | 3    | 3    | 2    | 2    | -    | -    | -    | 1    | -     | -    | 1    |
| CO5   | 3    | 2    | 3    | 2    | 2    | 2    | -    | -    | 1    | 1     | -    | 1    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO 1   | 2     | 3     |
| CO 2   | 3     | 2     |
| CO 3   | 3     | 2     |
| CO 4   | 3     | 2     |
| CO 5   | 3     | 2     |

**UNIT-I**

**Irrigation:** Necessity and importance, principal crops and crop seasons, types, methods of application, soil-water-plant relationship, soil moisture constants, consumptive use, estimation of consumptive use, crop water requirement, duty and delta, factors affecting duty, depth and frequency of irrigation, irrigation efficiencies.

**UNIT-II**

**Canals:** Classification, design of non-erodible canals - methods of economic section and maximum permissible velocity, economics of canal lining, design of erodible canals -Kennedy's silt theory and Lacey's regime theory.

**UNIT- III****Canal Structures:**

**Falls:** Types and location, design principles of Sarda type fall (Description only)

**Regulators:** Head and cross regulators, design principles (Description only)

**Cross Drainage Works:** Types, selection, design principles of aqueduct, siphon aqueduct and super passage. (Description only)

**Outlets:** Types, proportionality, sensitivity and flexibility

**River Training:** Objectives and approaches

**UNIT-IV**

**Diversion Head Works:** Types of diversion head works, weirs and barrages, layout of diversion head works, components. Causes and failures of weirs on permeable foundations, Bligh's creep theory, Khosla's theory, design of impervious floors for subsurface flow, exit gradient.

**UNIT-V**

**Reservoir Planning:** Investigations, site selection, zones of storage, yield and storage capacity of reservoir, reservoir sedimentation.

**Dams:** Types of dams, selection of type of dam, selection of site for a dam.

**Gravity dams:** Forces acting on a gravity dam, causes of failure of a gravity dam, elementary profile and practical profile of a gravity dam.

**Earth Dams:** Types, causes of failure, criteria for safe design, seepage, measures for control of seepage-filters.

**Spillways:** Types, design principles of Ogee spillways, types of spillways crest gates.

**TEXTBOOKS:**

1. 'Irrigation and Waterpower Engineering' by Punmia B C, P.B.B Lal, A.K. Jain and A.K. Jain (2009),  
Laxmi Publications Pvt. Ltd., New Delhi
2. 'Irrigation and Water Resources Engineering' by Asawa G L (2013), New Age International Publishers

**REFERENCES:**

1. 'Water Resources Engineering' by Mays L.W (2013), Wiley India Pvt. Ltd, New Delhi.
2. 'Irrigation Engineering' by Sharma R.K. and Sharma, T. K (2012), S. Chand & Co Publishers.

**Weblinks:**

1. <http://www.academicpub.org/jwrhe/>
2. <https://nptel.ac.in/downloads/105105110/>



## BASIC CONCRETE TECHNOLOGY (Open Elective-II)

VI Semester

L T P C

Course Code: 231CE6O01

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Demonstrate the basic concepts of concrete.

**CO2:** Illustrate the importance of fresh concrete

**CO3:** Discuss the basic ingredient's role in the production of concrete.

**CO4:** Classify the fresh and the hardened concrete properties.

**CO5:** Design the concrete mix by BIS method.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO1   | 2    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     | -     |
| CO2   | 2    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     | -     |
| CO3   | 2    | 1    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     | -     |
| CO4   | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     | -     |
| CO5   | 3    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | 3     |
| CO2    | -     | 3     |
| CO3    | -     | 3     |
| CO4    | -     | 3     |
| CO5    | -     | 3     |

### Unit - I

Ingredients of Concrete cements & Admixtures Portland cement

Chemical composition –Hydration, Setting of cement, Fineness of cement Structure of hydrate cement – Test for physical properties – Different grades of cements –Admixtures – Mineral and chemical admixtures – accelerators, retarders, air entrainers, plasticizers, super plasticizers, fly ash and silica fume. Aggregates Classification of aggregate – Particle shape & texture – Bond, strength & other mechanical properties of aggregates – Specific gravity, Bulk density, porosity, adsorption & moisture content of aggregate – Bulking of sand –Deleterious substance in aggregate – Soundness of aggregate – Alkali aggregate reaction – Thermal properties – Sieve analysis – Fineness modulus – Grading curves – Grading of fine & coarse Aggregates – Gap

graded and well graded aggregate as per relevant IS code – Maximum aggregate size. Quality of mixing water.

## **Unit – II**

### **Fresh Concrete**

Steps in Manufacture of Concrete–proportion, mixing, placing, compaction, finishing, curing – including various types in each stage. Properties of fresh concrete-Workability – Factors affecting workability – Measurement of workability by different tests, Setting times of concrete, Effect of time and temperature on workability – Segregation & bleeding – Mixing and vibration of concrete, Ready mixed concrete, Concrete.

## **Unit – III**

### **Hardened Concrete**

Water / Cement ratio – Abram’s Law – Gel space ratio –Nature of strength of concrete – Maturity concept – Strength in tension & compression – Factors affecting strength – Relation between compression & tensile strength – Curing, Testing of Hardened Concrete: Compression tests – Tension tests – Factors affecting strength – Flexure tests – Splitting tests – Non-destructive testing methods – codal provisions for NDT. Anti washout concrete.

## **Unit – IV**

### **Elasticity, Creep & Shrinkage**

Modulus of elasticity, Dynamic modulus of elasticity, Poisson’s ratio, Creep of concrete, Factors influencing creep, Relation between creep & time, Nature of creep, Effects of creep – Shrinkage –types of shrinkage.

Mix Design Factors in the choice of mix proportions – Durability of concrete –Quality Control of concrete – Statistical methods – Acceptance criteria – Concepts Proportioning of concrete mixes by various methods – BIS method of mix design

## **Unit – V**

### **Special Concretes**

Ready mixed concrete, Shotcrete, Light weight aggregate concrete, Cellular concrete, No-fines concrete, High density concrete, Fiber reinforced concrete, Different types of fibers, Factors affecting properties of F.R.C, Polymer concrete, Types of Polymer concrete, Properties of polymer concrete, High performance concrete – Self consolidating concrete, SIFCON, self-healing concrete, Recycled concrete

### **Text Books:**

1. Concrete Technology: Theory and Practice, M.L. Gambhir, McGraw Hill, 5th Edition, 2017.
2. Concrete Technology, M.S.Shetty, Chand Publication, 2006

### **Reference Books:**

1. Concrete Technology, A.M. Neville and J.J. Brooks, Pearson,2019.
2. Concrete Technology, A.R. Santhakumar, Oxford,2018.

### **Web Links:**

1. <https://nptel.ac.in/courses/105102012>
2. [www.brighthubengineering.com](http://www.brighthubengineering.com) › Concrete Technology

**Basic Surveying**  
**(Open Elective-II)**

VI Semester

**L T P C****Course Code: 231CE6O02****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Explain the various fundamental principles Geodetics**CO2:** Explain the Measurement of Horizontal Distances.**CO3:** Describe the Measurement of Directions and Angles horizontal and vertical plane.**CO4:** Explain Plane Table Surveying**CO5:** Describe the compute areas and volumes and represent 3D data on plane figures as contours.**Mapping of Course Outcomes with Program Outcomes:**

| CO/PSO     | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 3    | 2    | 1    | -    | -    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 2    | 2    | 1    | -    | -    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | 2    | -    | -    | -    | 2    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO 2 |
|------------|------|-------|
| <b>CO1</b> | -    | -     |
| <b>CO2</b> | -    | -     |
| <b>CO3</b> | -    | -     |
| <b>CO4</b> | -    | -     |
| <b>CO5</b> | -    | -     |

**Unit – I****Introduction**

Definition of surveying, Objectives and importance of surveying. Classification of surveys. Principles of surveying. Units of measurements, Surveying measurements and errors, types of errors, precision and accuracy. Classification of maps, map scale, conventional symbols, topographic maps, map layout, Survey of India Map numbering systems.

Measurement of Horizontal Distances:

Measuring tape and types. Measurement using tapes, Taping on level ground and sloping ground. Errors and corrections in tape measurements, ranging of lines, direct and indirect methods of ranging, Electronic distance measurement, basic principle. Booking of tape survey work, Field book, entries, Conventional symbols, Obstacles in tape survey, Numerical problems.

**Unit – II**

Measurement of Directions and Angles:

Compass survey: Basic definitions; meridians, bearings, magnetic and True bearings. Prismatic and surveyor's compasses, temporary adjustments, declination. Quadrantal bearings, whole circle bearings, local attraction and related problems

Traversing:

Traverse Survey and Computations: Latitudes and departures, rectangular coordinates, Traverse adjustments, Bowditch rule and transit rule, Numerical Problems.

**Unit – III**

Leveling:

Basic terms and definitions, Methods of leveling, Dumpy level, auto level, digital and laser levels. Curvature and refraction corrections. Booking and reduction of levels. Differential leveling, profile leveling, fly leveling, check leveling, reciprocal leveling.

**Unit – IV**

Plane Table Surveying:

Plane table and accessories, Advantages and limitations of plane table survey, Orientation and methods of orientation, Methods of plotting – Radiation, Intersection, Traversing, Resection method, Two point and three point problems, Solution to two point problem by graphical method, Solution to three point problem Bessel's graphical method, Errors in plane table survey.

**Unit – V**

Areas and Volumes:

Measurement of area by dividing the area into geometrical figures, area from offsets, mid ordinate rule, trapezoidal and Simpson's one third rule, area from co-ordinates, introduction to planimeter, digital planimeter. Measurement of volumes- trapezoidal and prismoidal formula.

Contouring: Contours, Methods of contouring, Interpolation of contours, contour gradient, characteristics of contours and uses.

**Text Books:**

1. B.C. Punmia, "Surveying Vol.1", Laxmi Publications pvt. Ltd., New Delhi –2017.
2. Kanetkar T P and S V Kulkarni , Surveying and Leveling Part I, Pune VidyarthiGrihaPrakashan,2015

**Reference Books:**

1. S.K. Duggal, "Surveying Vol.1", Tata McGraw Hill Publishing Co. Ltd. New Delhi.2019.
2. K.R. Arora, "Surveying Vol. 1" Standard Book House, New Delhi. –2017

**Web Links:**

1. [nptel.iitm.ac.in](http://nptel.iitm.ac.in)
2. <https://nptel.ac.in/courses/105/105/105105176/>

## REPAIR AND REHABILITATION OF STRUCTURES

### (Open Elective-II)

VI Semester

Course Code: 231CE6003

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Recognize the mechanisms of degradation of concrete structures and to design durable Concrete structures.
- CO2:** Conduct field monitoring and non-destructive evaluation of concrete structures
- CO3:** Design and suggest repair strategies for deteriorated concrete structures, including the use of composites for repair.
- CO4:** Understand the strengthening methods for concrete structures.
- CO5:** Assessment of the serviceability and residual life span of concrete structures by visual inspection and in situ tests.

#### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | 1    |      | 1    | -    | 2    | 3    | -    | 1    | -     | -     | -     |
| CO2   | 2    | 1    |      | 2    | -    | 2    | 2    | -    | 2    | -     | -     | -     |
| CO3   | 2    | 2    | 3    | 2    | -    | 2    | 2    | -    | 2    | -     | -     | -     |
| CO4   | 2    | 2    |      | 2    | -    | 2    | 2    | -    | 2    | -     | -     | -     |
| CO5   | 2    | 2    |      | 2    | -    | 2    | 2    | -    | 2    | -     | -     | -     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO2 |
|--------|-------|------|
| CO1    | 3     | -    |
| CO2    | 3     | -    |
| CO3    | 3     | -    |
| CO4    | 3     | -    |
| CO5    | 3     | -    |

#### UNIT: I

Materials for repair and rehabilitation- Admixtures- Types of admixtures- Purposes of using admixtures, chemical composition, Natural admixtures and Carbon fiber wraps, Steel Plates, Nondestructive evaluation: Importance-Concrete behavior under corrosion, disintegrated mechanisms- moisture effects and thermal effects –Visual investigation- Acoustical emission methods-Corrosion activity measurement- chloride content–Depth of carbonation-Impact echo methods-Ultra sound pulse velocity methods- pull out tests.

#### UNIT:II

Strengthening and stabilisation- Techniques- design considerations shear capacity strengthening- Shear Transfer strengthening-stress reduction techniques- Column strengthening-flexural strengthening-Connection stabilization and strengthening, Crack stabilization.

### **UNIT: III**

Bonded installation techniques-Externally bonded FRP-Wetlay upsheet, bolted plate, near surface mounted FRP, fundamental debonding mechanisms-intermediate crack debonding-CDC debonding-plate end de bonding-strengthening of floor of structures post grout tests. Introduction to Liquefaction & its effects & applications.

### **UNIT: IV**

Fiber reinforced concrete-Properties of constituent materials-Mix proportions, mixing and casting methods-Mechanical properties of fiber reinforced concrete-applications of fiber reinforced concretes-Lightweight concrete-properties of light weight concrete-No fines concrete-design of light weight concrete-Fly ash concrete-Introduction-classification of fly ash-properties and reaction mechanism of fly ash-Properties of fly ash concrete in fresh state and hardened state-Durability of fly ash concretes.

### **UNIT:V**

High performance concretes-Introduction-Development of high performance concretes- Materials of high performance concretes-Properties of high performance concretes-Self Consolidating concrete-properties-qualifications.

### **TEXT BOOKS**

1. Maintenance Repair Rehabilitation & Minor works of Buildings -P.C.Varghese, PHI Publications
2. Repair and Rehabilitation of Concrete Structures–P.I.Modi,C.N.Patel,PHI Publications

### **REFERENCE:**

1. Concrete Technology Theory and Practice-M.S.Shetty,SChandand Company
2. Concrete Repair and Maintenance illustrated-PeterHEmmons

### **WEB LINKS:**

1. [https://www.academia.edu/30633495/Repair\\_and\\_Rehabilitation\\_of\\_Structures](https://www.academia.edu/30633495/Repair_and_Rehabilitation_of_Structures)
2. <https://www.vidyarthiplus.com/vp/Thread-CE2071-Repair-and-Rehabilitation-of-Structures-Lecture-Notes>

## Air Pollution Control (Open Elective – II)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VI Semester</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE6O04</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Interpret the various ambient air quality parameters.  
**CO 2:** Examine the plume behavior in prevailing atmospheric conditions.  
**CO 3:** Explain the various methods related to sampling and analysis.  
**CO 4:** Choose the appropriate air pollution control devices.  
**CO 5:** Apply suitable particulate and gaseous control measures for an industry.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO       | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO 1</b> | 2    | 1    | -    | -    | -    | -    | 3    | -    | -    | -     | -    | 2    |
| <b>CO 2</b> | 3    | 2    | -    | -    | -    | -    | 2    | -    | -    | -     | -    | 3    |
| <b>CO 3</b> | 1    | 1    | -    | -    | -    | -    | 2    | -    | -    | -     | -    | 2    |
| <b>CO 4</b> | 1    | 2    | -    | -    | -    | -    | 1    | -    | -    | -     | -    | 3    |
| <b>CO 5</b> | -    | 2    | -    | -    | -    | -    | 1    | -    | -    | -     | -    | 3    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO / PSO    | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | -     | 1     |
| <b>CO 2</b> | -     | 2     |
| <b>CO 3</b> | -     | 1     |
| <b>CO 4</b> | -     | 2     |
| <b>CO 5</b> | -     | 2     |

### UNIT I

#### **Air Pollution:**

Definition – Sources and classification of Air Pollutants –indoor air quality – Effects of air pollution on health of Human & Animals, vegetation & materials, Global effects of air pollution - Carbon Credits and Carbon Trade.

### UNIT II

#### **Meteorology and Air Pollution:**

Factors influencing air pollution – Temperature lapse rate and atmospheric stability – wind rose –Plume behaviour – Mixing depths – Plume rise and dispersion – prediction of air quality – box model – Gaussian model – Dispersion coefficient – Application of tall chimney for pollutant dispersion.

**UNIT III****Control of Particulate Pollutants:**

Sampling and analysis of air pollutants– Properties of particulate pollution – particle size distribution – control mechanism –Dust removal equipment – Design and operation of settling chambers, cyclones, wet dust scrubbers, fabric filters and ESP.

**UNIT IV****Control of Gaseous Pollutants:**

Process and equipment for the removal of gaseous pollutants by chemical methods – Design and operation of absorption and adsorption equipment- combustion and condensation equipment.

**UNIT V****Control of Air and Noise Pollution:**

Noise pollution and control – Definition – significance in general – sources, measurement - effects and control measures. Air pollution control: Environmental friendly fuels – In plant control measures, process changes, methods of removal and recycling – Air Pollution legislation – Automobile pollution, odour pollution, flares and control – Emission standards.

**Text books:**

1. Air Pollution, M.N.Rao and H.V.N.Rao, Tata McGraw Hill Comapany.
2. Air pollution and Control, Prof.K.V.S.G. Muralikrishna, Kaushal Publications- Kakinada.
3. Fundamentals of air pollution engineering, Richard C Flagan and John H Seinfeld, Prentice hall Inc,

**Reference books:**

1. An introduction to Air pollution, R.K.Trivedy and P.K. Goel, B.S. Publications, 2003.
2. Air Pollution control–A design approach, C David Cooper and F.C. Alley, 4<sup>th</sup> Edition

**Web Links:**

1. <https://nptel.ac.in/courses/103107084>
2. <http://www.moef.nic.in/report/0203>
3. <http://home.iitk.ac.in/~anubha/APC>



## INTEGRATED SOLID WASTE MANAGEMENT FOR A SMART CITY (Open Elective – II)

VI Semester  
Course Code: 231CE6005

|   |   |   |   |
|---|---|---|---|
| L | T | P | C |
| 3 | 0 | 0 | 3 |

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1: Describe generation rates, composition, and issues of Solid waste
- CO2: Explain the issues, collection, recovery, reuse, processing of Municipal solid waste
- CO3: Illustrate the rules regarding MSW and current issues in Solid waste management
- CO4: Interpret Construction and demolition waste management
- CO5: Assess the issues related to E-waste generation and current management practices
- CO6: Illustrate hazardous waste and current management practices

### Mapping of Course Outcomes with Program Outcomes:

|     | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-----|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1 | 1    | -    | -    | -    | -    | -    | 3    | 2    | -    | -     | -     | -     |
| CO2 | 1    | -    | -    | -    | -    | -    | 3    | 2    | -    | -     | -     | -     |
| CO3 | 1    | -    | -    | -    | -    | -    | 3    | 2    | -    | -     | -     | -     |
| CO4 | 1    | -    | -    | -    | -    | -    | 3    | 2    | -    | -     | -     | -     |
| CO5 | 1    | -    | -    | -    | -    | -    | 3    | 2    | -    | -     | -     | -     |
| CO6 | 1    | -    | -    | -    | -    | -    | 3    | 2    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|     | PSO1 | PSO2 |
|-----|------|------|
| CO1 | -    | -    |
| CO2 | -    | -    |
| CO3 | -    | -    |
| CO4 | -    | -    |
| CO5 | -    | -    |

### Unit - I

Introduction:

Solid Waste Management- Definition, Concept of 4Rs (reduce, reuse, recycle and recover) of waste management, Elements of a waste management system, Issues in Solid Waste Management, Integrated Waste Management Hierarchy: Source reduction, Recycling, Waste-to-Energy and Landfilling, Review of waste management under Swachh Bharat Mission and Smart Cities Program.

### Unit – II

Municipal Solid Waste:

Waste Composition and Quantities, Collection, Transportation, Segregation, and Processing.

### Unit – III

Disposal of Municipal Solid Waste:

Landfill, Biochemical Processes and Composting, Energy Recovery from Municipal Solid Waste, Municipal Solid Waste (MSW) Rules 2016, Current Issues in Solid Waste Management and Review of MSW Management

### Unit – IV

Construction and Demolition (C&D) Waste Management:

Overview, Components; C&D Waste Management Rules 2016, Beneficial Reuse of C & D Waste Materials.

**Unit – V**

Electronic Waste (E-Waste) Management

Issues and Status in India and Globally, E-Waste Management Rules 2016 and Management Challenges.

Hazardous Wastes: Definition, Classification, Risk assessment, Transportation of hazardous waste, Current Management Practices: Environmental audit, Containment, Remedial alternatives.

**Textbooks:**

1. “Solid Waste Engineering”, William A Worrell and P. Aarne Vesilind, 2nd Edition (SI Edition) Cengage Learning, 2012
2. “Integrated Solid Waste management”, George Tchobanoglous, Hilary Theisen and Samuel A Vigil, Tata McGraw Hill, 1993

**Reference Books:**

1. Manual on Solid Waste Management, prepared by The Central Public Health and Environmental Engineering Organization (CPHEEO), India, 2016
2. MSW Management Rules 2016, Govt. of India, available online at CPCB website
3. Construction and Demolition Waste Management Rules, 2016, MoEF&CC
4. Electronic Waste Management Rules 2016, Govt. of India, available online at CPCB website.

**Web Links:**

1. <https://nptel.ac.in/courses/105/105/105105160/>
2. <http://swachhbharatmission.gov.in/sbmcms/index.htm>
3. <http://swachhbharaturban.gov.in/>

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## FUNDAMENTALS OF ELECTRIC VEHICLES (OPEN ELECTIVE-II)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VI Semester</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EE6O01</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1** Illustrate the use and advantages of different types of electric vehicles
- CO2** Use suitable power converters for EV application.
- CO3** Select suitable electric motor for EV power train
- CO4** Design HEV configuration for a specific application.
- CO5** Analyse various storage systems and battery management system for EVs.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 2    | 2    | -    | 1    | -    | -    | -    | 1    | 1     | -     | -     |
| <b>CO2</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | 1    | 1     | -     | -     |
| <b>CO3</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | 1    | 1     | -     | -     |
| <b>CO4</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | 1    | 1     | -     | -     |
| <b>CO5</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | 1    | 1     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    | -    |
| <b>CO2</b> | 1    | -    |
| <b>CO3</b> | 1    | -    |
| <b>CO4</b> | 1    | -    |
| <b>CO5</b> | 1    | -    |

### UNIT – I

#### Introduction

Fundamentals of vehicles – Vehicle model – Calculation road load and tractive force – Components of conventional vehicles – Drawbacks of conventional vehicles – Need for electric vehicles– Advantages and applications of Electric Vehicles – History of Electric Vehicles – EV Market in India and outside India –Types of Electric Vehicles.

### UNIT – II

#### Components of Electric Vehicles

Main components of Electric Vehicles – Electric Traction Motor and Controller –Power Converters – Rectifiers used in EVs – Bidirectional DC–DC Converters – Voltage Source Inverters – PWM inverters used in EVs.

**UNIT – III****Motors for Electric Vehicles**

Characteristics of traction drive – requirements of electric machines for EVs – Comparison of Different motors for Electric and Hybrid Vehicles – Induction Motors – Synchronous Motors – Permanent Magnetic Synchronous Motors – Brushless DC Motors – Switched Reluctance Motors (Construction details and working only).

**UNIT – IV****Hybrid Electric Vehicles**

Evolution of Hybrid Electric Vehicles – Advantages and Applications of Hybrid Electric Vehicles – Architecture of HEVs – Series and Parallel HEVs – Complex HEVs – Range extended HEVs – Examples – Merits and Demerits.

**UNIT – V****Energy Sources for Electric Vehicles**

Batteries– Types of Batteries – Lithium-ion – Nickel-metal hydride – Lead-acid – Comparison of Batteries – Battery Charging – Fast Charging –Battery Management System – Ultra capacitors – Flywheels – Compressed air energy storage (CAES)– Fuel Cell – it's working.

**Text Books:**

- 1 Iqbal Hussein - Electric and Hybrid Vehicles: Design Fundamentals - CRC Press - 2021.
- 2 [Tom Denton](#), [Hayley Pells](#) - Electric and hybrid vehicles, Third Edition, 2024

**Reference Books:**

- 1 Kumar - L. Ashok - and S. Albert Alexander. Power Converters for Electric Vehicles. CRC Press - 2020.
- 2 Chau - Kwok Tong. Electric vehicle machines and drives: design - analysis and application. John Wiley & Sons - 2015.
- 3 Berg - Helena. Batteries for electric vehicles: materials and electrochemistry. Cambridge university press - 2015.

**Web Links:**

- 1 MOOC at <https://www.edx.org/learn/electric-cars>
- 2 <https://archive.nptel.ac.in/courses/108/106/108106170>

**(OPEN ELECTIVE-II)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VI Semester</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EE6O02</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1** Demonstrate the various electrical apparatus and their interconnections
- CO2** Examine various components of electrical installations.
- CO3** Estimate the cost for installation of wiring for different types of building and small industries.
- CO4** Illustrate the components of electrical substations
- CO5** Design suitable control circuit for starting of three phase induction motor and synchronous motor.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 1    | 1    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | 3    | 1    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 2    | 2    | 3    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 3    | 1    | 1    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | 2    | 3    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | -    |
| <b>CO2</b> | -    | -    |
| <b>CO3</b> | -    | -    |
| <b>CO4</b> | -    | -    |
| <b>CO5</b> | -    | -    |

**UNIT – I**

**Electrical Symbols and Simple Electrical Circuits**

Identification of electrical symbols - Electrical wiring Diagrams - Methods of representation of wiring diagrams - introduction to simple light and fan circuits - system of connection of appliances and accessories.

**UNIT – II**

**Design Considerations of Electrical Installations**

Electric supply system - Three-phase four wire distribution system - protection of electric installation against overload - short circuit and earth fault - earthing - neutral and earth wire - types of loads - systems of wiring - permissible of voltage drops and sizes of wires - estimating and costing of electrical installations.

**UNIT – III**

**Electrical Installation for Different Types of Buildings and Small Industries**

Electrical installations for electrical buildings - estimating and costing of material - simple examples on electrical installation for residential buildings - electrical installations for commercial buildings - electrical installation for small industries-case study.

**UNIT – IV****Substations**

Introduction - types of substations - outdoor substations-pole mounted type - indoor substations-floor mounted type - simple examples on quantity estimation-case study.

**UNIT – V****Motor control circuits**

Introduction to AC motors - starting of three phase squirrel cage induction motors - starting of wound rotor motors - starting of synchronous motors - contractor control circuit components - basic control circuits - motor protection – Schematic and wiring diagrams for motor control circuits.

**Text Books:**

- 1 Electrical Design and Estimation Costing - [K. B. Raina](#) and S.K.Bhattacharya  
Age International Publishers - 2007

**Reference Books:**

- 1 Electrical wiring estimating and costing – S.L.Uppal and G.C.Garg –  
Khanna publishers - 6<sup>th</sup> edition – 1987.
- 2 A course in electrical installation estimating and costing – J.B.Gupta –  
Kataria SK & Sons - 2013.

**Web Links:**

- 1 [https://onlinecourses.swayam2.ac.in/nou25\\_ec07/preview](https://onlinecourses.swayam2.ac.in/nou25_ec07/preview)

## INTRODUCTION TO INDUSTRIAL ROBOTICS (Open Elective-II)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>Semester: VI</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231ME6O01</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Understand the fundamental components, types, and configurations of industrial robots.
- CO2** Develop and analyze forward and inverse kinematic models of robotic manipulators.
- CO3** Analyze the dynamics of robotic systems using Lagrangian and Newton-Euler methods.
- CO4** Plan robot trajectories and motions, including path and slew motion planning.
- CO5** Select and evaluate appropriate actuators, sensors, and end effectors for robotic tasks.
- CO6** Apply robot programming methods for industrial tasks such as material handling and welding.

### Mapping of Course Outcomes with Program Outcomes:

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 2    | -    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 3    | 3    | 3    | 2    | 3    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 3    | 3    | 3    | 3    | 3    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 2    | 2    | 3    | 2    | 3    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 2    | 2    | 3    | -    | 3    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO6:</b> | 2    | 2    | 3    | -    | 3    | -    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | 3    | -    |
| <b>CO2:</b> | 3    | 2    |
| <b>CO3:</b> | 3    | 3    |
| <b>CO4:</b> | 3    | 3    |
| <b>CO5:</b> | 2    | 3    |
| <b>CO6:</b> | 3    | 3    |

### UNIT – I

Introduction: Automation and Robotics – An over view of Robotics – present and future applications. Components of the Industrial Robotics: common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, Design of end effectors, Precision of Movement: Resolution, Accuracy and Repeatability, Speed of Response and Load Carrying Capacity.

### UNIT – II

Motion Analysis: Basic Rotation Matrices, Equivalent Axis and Angle, Euler Angles, Composite Rotation Matrices. Homogeneous transformations as applicable to rotation and translation – problems. Manipulator Kinematics-H notation-H method of Assignment of frames-H Transformation Matrix, joint coordinates and world coordinates, Forward and inverse kinematics – problems on Industrial Robotic Manipulators.

### **UNIT – III**

Differential transformation of manipulators, Jacobians – problems. Dynamics: Lagrange – Euler and Newton – Euler formations – Problems. Trajectory planning and avoidance of obstacles, path planning, Slew motion, joint interpolated motion – straight line motion.

### **UNIT - IV**

Robot actuators and Feedback components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison of Actuators, Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors, Tactile and Range sensors, Force and Torque sensors – End Effectors and Tools.

### **UNIT V**

Robot Application in Manufacturing: Material Transfer - Material handling, loading and unloading Processing - spot and continuous arc welding & spray painting - Assembly and Inspection. Robotic Programming Methods – Languages: Lead Through Programming, Textual Robotic Languages such as APT, MCL.

### **TEXT BOOKS:**

1. Industrial Robotics / Groover M P /Mc Graw Hill
2. Introduction to Industrial Robotics / Ramachandran Nagarajan / Pearson

### **REFERENCE BOOKS:**

1. Robot Dynamics and Controls / Spony and Vidyasagar / John Wiley
2. Robot Analysis and control / Asada, Slotine / Wiley Inter-Science
3. Robotics – Fu et al / TMH Publications

### **Weblink:**

1. [https://onlinecourses.nptel.ac.in/noc23\\_me143/preview](https://onlinecourses.nptel.ac.in/noc23_me143/preview)
2. [https://www.youtube.com/playlist?list=PLXDsvE7qtfNf\\_N99hJZbdTEM001mOii6](https://www.youtube.com/playlist?list=PLXDsvE7qtfNf_N99hJZbdTEM001mOii6)



**Semester: VI****L T P C****Course Code: 231ME6O02****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Explain the theories of management and techniques of plant layout**CO2:** Develop an efficient work system using method study and time study**CO3:** Analyze the characteristics of quality control using control charts.**CO4:** Explain the scope and nature of financial management**CO5:** Discuss human resource management and value engineering**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | -    | -    | -    | -    | -    | 1    | -    | 2    | 1    | -     | -     | 2     |
| <b>CO2:</b> | 2    | 1    | -    | -    | -    | -    | -    | -    | 2    | -     | -     | 2     |
| <b>CO3:</b> | 3    | -    | -    | -    | -    | 1    | -    | -    | -    | -     | -     | 2     |
| <b>CO4:</b> | -    | -    | -    | -    | -    | 1    | -    | 2    | -    | -     | -     | 2     |
| <b>CO5:</b> | -    | 1    | -    | -    | -    | 1    | -    | 2    | 2    | -     | -     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | 1    | -    |
| <b>CO2:</b> | 1    | -    |
| <b>CO3:</b> | 1    | -    |
| <b>CO4:</b> | 1    | -    |
| <b>CO5:</b> | 1    | -    |

**Unit - I**

Introduction: Definition of industrial engineering (I.E), development, applications, role of an industrial engineer, differences between production management and industrial engineering, quantitative tools of IE and productivity measurement. concepts of management, importance, functions of management, scientific management, Taylor's principles, theory X and theory Y, Fayol's principles of management.

Plant Layout: Factors governing plant location, types of production layouts, advantages and disadvantages of process layout and product layout, applications, quantitative techniques for optimal design of layouts, plant maintenance, preventive and break down maintenance.

**Unit -II**

Work Study: Importance, types of production, applications, work study, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs.

**Unit – III**

**Statistical Quality Control:** Quality control Queuing assurance and its importance, SQC, attribute sampling inspection with single and double sampling, Control charts –  $\bar{X}$  and R – charts  $\bar{X}$  and  $S$  charts and their applications, numerical examples.

Total Quality Management: Zero defect concept, quality circles, implementation, applications, ISO quality systems. Six Sigma–definition, basic concepts

#### Unit - IV

Financial Management: Scope and nature of financial management, Sources of finance, Ratio analysis, Management of working capital, estimation of working capital requirements, stock management, Cost accounting and control, budget and budgetary control, Capital budgeting – Nature of Investment Decisions – Investment Evaluation criteria- NPV, IRR, PI, Payback Period, and ARR, numerical problems.

#### Unit – V

**Human Resource Management:** Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job- evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, and types.

Value Analysis: Value engineering, implementation procedure, enterprise resource planning and supply chain management.

#### Text Books:

- 1 Industrial Engineering and Production Management, Mart and Telsang, S. Chand & Company Ltd. New Delhi.
- 2 Industrial Engineering and Management, O.P Khanna, Dhanpat Rai Publications (P) Ltd, 2018.

#### Reference Books:

- 1 Industrial Engineering and Management Science, T. R. Banga, S. C. Sharma, N. K. Agarwal, Khanna Publishers, 12th Edition
- 2 Operations Management, J.G Monks, McGraw Hill Publishers, 3rd edition.
- 3 Principles of Management, Koontz O' Donnell, McGraw Hill Publishers, 4edition.
- 4 Industrial Management, Bhattacharya DK, S. Chand, publishers.

#### Weblinks:

- 1 [https://onlinecourses.nptel.ac.in/noc20\\_mg43/preview](https://onlinecourses.nptel.ac.in/noc20_mg43/preview)
- 2 [https://onlinecourses.nptel.ac.in/noc24\\_me15/preview](https://onlinecourses.nptel.ac.in/noc24_me15/preview)
- 3 [https://onlinecourses.nptel.ac.in/noc20\\_me43/preview](https://onlinecourses.nptel.ac.in/noc20_me43/preview)

**Semester: VI****L T P C****Course Code: 231ME6O03****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Demonstrate appropriate level of understanding on principles of additive manufacturing processes.**CO2:** Identify the materials for solid based AM process.**CO3:** Apply powder-based RP systems.**CO4:** Analyze and apply various rapid tooling techniques.**CO5:** Represent a 3D model in STL format and other RP data formats to store and retrieve the geometric data of the object.**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 2    | -    | 1    | 2    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 3    | 1    | -    | 1    | 2    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 3    | 1    | -    | 1    | 2    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 3    | 1    | -    | 1    |      | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 3    | 2    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | 3    | -    |
| <b>CO2:</b> | 3    | -    |
| <b>CO3:</b> | 3    | -    |
| <b>CO4:</b> | 3    | -    |
| <b>CO5:</b> | 3    | -    |

**UNIT – 1**

**INTRODUCTION TO ADDITIVE MANUFACTURING:** Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages and Limitations of AM and Types of materials for AM.

**LIQUID-BASED ADDITIVE MANUFACTURING PROCESS:** Stereo lithography Apparatus (SLA): models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid Ground Curing (SGC): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

**UNIT – 2**

**Solid-based additive manufacturing process:** Laminated object manufacturing (LOM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

Fused deposition modelling (FDM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

### UNIT – 3

**Powder based additive manufacturing process:** Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, Case studies. Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, applications, advantages and disadvantages, Case studies.

### UNIT – 4

**Rapid tooling:** Introduction to rapid tooling (RT), conventional tooling Vs RT, Need for RT. rapid tooling classification: indirect rapid tooling methods: spray metal deposition, RTV epoxy tools, Ceramic tools, investment casting, spin casting, die casting, sand casting process. Direct rapid tooling: Direct AIM, LOM Tools, and Direct Metal Tooling using 3DP.

### UNIT – 5

**Rapid prototyping data formats:** STL Format, STL File Problems, consequence of building valid and invalid tessellated models, STL file Repairs: Generic Solution, other Translators, and Newly Proposed Formats.

**Am applications:** Application in engineering, analysis and planning, aerospace industry, automotive industry, jewelry industry, coin industry, GIS application, RP medical and bioengineering applications: customized implants and prosthesis, forensic sciences.

#### Text Books:

- 1 “Rapid prototyping: Principles and applications”, Chua, C.K., Leong K.F. and Lim C.S., Third edition, World Scientific Publishers, 2010.
- 2 “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Gibson, I., Rosen, D.W. and Stucker, BSpringer, 2015.

#### Reference Books:

- 1 Additive Manufacturing: A Tool for Industrial Revolution 4.0, M. Manjaiah, K. Raghavendra, N. Balashanmugam, J. Paulo Davim, Woodhead Publishing, Elsevier, 2021
- 2 “Additive Manufacturing: Principles, Technologies and Applications , C.P Paul, A.N Junoop, Second Edition, McGrawHill, 2021.
- 3 Additive Manufacturing, Second Edition, Amit Bandyopadhyay Susmita Bose, CRC Press Taylor & Francis Group, 2020.
- 4 Rapid Tooling: Technologies and Industrial Applications, Hilton, P.D. and Jacobs, P.F., CRC Press, 2000

#### Weblinks:

- 1 <https://www.nist.gov/additive-manufacturing>
- 2 <https://archive.nptel.ac.in/courses/112/103/112103306/>

## VEHICLE TECHNOLOGY

### (Open Elective-II)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>Semester: VI</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231ME6O04</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Discuss the latest trends in engine technology
- CO2:** Discuss the need of advanced combustion technologies and its impact on reducing carbon foot-print on the environment.
- CO3:** Analyzing the basic characteristics of low carbon fuels, its impact over conventional fuels and in achieving sustainable development goals.
- CO4:** Discuss the working and energy flow in various hybrid and electric configurations.
- CO5:** Analyzing the need for fuel cell technology in automotive applications.

### Mapping of Course Outcomes with Program Outcomes:

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | -    |
| <b>CO2:</b> | -    | -    |
| <b>CO3:</b> | -    | -    |
| <b>CO4:</b> | -    | -    |
| <b>CO5:</b> | -    | -    |

### Unit - I

#### Advanced Engine Technology:

Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder De-activation, After Treatment Technologies, Electric EGR, Current EMS architecture.

**Unit -II****Combustion Technology:**

Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.

**Unit - III****Low Carbon Fuel Technology:**

Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward

**Unit – IV****Hybrid and Electric Vehicle (Battery Powered)**

Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges and Way forward

**Unit – V****Fuel Cell Technology**

Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.

**Text Books:**

- 1 Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
- 2 Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines. ISBN 978-3-319-68507-6 , SPRINGER

**Reference Books:**

- 1 Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
- 2 James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
- 3 Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998
- 4 Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

**Weblinks:**

- 1 [https://onlinecourses.nptel.ac.in/noc20\\_ee18/preview](https://onlinecourses.nptel.ac.in/noc20_ee18/preview)
- 2 <https://nptel.ac.in/courses/108106170>

## INDUSTRIAL SAFETY

### (Open Elective-II)

**Semester: VI**

**L      T      P      C**

**Course Code: 231ME6005**

**3      0      0      3**

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Understand the concepts of industrial safety and management

**CO2:** Describe about the smart machines and smart sensors

**CO3:** Apply IoT to Industry 4.0 and they are able to make a system tailor-made as per requirement of the industry

**CO4:** Explain about fire prevention and protection systems.

**CO5:** Understand and apply the fire safety principles in buildings

### Mapping of Course Outcomes with Program Outcomes:

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 2    | -    | -    | -    | 1    | 3    | 1    | 1    | 2    | 1     | -     | -     |
| <b>CO2:</b> | 2    | -    | -    | -    | 1    | 1    | 2    | 1    | 2    | 2     | -     | -     |
| <b>CO3:</b> | 2    | -    | -    | -    | 3    | 3    | 2    | 1    | 2    | 3     | -     | -     |
| <b>CO4:</b> | 2    | -    | -    | -    | 2    | 2    | 2    | 1    | 2    | 1     | -     | -     |
| <b>CO5:</b> | 2    | -    | -    | -    | 2    | 2    | 2    | 1    | 2    | 1     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    |      |
| <b>CO2:</b> | -    |      |
| <b>CO3:</b> | -    |      |
| <b>CO4:</b> | -    |      |
| <b>CO5:</b> | -    |      |

### Unit-I

#### Introduction to the Development of Industrial Safety and Management:

History and development of Industrial safety: Implementation of factories act, Safety and productivity, Safety organizations. Safety committees and structure, role of management and role of Govt. in industrial safety.

### Unit-II

#### Accident Preventions and Protective Equipment:

Personal protective equipment, Survey the plant for locations, Part of body to be protected, Education and training in safety, Prevention causes and cost of accident, Housekeeping, First aid, Accident reporting, Investigations. Industrial psychology in accident prevention, Safety trials, Safety related to operations.

**Unit - III****Safety Acts:**

Features of Factory Act, Introduction of Explosive Act, Boiler Act, ESI Act, Workman's compensation Act, Industrial hygiene, Occupational safety, Diseases prevention, Ergonomics, Occupational diseases, stress, fatigue, health, safety and the physical environment, Engineering methods of controlling chemical hazards, safety and the physical environment, Control of industrial noise and protection against it, Code and regulations for worker safety and health, codes for safety of systems.

**Unit - IV****Fire Prevention and Protection:**

Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E-Fire extinguishing agents- Water, Foam, Dry chemical powder, Carbon-dioxide Halon alternatives Halocarbon compounds-Inert gases, dry powders – types of fire extinguishers – fire stoppers –hydrant pipes – hoses – monitors – fire watchers – layout of stand pipes – fire station-fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills –first aid for burns.

**Unit-V**

Building Fire Safety: Objectives of fire safe building design, Fire load, fire resistant material and fire testing – structural fire protection – structural integrity – concept of egress design -exit– width calculations –fire certificates – fire safety requirements for high-rise buildings.

**Text Books:**

- 1 Industrial Maintenance Management Srivastava, S.K.-S. Chand and Co.
- 2 Occupational Safety Management and Engineering Willie Hammer–Prentice Hall

**Reference Books:**

- 1 Installation, Servicing and Maintenance Bhattacharya, S.N.-S.Chand and Co.
- 2 Jain VK “Fire Safety in Building” New Age International 1996.

**Web links:**

- 1 <https://nptel.ac.in/courses/110105094>
- 2 [https://onlinecourses.swayam2.ac.in/nou23\\_ge81/preview](https://onlinecourses.swayam2.ac.in/nou23_ge81/preview)
- 3 <https://www.youtube.com/watch?v=jFDWIKayrTc>



## PRINCIPLES OF COMMUNICATIONS (Open Elective-II)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| VI Semester                   | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EC6001</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1** Summarize the functional blocks of a communication system.
- CO2** Illustrate the working principle of amplitude modulation and demodulation.
- CO3** Compare types of amplitude modulation.
- CO4** Analyze the generation and detection of FM and PM signals.
- CO5** Classify the radio transmitter and receivers.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| CO3   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| CO4   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| CO5   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

### Unit - I

Introduction: Definition of Signal, Types of signals, Fourier Transform (FT), Inverse Fourier Transform (IFT) and their properties, Introduction to Communication system, Elements of Communication system, Modulation, Need for Modulation, Electromagnetic Spectrum, Frequency Division Multiplexing (FDM).

### Unit – II

Amplitude Modulation: Introduction to Amplitude Modulation (AM), Square law modulation, Envelope detector, Spectrum of AM Signals, Power and Power Efficiency of AM, Double Sideband Suppressed Carrier ((DSB-SC) Modulation, Spectrum of DSB-SC Signals, Balanced modulator, Coherent Demodulation of DSB-SC signals, Introduction to Single Sideband (SSB) Modulation and VSB modulation.

### Unit – III

Angle modulation: Introduction, Phase Modulation, Frequency Modulation: Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Direct Method of FM generation, Phase locked loop, Comparison of FM and AM.

### Unit – IV

Radio Transmitters and Receivers: Introduction, Classification of Transmitters, AM Transmitter, Variable Reactance type FM Transmitter, Radio Receiver types, TRF Receiver, Super heterodyne Receiver, FM receiver, Comparison of AM and FM receivers.

### **Unit – V**

Pulse Modulation: Need for Digitizing Analog information, Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation, Time Division Multiplexing, Introduction to Pulse Code Modulation and Delta Modulation.

### **Text Books:**

1. Principles of Communication Systems – H Taub & D. Schilling, Gautam Sahe, TMH, 2007, 3rd Edition.
2. Communication Systems: Analog and Digital, R P Singh and S D Sapre, McGraw Hill India, Third Edition.
3. Communication Systems – B. P. Lathi, BS Publication, 2006

### **Reference Books:**

1. Principles of Communication Systems - Simon Haykin, John Wiley, 2nd Edition.
2. Electronics & Communication System – George Kennedy and Bernard Davis, TMH 2004.
3. Analog and Digital Communications: Theory and Lab Work- Abhay Gandhi, Cengage, 2015.

### **Web Links:**

1. <https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ee08/>, Principles of Communication Systems-I,
2. Prof. Aditya K. Jagannatham, IIT Kanpur.  
[https://onlinecourses.nptel.ac.in/noc21\\_ee74/preview,AnalogCommunication,Prof.GoutamDas,IITKharagpur](https://onlinecourses.nptel.ac.in/noc21_ee74/preview,AnalogCommunication,Prof.GoutamDas,IITKharagpur).

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## BIOMEDICAL ENGINEERING (Open Elective-II)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VI Semester</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EC6O02</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Summarize the physiological relation of the human body with the environment and bio potentials
- CO2** Illustrate various electrodes sensing and measurement devices of electrical origin
- CO3** Choose a device for measurement of cardiovascular and respiratory signals.
- CO4** Make use of therapeutic equipment for bio medical signals.
- CO5** Interpret the methods for diagnostic techniques.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

### Unit - I

Introduction: Age of Biomedical Engineering, Development of Biomedical Instrumentation, Man Instrumentation System, Components of the Man-Instrument System, Physiological System of the Body. Bioelectric Potential Electrodes- Examples, Physiological signals, Bio-Amplifiers, transducers- Piezo-electric and ultrasonic, Bio Sensors – Principles – Piezo-electric, Thermal, Optical. Safety issues from electrical Hazards

### Unit – II

Biopotential Measurements: Bio signals characteristics – frequency and amplitude ranges. ECG – Einthovens triangle, standard lead system, Measurement of Heart sound, Recording methods. EEG – 10-20 electrode system, unipolar, bipolar and average mode, Recording methods. EMG- unipolar and bipolar mode, Recording methods. Recording of ERG, EOG and EGG

### Unit – III

Non-Electrical Measurements: Heart and Cardiovascular System, Electro Cardiograph, Blood Pressure Measurement, Measurement of Blood Flow and Cardiac Output, Angiogram. Body Plethysmography- Blood Gas analyzers, pH of blood. Respiratory System: The Physiology of the Respiratory System, Tests and Instrumentation for the Mechanics of Breathing, Respiratory Therapy Equipment.

**Unit – IV**

Critical Care Equipment: Elements of Intensive-Care Monitoring, Clinical Laboratory Instruments, Biomaterials, Ventilators: Mechanics of Respiration, artificial ventilators, Positive pressure ventilator, Types and classification of ventilators. Cardiac Defibrillators: Need for defibrillators, DC defibrillator, Implantable defibrillators, Defibrillator analyzer. Therapeutic Equipment: Cardiac pacemakers: Need for cardiac pacemakers, External and implantable pacemakers. Audiometers and Hearing Aids, Myoelectric Arm, Physiotherapy Equipment: Diathermy-short wave, Microwave, and ultrasonic. Electrotherapy Equipment: Nerve muscle stimulator, Functional electrical stimulator

**Unit – V**

Diagnostic Techniques and Biotelemetry: Principles of Ultrasonic Measurement, Ultrasonic imaging, Ultrasonic Applications of Therapeutic uses, Ultrasonic diagnosis, X-Ray and Radio-Isotope instrumentations, CAT Scan, Emission Computerized Tomography, MRI, Telemedicine Technology.

Introduction to Telemedicine, Cyber Medicine, Applications of Telemedicine: Introduction to Biotelemetry, Physiological Parameters Adaptable to Biotelemetry, the Components of Biotelemetry System, Implantable Units, Telemetry for ECG Measurements during Exercise, Telemetry for Emergency Patient Monitoring, wireless wearable technology in health care monitor

**Text Books:**

1. Bio-Medical Instrumentation Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, 2nd edition, PHI, 2011
2. Introduction to Bio-Medical Equipment Technology - Joseph J. Carr, John M. Brown, 4th edition, Pearson Publications, 2012.
3. Medical Instrumentation Application and design, John G. Webster, Wiley India Edition, 2009.
4. Handbook of Biomedical Instrumentation, Khandpur R.S, Tata McGraw-Hill, New Delhi, 2nd edition, 2003

**Reference Books:**

1. Handbook of Bio-Medical Instrumentation, Khandapur, R.S., McGrawHill, 2nd edition, 2003.
2. Biomedical Instrumentation, Arumugam, M., Anuradha Publications, 2006.
3. Health Care Systems, Technology and Techniques, Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Springer, 1st Edition, 2011.
4. Standard Handbook of Biomedical Engineering and Design, Myer Kutz, McGraw Hill Publisher, 2003.

**Web Links:**

1. [https://onlinecourses.nptel.ac.in/noc21\\_ee17/preview](https://onlinecourses.nptel.ac.in/noc21_ee17/preview), IIT Kharagpur, By Prof. Sudipta Mukhopadhyay
2. <https://www.class-central.com/course/nptel-medical-image-analysis-7934> , IIT Kharagpur, By Prof. Debdoot Sheet
3. <https://www.electrical4u.com/introduction-to-biomedical-instrumentation/>

## ECAD TOOLS (Open Elective-II)

VI Semester

Course Code: 231EC6O03

|   |   |   |   |
|---|---|---|---|
| L | T | P | C |
| 3 | 0 | 0 | 3 |

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1** Summarize the basic concepts on ECAD tools and PSPICE.
- CO2** Build various types passive element circuits and its performance using PSPICE.
- CO3** Construct BJT configuration amplifiers using PSPICE.
- CO4** Build various FET amplifiers circuits using PSPICE.
- CO5** Make use of MATLAB functions for solving the mathematical equations.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| CO2   | 2    | 1    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| CO3   | 2    | 1    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| CO4   | 2    | 1    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| CO5   | 3    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

### Unit - I

**Introduction to ECAD tools:** Introduction, various ECAD tools, applications of ECAD tools  
**Introduction to PSPICE:** History, professional version, types of sources, analysis menu, circuit topology and analysis.

### Unit – II

**Implementation of passive circuits (RC, RL, LC, RLC) using Pspice:** Voltage-current relation of an inductors, capacitors, series and parallel connections of initially uncharged capacitors and inductors, phasor relation for a resistor, capacitor, inductors. Charging and discharging responses of capacitors and inductors, natural responses of RLC circuits.

### Unit – III

**Implementation of active circuits using PSPICE:** Diodes, transistor switches, BJT amplifiers-CE amplifier, CC amplifier, differential amplifier, and tuned amplifier, JFET amplifiers, MOSFET amplifiers-common source amplifier, common drain amplifier.

### Unit – IV

**Introduction to MATLAB:** Array of numbers, MATLAB for plotting, functions in MATLAB, Vectors and matrices, linear equations geometry and statics, polynomials equations, Iterative solution of equations

**Unit – V**

**MATLAB Simulink:** Introduction to Simulink, model of momentum law, capacitor discharge, a mass spring dash spot system, series RLC circuit.

**Applications of frequency domain:** Introduction, signals, DFT, power spectrum, trigonometric expansion of signals, high frequency signals.

**Text Books:**

1. Circuit analysis with PSPICE, Nassir H. Sabah, 2017.
2. MATLAB and Simulink, Adrian B. Biran, CRC press Taylor& Francis group.

**Reference Books:**

1. Electronics Circuits and Systems, Owen Bishop, 4th edition, 2011.
2. MATLAB for Electrical and computer engineering, Roland Priemer, 2013.

**Web Links:**

1. <https://www.mccormick.northwestern.edu/documents/students/undergraduate/introduction-to-matlab.pdf>
2. <https://vdocument.in/orcad-pspice-course-material.html>

**QUANTUM SCIENCE**  
**(Open Elective – II)**

**VI Semester**  
**Course Code: 231EC6004**

**L**     **T**     **P**     **C**  
**3**     **0**     **0**     **3**

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1** Explain the fundamental postulates and mathematical formulation of quantum mechanics.
- CO2** Analyze quantum phenomena such as wave-particle duality, uncertainty, and tunneling.
- CO3** Apply Schrödinger's equation to simple physical systems and interpret the results.
- CO4** Understand the role of quantum theory in semiconductors, nanomaterials, and modern electronics.
- CO5** Describe the basic principles of quantum computing and its potential applications.

**CO–PO Mapping:**

| CO/PO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO2</b> | 3   | 2   | 1   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO3</b> | 3   | 2   | 1   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO4</b> | 2   | 2   | 1   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO5</b> | 2   | 2   | 2   | 1   | 1   | -   | -   | -   | -   | -    | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

**UNIT – I: Fundamentals of Quantum Mechanics**

Introduction to quantum theory, Limitations of classical mechanics, Wave-particle duality, de Broglie wavelength, Heisenberg's uncertainty principle, Concept of wave function and operators, Expectation value, Time-dependent and time-independent Schrödinger equations.

**UNIT – II: Quantum States and Applications**

Particle in a one-dimensional box, Energy quantization, Potential step and barrier, Quantum tunneling, Harmonic oscillator (qualitative), Quantum confinement in low-dimensional systems (quantum wells, wires, and dots).

**UNIT – III: Quantum Electronics**

Quantum transitions, Absorption, spontaneous and stimulated emission, Population inversion, Laser principle, Einstein's coefficients, Working of LASERS (He-Ne, Semiconductor laser), Quantum cascade laser, Photonic devices and detectors based on quantum effects.

**UNIT – IV: Quantum Materials and Devices**

Quantum Free electron theory, Fermi energy and density of states, Band formation in solids, Semiconductors, Quantum Hall effect, Quantum dots, Spintronics and quantum tunneling devices.

**UNIT – V: Introduction to Quantum Computing**

Qubits and superposition, Quantum entanglement, Quantum gates and circuits, Quantum algorithms (qualitative discussion on Deutsch-Jozsa and Shor's algorithm), Quantum communication and cryptography, Emerging applications of quantum technology.

**Text Books:**

1. David J. Griffiths, Introduction to Quantum Mechanics, Pearson Education.
2. S. Singh, Quantum Mechanics: Fundamentals and Applications, New Age International.
3. Ajoy Ghatak & S. Lokanathan, Quantum Mechanics: Theory and Applications, Springer.

**Reference Books:**

1. Leonard Susskind & Art Friedman, Quantum Mechanics: The Theoretical Minimum, Basic Books.
2. Richard P. Feynman, Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher, Penguin.
3. John Preskill, Quantum Computation and Information, Lecture Notes (Caltech).

**Web Links:**

1. <https://nptel.ac.in/courses/115106086>
2. <https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2016/>
3. <https://qiskit.org/textbook>
4. <https://quantum.country>
5. <https://www.khanacademy.org/science/physics/quantum-physics>



**WEB TECHNOLOGIES****(Open Elective-II)**

VI Semester

**L T P C****Course Code: 231CS6001****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:****CO 1:** Develop static web pages using HTML and CSS.**CO 2:** Apply JavaScript for Client side validations and Node.JS to learn server side applications using JavaScript.**CO 3:** Make use of Angular JS for developing dynamic and responsive web pages.**CO 4:** Utilize React JS for developing dynamic and responsive web pages.**CO 5:** Create and deploy secure, usable database driven web applications using PHP and MySQL/MongoDB.**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 2    | -    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 3    | -    | 3    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 2    | -    | 2    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 2    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

**Unit - I**

HTML, HTML5, CSS, CSS3 HTML: Basic Syntax, Standard HTML Document Structure, Basic Text Markup, HTML styles, Elements, Attributes, Heading, Layouts, HTML Media, Iframes, Images, Links, Lists, Tables, Forms, GET and POST method, HTML 5, Dynamic HTML. CSS: Cascading style sheets, Levels of Style Sheets, Style Specification Formats, Selector Forms, Box Model, Conflict Resolution, CSS3.

## Unit – II

JavaScript & XML Javascript - Introduction, Primitives, Variables – var, let, const, Operations and Expressions, Control Statements, Functions, Objects (Predefined - String, Number, Array, Date, Math, Random, RegExp, User Defined – Definition, Properties, Methods, Display, Accessors, Constructors), Events, Pattern Matching using Regular Expressions, Working with XML: Document type Definition (DTD), XML schemas, XSLT, XML and

CSS, Document object model, Parsers - DOM and SAX.

## Unit – III

Node JS & Angular JS Node.js- Introduction, Advantages, Process Model, Modules, HTTP Module, File system, URL module, NPM, Events, Upload Files, Email. Angular JS – Introduction, Expressions, Modules, Directives, Model, Data Binding, Controllers, Scopes, Filters, Services, HTTP, Tables, Select, Events, Forms, Validation, API, W3.CSS, Includes, Routing, SQL, DOM, Application.

## Unit – IV

React JS React JS – Introduction, Displaying “Welcome React”, Introducing JSX, Rendering Elements, Components and Props, State and Lifecycle, Handling Events, Conditional Rendering, Lists and Keys, Forms, Lifting State Up, Composition vs Inheritance, Thinking in React.

## Unit – V

PHP PHP Programming - Introduction, Creating and Running PHP Script. Variables, Constants, DataTypes, Operators. Controlling Program Flow - Conditional and Loop statements, Arrays, Functions, Client-Server Scripting – XAMPP/LAMP Introduction, Running PHP Script in XAMPP, Super Globals, Working with Form Data, Database Connectivity – MySQL Introduction using XAMPP in Command Mode and GUI, Working with MySQL Queries, Integrating PHP and MySQL to work with Form Data. No SQL Database - MongoDB Introduction, Create and Drop Database, Create and Drop Collection, Data Types, Insert, Query, Update, Delete, Integrating PHP with MongoDB.

### Text Books:

1. Programming the World Wide Web, 7th Edition, Robert W Sebesta, Pearson.
2. Pro Mean Stack Development, 1st Edition, Elad Elrom, Apress O'Reilly.
3. React Explained, 2020 Edition, Zac Gordon, OStraining.
4. MongoDB – The Definitive Guide, 2nd Edition, Kristina Chodorow, O'Reilly.

### Reference Books:

1. Web Technologies, HTML, JavaScript, PHP, Java, JSP, XML and AJAX, Black book, 1st Edition, Dream Tech.
2. An Introduction to Web Design, Programming, 1st Edition, Paul S Wang, Sanda S Katila, Cengage Learning.

**Web Links:**

1. <https://www.w3schools.com/> (html, css, js, xml, nodejs, angular, react, php)
2. <https://www.angular.io/docs>
3. <https://www.reactjs.org/docs/getting-started.html>
4. <https://www.university.mongodb.com/>

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## OPERATING SYSTEMS

(Open Elective-II)

**VI Semester**

**L    T    P    C**

**Course Code: 231IT6O01**

**3    0    0    3**

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Describe various concepts of operating systems and system calls.

**CO2:** Describe the concept of program, process and thread and analyze various CPU Scheduling

Algorithms and compare their performance

**CO3:** Solve Inter Process Communication problems by various methods

**CO4:** Compare various Memory Management Schemes especially paging and Segmentation in Operating System and apply various Page Replacement Techniques.

**CO5:** Outline File Systems implementation in Operating System.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO       | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1:</b> | 2   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO2:</b> | 1   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO3:</b> | 1   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO4:</b> | 1   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO5:</b> | 2   | 2   | -   | -   | -   | -   | -   | -   | 1   | 1    | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 1    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 1    | -    |

### UNIT – I

**Operating Systems Overview:** Introduction, Operating system functions, Operating systems operations, Computing environments, Free and Open-Source Operating Systems

**Structures:** Operating System Services, User and Operating-System Interface, system calls, Types of System Calls, system programs, Operating system Design and Implementation, Operating system structure, Building and Booting an Operating System, Operating system debugging.

**UNIT – II**

**Processes:** Process Concept, Process scheduling, Operations on processes, Inter-process communication. Threads and Concurrency: Multithreading models, Thread libraries, Threading issues. CPU Scheduling: Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling.

**UNIT – III**

**Synchronization Tools:** The Critical Section Problem, Peterson's Solution, Mutex Locks, semaphores, Monitors, Classic problems of Synchronization. Deadlocks: system Model, Deadlock characterization, Methods for handling Deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from Deadlock.

**UNIT – IV**

**Memory- Management Strategies:** Introduction, Contiguous memory allocation, Paging, Structure of the Page Table, Swapping. Virtual Memory Management: Introduction, Demand paging, Copy-on-write, Page replacement Allocation of frames, Thrashing Storage Management: Overview of Mass Storage Structure, HDD Scheduling.

**UNIT – V**

**File System:** File System Interface: File concept, Access methods, Directory Structure; File system Implementation: File-system structure, File-system Operations, Directory implementation, Allocation method, Free space management; File-System Internals: File-System Mounting, Partitions and Mounting, File Sharing. Protection: Goals of protection, Principles of protection, Protection Rings, Domain of protection, Access matrix.

**Text Books:**

1. Operating System Concepts, Silberschatz A, GalvinPB, GagneG, 10th Edition, Wiley, 2018.
2. Modern Operating Systems, Tanenbaum AS, 4th Edition, Pearson, 2016

**Reference Books:**

1. Operating Systems -Internals and Design Principles, Stallings W, 9<sup>th</sup> edition, Pearson, 2018
2. Operating Systems: A Concept Based Approach, D. M Dhamdhare, 3<sup>rd</sup> Edition, McGraw- Hill, 2013

**Web Links:**

1. <https://archive.nptel.ac.in/courses/106/105/106105214/>
2. <https://www.coursera.org/specializations/codio-introduction-operating-systems>
3. <https://www.codecademy.com/learn/fundamentals-of-operating-systems>

## Computer Organization Architecture

(Open Elective-II)

**VI Semester**

**L      T      P      C**

**Course Code: 231AM6001**

**3      0      0      3**

**Course Outcomes: At the end of the course, student will be able to:**

- CO1:** Describe the basic structure of a computer system, various number systems and arithmetic operations
- CO2:** Explain the Operation of CPUs including RTL, ALU, Instruction Cycle and Buses
- CO3:** Demonstrate the architecture and functionality of central processing unit
- CO4:** Illustrate the I/O and memory organization in an efficient way.
- CO5:** Make use of multi processors and pipelining to improve the efficiency of computer system.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | 1    | -    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 2    | 1    | -    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 3    | 1    | -    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 2    | 1    | -    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 3    | 2    | -    | -    | 3    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | 2     |       |
| CO2      | 2     |       |
| CO3      | 2     |       |
| CO4      | 2     |       |
| CO5      | 3     |       |

### UNIT-I

Basic Structure of Computers: Basic Organization of Computers, Historical Perspective, Bus Structures. Data Representation: Data types, Complements, Fixed Point Representation. Floating – Point Representation. Other Binary Codes, Error Detection Codes.

Computer Arithmetic: Addition and Subtraction, Multiplication Algorithms, Division Algorithms

## **UNIT-II**

Register Transfer Language and Microoperations: Register Transfer language. Register Transfer Bus and Memory Transfers, Arithmetic Micro operations, Logic Micro Operations, Shift Micro Operations, Arithmetic Logic Shift Unit

Basic Computer Organization and Design: Instruction Codes, Computer Register, Computer Instructions, Instruction Cycle, Memory – Reference Instructions. Input – Output and Interrupt, Complete Computer Description

## **UNIT-III:**

Central Processing Unit: General Register Organization, STACK Organization. Instruction Formats, Addressing Modes, Data Transfer and Manipulation, Program Control, Reduced Instruction Set Computer.

Microprogrammed Control: Control Memory, Address Sequencing, Micro Program example, Design of Control Unit.

## **UNIT-IV:**

Memory Organization: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory.

Input-Output Organization: Peripheral Devices, Input-Output Interface, Asynchronous data transfer, Modes of Transfer, Priority Interrupts, Direct Memory Access

## **UNIT – V:**

Multi Processors: Introduction, Characteristics of Multiprocessors, Interconnection Structures, Inter Processor Arbitration.

Pipeline: Parallel Processing, Pipelining, Instruction Pipeline, RISC Pipeline, Array Processor

## **Text Books:**

- 1 Computer System Architecture, M. Morris Mano, Third Edition, Pearson, 2008.
- 2 Computer Organization, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, 5/e, McGraw Hill, 2002.

**Reference Books:**

- 1 Computer Organization and Architecture, William Stallings, 6/e, Pearson, 2006.
- 2 Structured Computer Organization, Andrew S. Tanenbaum, 4/e, Pearson, 2005.
- 3 Fundamentals of Computer Organization and Design, Sivarama P. Dandamudi, Springer, 2006

**Web Links:**

- 1 <https://nptel.ac.in/courses/106/105/106105163/>
- 2 <https://nptel.ac.in/courses/106/106/106106092/>
- 3 <https://www.udemy.com/course/computer-architecture-computer-organization-course/>
- 4 <http://www.cuc.ucc.ie/CS1101/David%20Tarnoff.pdf>



## MINERAL ECONOMICS

### (OPEN ELECTIVE – II)

**VI Semester**

**L T P C**

**Course Code: 231MI6O01**

**3 0 0 3**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Explain the economic significance of the mineral industry and analyze factors influencing mineral prices and national mineral policies.
- CO 2:** Classify mineral reserves and resources, apply geostatistical tools for estimation, and interpret demand trends through market surveys.
- CO 3:** Illustrate conservation methods, sampling techniques, and evaluate mineral losses, dilution, and recovery in economic terms.
- CO 4:** Conduct mine valuation using static and dynamic investment appraisal methods and analyze cost components in mine budgeting and finance.
- CO 5:** Assess mineral taxation systems, understand international trade in minerals, and evaluate the structure and challenges of mineral information systems.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PO | PSO1 | PSO2 | PSO3 |
|-------|------|------|------|
| CO1   | -    | 3    | -    |
| CO2   | -    | 3    | -    |
| CO3   | -    | 3    | -    |
| CO4   | -    | 3    | -    |
| CO5   | -    | 3    | -    |

### UNIT-I

**General:** Economic importance of the mineral industry; Risky nature of the mining industry; Demand and Supply analysis, National mineral policy;

**Mineral price and pricing:** International monetary system, Factors affecting mineral price, kinds of price quotation, Mineral price index, Mineral prices.

## UNIT-II

**Mineral Resource/Reserve:** Concept, classification and estimation of reserves. Applications of Geostatistics.

**Mineral inventory:** concept, characteristic features, composition and economic significance; Estimation of life index.

**Demand analysis and Market survey:** Meaning and law of demand; methodology of demand analysis, Market survey.

## UNIT-III

**Conservation of mineral resources** – Means of conservation and limitations in the scope of Conservation

**Mine Sampling:** Definition, purpose and scope, Preparation of samples, methods and computations; Application of statistical methods in sampling.

b - Classification and incorporation of losses, co-efficient of completeness of mineral extraction, Dilution and recovery

**Examination of mineral properties:** Definition, purpose, type and scope of examination.

## UNIT-IV

**Mine valuation:** Basic concept, Earlier approaches to mine valuation, recent approaches to evaluation **Investment Appraisal:** Elements of investment appraisal, Static methods of investment appraisal, Dynamic methods of appraisal, discounted cash flow analysis

**Mining costs:** Capital and operating costs; Factors affecting operating cost; Methods of estimating future costs; Standard cost and forecast; Budget and budgetary control.

**Mine finance:** Capital – its importance, various forms and formation; mine accountancy and book keeping.

## UNIT-V

**Mineral Taxation System:** Theory of taxation on minerals, Mineral tax designing, Types of mineral taxes, Taxes affecting mineral sector

**Internal and External Trade:** Taxes and duties; Imports and exports; International investment and trade in mineral materials & products.

**Mineral information system:** Data-information-informatics-data base, Mineral information system in India and problems, Mineral information system in outside India.

**TEXT BOOKS:**

- 1) Alwyn E. Annels, Mineral Deposit Evaluation: A Practical Approach, Chapman Hall, 1991.
- 2) Deshmukh R.T. Mine and Mineral Economics, Emdee Publishers, 1986.
- 3) Arogyaswamy, R.N.P. Courses in Mining Geology, Oxford and IBH Publishing Co., 1994.

**REFERENCES:**

- 1) Sloan, D.A., Mine Management, Chapman and Hall, London, 1983.
- 2) Chatterjee, K.K., Mineral economics, Wiley Eastern, 1992.
- 3) Park, R.J., Examination and Valuation of mineral property
- 4) How to read a balance sheet ILO 1992.

**Web Links:**

1. <https://pubs.usgs.gov/circ/1953/0231/report.pdf>
2. <https://www.min.int/impact/whatis.shtml>
3. <https://www3.nd.edu/~cneal/planetearth/Chapt-15-Marshak.pdf>

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## LANDSLIDES & SLOPE STABILITY ENGINEERING

### (OPEN ELECTIVE – II)

**VI Semester**

**L T P C**

**Course Code: 231MI6002**

**3 0 0 3**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Classify types of mine slopes and slope failures, and identify key factors affecting slope stability for effective slope investigation planning.
- CO 2:** Acquire and interpret geological and geotechnical data required for evaluating highwall slope stability, including shear strength characteristics.
- CO 3:** Explain water flow mechanisms through various materials in mine slopes, and apply seepage analysis using flow nets and permeability estimation.
- CO 4:** Apply analytical and probabilistic methods for the design and stability assessment of pit slopes, waste dumps, and backfills.
- CO 5:** Analyze slope failure mechanisms using physical, empirical, and numerical models; evaluate stabilization and monitoring techniques with case study applications.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PO | PSO1 | PSO2 |
|-------|------|------|
| CO1   | -    | 3    |
| CO2   | -    | 3    |
| CO3   | -    | 3    |
| CO4   | -    | 3    |
| CO5   | -    | 3    |

### UNIT-I

#### Introduction

Types and formation of slopes in surface mines, pit slope vis-à-vis mine economics, mechanism of common modes of slope failure, factors influencing stability of slopes, and planning of slope stability investigations.

### UNIT-II

#### Geotechnical Information

Geotechnical data required for highwall slope stability studies. Collection of Geological Data and their interpretation for stability studies of highwall slopes.

**Shear Strength**

Shear strength of intact rock, discontinuity surfaces, filled discontinuities and rock-mass - estimation and determination; Surface roughness, joint roughness coefficient – estimation and determination.

**UNIT-III****Water Flow**

Concepts of water flow through a material and its permeability; water flow through rock-mass, water flow through soil type material and broken spoil material; Estimation and measurement of permeability and water pressure; Graphical solution of seepage problems (flow nets), seepage forces and seepage patterns under different conditions.

**UNIT-IV****Analysis and Design of Pit Slopes and Waste Dumps**

Slope stability assessment methods and techniques; Analysis and design criteria and methodology for highwall slopes and backfill and waste dumps; Probabilistic approaches of slope analysis and design.

**UNIT-V****Mechanisms of slope failures**

Field investigations and data collection. Design of slopes - physical, empirical, probabilistic methods, analytical (limit equilibrium analysis) and numerical (continuum models, discontinuum and crack propagation models) modeling.

**Stabilization and reinforcement of slopes.** Slope failure monitoring-modern techniques (SSR). Software for slope stability analysis. Case studies

**TEXT BOOKS:**

- 1) Hoek, E. and Bray, J.W; Rock Slope Engineering; John Wiley & Sons; New York; 1984
- 2) Brawner, C.O; Stability in surface mining, SME of USA; New York, 1982.

**REFERENCES:**

- 1) Giani, F; Rock Slope Stability Analysis; Balkema; Rotterdam; 1992.
- 2) Fundamentals and applications of rock mechanics, Deb.D and Verma A.K, PHI Publications.

**Web Links:**

1. <http://www.rocsience.com/learning/resource-library/books-by-r-e-goodman>
2. <http://www.sciencedirect.com/topics/earth-and-planetary-sciences/rock-mechanics>
3. <https://www.brighthubengineering.com/geotechnical-engineering/96483-rock-mechanics-defined/>

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**REMOTE SENSING AND GIS****(OPEN ELECTIVE – II)****VI Semester****L T P C****Course Code: 231MI6O03****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Explain the evolution of Remote Sensing and GIS, the energy interactions in the atmosphere and earth surface features.
- CO2:** Elaborate on photogrammetry and various satellites.
- CO3:** Interpret the images for preparation of thematic maps.
- CO4:** Develop GIS based raster and vector data models.
- CO5:** Explain navigation applications based on GCS and GPS systems.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | 1    | -    | 1    | -    |      | -    | -    | 2    | -     | -     | -     |
| CO2   | 2    | 1    | -    | 1    | -    | -    | -    | -    | 2    | -     | -     | -     |
| CO3   | 2    | 1    | -    | 1    | -    | -    | -    | -    | 2    | -     | -     | -     |
| CO4   | 3    | 2    | -    | 1    | -    | -    | -    | -    | 2    | -     | -     | -     |
| CO5   | 3    | 2    | -    | 1    | -    | -    | -    | -    | 2    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

**UNIT – I**

**Introduction to Remote sensing:** Basic concepts of remote sensing, interaction with atmosphere, energy interaction with the earth surfaces, characteristics of remote sensing systems, types of resolutions, types of sensors, airborne remote sensing, space borne remote sensing, image data characteristics, digital image data formats-band interleaved by pixel, band interleaved by line, band sequential, IRS, LANDSAT, SPOT & Recent satellite.

**UNIT – II**

**Image analysis:** Introduction, elements of visual interpretations, digital image processing-image preprocessing, image enhancement, image classification, supervised classification, unsupervised classification.

**UNIT – III**

**Geographic Information System:** Basic Principles, components, application areas of GIS, map projections. Data entry and preparation: spatial data structures, raster and vector data formats, data inputs, data manipulation, data retrieval, data analysis and data display.

**UNIT – IV**

**Spatial data analysis:** Introduction, overlay function-vector overlay operations, raster overlay operations, arithmetic operators, comparison and logical operators, conditional expressions, overlay using a decision table, network analysis-optimal path finding, network allocation, network tracing.

**UNIT – V**

**Applications:** Land cover and land use, agriculture, forestry, geology, geomorphology, urban & transportation, Hydrology and Water Resources: Flood zoning and mapping, groundwater prospects, groundwater quality monitoring and potential recharge zones, watershed management of application with case studies.

**TEXTBOOKS:**

1. 'Remote Sensing and Image Interpretation, by Lillesand, T.M, R.W. Kiefer and J.W. Chipman, Wiley India Pvt. Ltd., (2015), 7<sup>th</sup> Edition.
2. 'Remote Sensing - Models and Methods for Image Processing' by Robert A Schowenger, Elsevier publishers, (2009).
3. 'Fundamentals of Remote Sensing' by George Joseph, Universities Press, (2013) 3<sup>rd</sup> Edition.
4. 'Fundamentals of Geographic Information Systems' by Michael N. Demers, Wiley India Pvt. Ltd, (2012) 4<sup>th</sup> Edition.
5. 'Remote Sensing and GIS', by Bhatta B, Oxford University Press, (2011) 2<sup>nd</sup> Edition'.

## GEOSTATISTICS

### (OPEN ELECTIVE – II)

VI Semester

L T P C

Course Code: 231MI6O04

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Explain the stages of mineral exploration, sampling methods, and classical ore reserve estimation techniques.
- CO 2:** Apply classical statistical distributions and understand the foundational principles and scope of geostatistics in mineral resource evaluation.
- CO 3:** Construct and interpret semi-variograms and co-variograms, address modeling challenges, and apply basic Kriging methods for resource estimation.
- CO 4:** Analyze advanced geostatistical concepts including anisotropy, non-stationarity, and estimation variances for accurate grade control and mine planning.
- CO 5:** Utilize geostatistical tools for exploration optimization, mineral inventory computation, grade-tonnage modeling, and simulate real-world case studies.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PO | PSO1 | PSO2 | PSO3 |
|-------|------|------|------|
| CO1   | -    | 3    | -    |
| CO2   | -    | 3    | -    |
| CO3   | -    | 3    | -    |
| CO4   | -    | 3    | -    |
| CO5   | -    | 3    | -    |

**UNIT – I**

**Introduction to mineral exploration:** Significance and necessity; Prospecting and exploration criteria; Exploration strategy and design - stages of mineral exploration; theory and methods of sampling; resources and reserves - terminology and classification schemes; conventional methods of ore estimation.

**UNIT - II**



**Classical statistical distributions:** normal and lognormal, and their applications in resource evaluation. **Geo-statistics:** definition; schools of thought; stationarity assumptions and regionalized variables; what, when and why of Geo-statistics.

### UNIT - III

**Semi-variogram and co-variogram:** definitions, characteristics, and computations in one, two and three dimensions; mathematical models; associated difficulties viz. anisotropy, non-stationarities, regularization, presence of nugget effect and presence of trend. Extension, estimation and dispersion variance; calculation by discretization and auxiliary functions. **Kriging:** definition and derivation of Kriging system of equations. Practice of semi-variogram modeling; practice of Kriging - steps and procedure. An introduction to advanced Geo-statistics.

### UNIT - IV

**Advanced Geo-statistics:** Practical difficulties associated with semi-variography, viz. anisotropy, non-stationarity, regularization, misclassified tonnage; grade control plan. presence of nugget effect and presence of trend. Extension, Estimation and Dispersion variances: definitions, methods of calculations and applications; Screen Effect.

### UNIT - V

**Geo-statistical applications:** optimization of exploration drilling; calculation of mineral inventory; establishment of grade-tonnage relations; misclassified tonnage; grade control plan. Geostatistical conditional simulation - theory and approach. Geo-statistical case studies of selected mineral deposits.

#### Text Books:

1. Sarma DD. Geo statistics with applications in earth sciences. Springer publications. 2009.

#### References:

1. Journel AG and Huijbregts C J. Mining geo statistics. Academic press. 1981.
2. Andereson F. Geo statistics by example approach using R. 2006.

#### Web Links:

1. <https://pdfcoffee.com/surpac-tutorialpdf-pdf-free.html>
2. <https://baixardoc.com/documents/surpac-introduction-tutorial-system%20software-technology-5dbde76f19168>
3. <https://www.brighthubengineering.com/geotechnical-engineering/96483-rock-mechanics-defined/>

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## ENGINEERING PROPERTIES OF AGRICULTURAL PRODUCE (Open Elective-II)

|                        |   |   |   |   |
|------------------------|---|---|---|---|
| VI Semester            | L | T | P | C |
| Course Code: 231AG6O01 | 3 | 0 | 0 | 3 |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Calculate the basic engineering properties of a biological material.

**CO2:** Analyze the flow behavior of biological materials and force deformation.

**CO3:** Analyze the Maxwell and Kelvin model equations in the rheology for important biological materials.

**CO4:** Explain the applications of frictional and aerodynamic properties in the design of processing equipment.

**CO5:** Explain the applications of electrical and thermal properties in the design of processing equipment.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 3    | 1    | 1    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 3    | 2    | 2    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | -    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | -    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | 3     |
| CO2    | -     | 3     |
| CO3    | -     | 3     |
| CO4    | -     | 3     |
| CO5    | -     | 3     |

### Unit - I

Physical Properties: Introduction and application of engineering properties of biological material. Physical properties of different food commodities and aided products – importance. Shape and size – criteria for describing shape and size. Roundness and sphericity – Volume and density – Specific gravity – Bulk density. Porosity – surface area – measurement of the same.

### Unit – II

Rheology: Introduction to rheology, basic concepts, Classification of rheology, ASTM standard definition of terms. Rheological Properties, Flow behavior of biological materials,

force deformation curve; linear elastic limit, yield point, bio-yield point and rupture point. Stress relaxation and creep behavior. Visco-elasticity and visco-plasticity.

### **Unit – III**

Rheological models: Introduction to mechanical models. Kelvin and maxwell models. Electrical equivalence of mechanical models. Rheological equations of maxwell model, generalized maxwell model, kelvin model and generalized kelvin model. Difference between kelvin and maxwell model. Viscosity; Measurement of viscosity using viscometer, types of viscometer, problems on viscometer.

### **Unit – IV**

Frictional Properties: Basic concepts, effect of load sliding velocity. Friction in agricultural materials, measurement. Rolling resistance, angle of internal friction and angle of repose. Applications of frictional properties in design of processing equipment. Aerodynamic Properties: Importance of aerodynamic properties in Agricultural Processing equipments with examples. Terminal velocity and drag coefficient; frictional drag and pressure drag. Terminal velocity of different grains, working of pneumatic conveyor based on aerodynamic properties.

### **Unit – V**

Electrical properties: Di-electrical properties; Dielectric loss factor and dielectric constant. Applications and role of electrical properties in food processing. Thermal Properties: Introduction to thermal properties; Specific heat, thermal conductivity, thermal diffusivity, latent heat of vaporization, latent heat of fusion, sensible heat, enthalpy and heat energy calculation.

### **Text Books:**

1. Physical properties of plant and animal materials, Mohsenin N N, Gordon and Breach Science Publishers, New York, 2nd edition, 1986.
2. Engineering Properties of Foods, Rao M A, Syed S H Rizvi and Ashim K Datta, CRC Press – Taylor & Francis Group, Boca Raton, FL, 4th edition, 2014

### **Reference Books:**

1. Food and Process Engineering Technology, Wilhelm LR, Suler W A and Brusewitz, G H, American Society of Agricultural Engineers (ASAE), St. Joseph, MI.
2. Engineering Properties of Biological Materials, O.P. Singhal and D.V.K. Samuel, Saroj Prakashan, Allahabad, 1st edition, 2003.

### **Web Links:**

1. [http://ecourses.iasri.res.in/email\\_authentication.aspx?Degree\\_Id=04](http://ecourses.iasri.res.in/email_authentication.aspx?Degree_Id=04)
2. <http://ecoursesonline.iasri.res.in/course/view.php?id=25>
3. <http://www.cigr.org/documents/CIGRHandbookVol4.pdf>
4. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=1011>
5. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=1013>

**PLASTIC APPLICATIONS IN AGRICULTURE**  
**(Open Elective-II)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VI Semester</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231AG6O02</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Assess types and quality of plastics used in soil and water conservation.

**CO2:** Design, estimation and laying of plastic films in lining of canal, reservoir and water Harvesting Ponds.

**CO3:** Design, estimation and installation of green, poly and shade net houses, low tunnels etc.

**CO4:** Explain plastics application in drying, preservation, handling and storage of agricultural produce.

**CO5:** Outline plastic usage with hands on experience through visit to a greenhouse and farmers field.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | 1    | -    | -    | -    | -    | 3    | -    | -    | -     | 2     | -     |
| CO2   | 3    | 2    | 1    | -    | -    | -    | 1    | -    | -    | -     | -     | -     |
| CO3   | 3    | 2    | 1    | -    | -    | -    | 1    | -    | -    | -     | -     | -     |
| CO4   | 3    | 1    | -    | 2    | -    | 1    | -    | -    | -    | -     | -     | -     |
| CO5   | 3    | 1    | -    | 2    | -    | 1    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

**Unit - I**

Introduction of plasticulture - types and quality of plastics used in soil and water conservation, production agriculture and post harvest management. Quality control measures. Present status and future prospective of plasticulture in India. Water management - use of plastics in in-situ moisture conservation and rain water harvesting. Plastic film lining in canal, pond and reservoir. Design, estimation and laying of plastic films in lining of canal, reservoir and water harvesting Ponds.

**Unit – II**

Plastic pipes for irrigation water management, bore-well casing and subsurface drainage. Study of plastic components of drip and sprinkler irrigation systems, laying and flushing of laterals. Use of polymers in control of percolation losses in fields. Soil conditioning - soil solarisation, effects of different colour plastic mulching in surface covered cultivation.

**Unit – III**

Nursery management - Use of plastics in nursery raising, nursery bags, trays etc. Controlled environmental cultivation - plastics as cladding material, green / poly / shade net houses, wind breaks, poly tunnels and crop covers. Design, estimation and installation of green, poly and shade net houses, low tunnels etc.

**Unit-IV**

Plastic nets for crop protection - anti insect nets, bird protection nets. Plastic fencing. Plastics in drying, preservation, handling and storage of agricultural produce, innovative plastic packaging solutions for processed food products. Plastic cap covers for storage of food grains in open. Silage film technique for fodder preservation.

**Unit-V**

Use of plastics as alternate material for manufacturing farm equipment and machinery. Plastics for aquacultural engineering and animal husbandry - animal shelters, vermi-beds and inland fisheries. Agencies involved in the promotion of plasticulture in agriculture at national and state level. Human resource development in particular applications.

**Text Books:**

1. Dubois. 1978. Plastics in Agriculture. Applied Science Publishers Limited, Essex, England.  
y Manas Chanda, Salil K. Roy. 2008. Plastics Fundamentals, Properties, and Testing. CRC Press.
2. Charles A. Harper. 2006. Handbook of Plastics Technologies. The Complete Guide to Properties and Performance. McGraw-Hill, New Delhi.
3. Central Pollution Control Board. 2012. Material on Plastic Waste Management. Parivesh Bhawan, East Arjun Nagar, Delhi-110032.
4. Brown, R.P. 2004. Polymers in Agriculture and Horticulture. RAPRA Review Reports : Vol. 15, No. 2, RAPRA Technology Limited, U.K

**Reference Books:**

1. Brahma Singh, Balraj Singh, Naved Sabir and Murtaza Hasan. 2014. Advances in Protected Cultivation. New India Publishing Agency, New Delhi.
2. Shankar, A.N. 2014. Integrated Horticulture Development in Eastern Himalayas, Plasticulture in Agri- Horticulture Systems, 241-247.
3. Ojha, T.P. and Michael, A.M., 2012, Principles of Agricultural Engineering - I. Jain Brothers, Karol Bagh, New Delhi.
4. Pandey, P.H. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana, India.

**Web Links:**

1. <https://krishi.icar.gov.in/jspui/bitstream/123456789/42008/1/Article%201.pdf>
2. [https://ec.europa.eu/eip/agriculture/sites/default/files/eipagri\\_fg\\_plastic\\_footprint\\_minipaper\\_c\\_final.pdf](https://ec.europa.eu/eip/agriculture/sites/default/files/eipagri_fg_plastic_footprint_minipaper_c_final.pdf)

## INTRODUCTION TO DATA SCIENCE

(Open Elective-II)

VI Semester

L T P C

Course Code: 231DS6001

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1** Apply principles of NumPy and Pandas to the analysis of data.
- CO 2** Make use of various file formats in loading and storage of data
- CO 3** Identify and apply the need and importance of pre-processing techniques
- CO 4** Show the results and present them in a pictorial format
- CO 5** Facilitate new solutions for visualization of datasets by using different plotting techniques.

### Mapping of course outcomes with program outcomes:

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 2   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 2   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO3   | 2   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 2   | 2   | -   | -   | 2   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 3   | -   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |

### Mapping of course outcomes with program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | -    | -    |
| CO2    | -    | -    |
| CO3    | -    | -    |
| CO4    | -    | -    |
| CO5    | -    | -    |

**UNIT I Data science:** definition, Datafication, Exploratory Data Analysis, The Data science process, A data scientist role in this process. NumPy Basics: The NumPy ndarray: A Multidimensional Array Object, Creating ndarrays ,Data Types for ndarrays, Operations between Arrays and Scalars, Basic Indexing and Slicing, Boolean Indexing, Fancy Indexing, Data Processing Using Arrays, Expressing Conditional Logic as Array Operations, Methods for Boolean Arrays , Sorting , Unique.

**UNIT II Getting Started with pandas:** Introduction to pandas, Library Architecture, Features, Applications, Data Structures, Series, DataFrame, Index Objects, Essential Functionality (Reindexing, Dropping entries from an axis, Indexing, selection, and filtering), Sorting and ranking, Summarizing and Computing Descriptive Statistics, Unique Values, Value Counts, Handling Missing Data, filtering out missing data.



**UNIT III Data Loading, Storage, and File Formats :** Reading and Writing Data in Text Format, Reading Text Files in Pieces, Writing Data Out to Text Format, Manually Working with Delimited Formats, JSON Data, XML and HTML: Web Scraping, Binary Data Formats, Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Databases, Storing and Loading Data in MongoDB

**UNIT IV Data Wrangling:** Combining and Merging Data Sets, Database style DataFrame Merges, Merging on Index, Concatenating Along an Axis, Combining Data with Overlap , Reshaping and Pivoting, Reshaping with Hierarchical Indexing, Data Transformation, Removing Duplicates, Replacing Values.

**UNIT V Plotting and Visualization:** A Brief matplotlib API Primer, Figures and Subplots, Colors, Markers, and Line Styles, Ticks, Labels, and Legends, Annotations and Drawing on a Subplot, Saving Plots to File, Plotting Functions in pandas, Line Plots, Bar Plots, Histograms and Density Plots, Scatter Plots.

**Text Books:**

T1: Wes McKinney, “Python for Data Analysis”, O’REILLY, ISBN:978-1-449-31979-3, 1st edition, October 2012.

T2: Rachel Schutt & O’neil, “Doing Data Science”, O’REILLY, ISBN:978-1-449-35865-5, 1<sup>st</sup> edition, October 2013

**Reference Books:**

R1: Joel Grus, “Data Science from Scratch: First Principles with Python”, O’Reilly Media, 2015

R2: Matt Harrison, “Learning the Pandas Library: Python Tools for Data Munging, Analysis, and Visualization , O’Reilly, 2016.

**Web Links:**

1. <https://www.geeksforgeeks.org/how-to-become-a-data-analyst-complete-roadmap/>
2. [https://en.m.wikipedia.org/wiki/Data\\_Science\\_and\\_Predictive\\_Analytics](https://en.m.wikipedia.org/wiki/Data_Science_and_Predictive_Analytics)

**INTRODUCTION TO DRILLING TECHNOLOGY**  
**(OPEN ELECTIVE – II)**

**VI Semester**

**L T P C**

**Course Code: 231PT6001**

**3 0 0 3**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Discuss about overview of drilling.  
**CO 2:** Identify different types of drilling fluids and their hydraulics.  
**CO 3:** Explain about types casing and cementation processes.  
**CO 4:** Explain about application of directional drilling.  
**CO 5:** Estimate the kick and explain special kick problems.

**Mapping of Course Outcomes with Program Outcomes**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | 3     | -     |
| CO2      | 3     | -     |
| CO3      | 3     | -     |
| CO4      | 3     | -     |
| CO5      | 3     | -     |

**UNIT-I**

**Overview of drilling:** Drilling Planning Approaches- Drilling team- Types of drilling.

**UNIT-II**

Rotary bit technology- Drilling string basics.

**Drilling fluids and hydraulics:** Drilling fluid economics- Drilling fluid properties- Drilling fluid report hydraulics calculations- Bit Hydraulics- Optimization- Swab & Surge-pressures- Mud hydraulics analysis report- Lost circulation. Disposing of the drilling fluids waste and drill cuttings waste.

**UNIT-III**

**Casing & cementation:** Casing standards- Casing coupling- Cementing: Introduction cement slurries-Typical field calculations- Cementing nomenclature- Cement additives- Casing & cementing analysis report.

**UNIT-IV**

**Directional drilling:** Applications- Well planning- Down-hole motors- Deflection tools and techniques- Face orientation- Direction control with rotary assemblies- Navigation drilling systems- Horizontal wells-Fishing operations- MWD, LWD & ERD and Bi-centric bits.

**UNIT-V**

**Stuck pipe, well control:** Kicks- Kick control- Pressure control theory- BOP-Special kick problems and procedures to free the pipes and Fishing operations.

**Driller's logs:** Sample logs- Miscellaneous logging devices.

**TEXT BOOKS:**

1. Petroleum Engineering: Drilling and Well Completion, Carl Gatlin, Prentice-Hall, Inc., 1960.
2. Drilling Engineering, J.J. Azar and G.Robello Samuel, PennWell Books, 2007.
3. Working Guide to Drilling Equipment and Operations, William Lyons, Gulf Publishing, 2009.

**REFERENCE BOOKS:**

1. Oil Well Drilling Engineering: Principles and Practice, H. Rabia, Graham & Trotman, 1985.
2. Drilling Engineering: A Complete Well Planning Approach, Neal Adams, Tommie Charrier Pennwell, 1985.
3. Practical Well Planning and Drilling Manual, Steve Devereux, Pennwell, 1998.

**Weblinks**

1. <https://www.drillopedia.com/direction-drilling-applications>
2. [https://www.academia.edu/17285077/Well\\_Control\\_Manual](https://www.academia.edu/17285077/Well_Control_Manual)

**INTRODUCTION TO WELL COMPLETIONS**  
**(OPEN ELECTIVE-II)**

VI Semester

L T P C

Course Code: 231PT6O02

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Discuss about functions of completions.  
**CO 2:** Identify different types of perforation techniques.  
**CO 3:** Explain about various completion equipment.  
**CO 4:** Discuss about General Procedure and considerations of DST and Tubing string design.  
**CO5:** Explain about well servicing and stimulation system.

**Mapping of Course Outcomes with Program Outcomes**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | 3     | -     |
| CO2      | 3     | -     |
| CO3      | 3     | -     |
| CO4      | 3     | -     |
| CO5      | 3     | -     |

**UNIT-I****Well completion:** Types of wells- Completion functions- Types of completion.**UNIT-II**

Mechanical aspects of well testing- Cased hole logging equipment and application and perforation methods and perforation equipment.

**Packers:** Function- Application- Proper selection- water / gas shut off, horizon separation etc.**UNIT-III**

Completion equipment (SSD, SSSV, mandrels, locks etc.)- Data acquisition in wells- Fibre optics- Permanent gauges- Memory gauges- SCADA systems- Intelligent completion equipment.

**UNIT-IV**

Tubing string design (dimension, materials and connections etc.) based on pressure, temperature, operating conditions- Media- Safety requirements.

Drill Stem Testing: General Procedure and considerations- Test tool components and arrangement- Analysis of Test data.

**UNIT-V**

HPHT and horizontal well completions- Workover equipment wireline- Snubbing unit- Coil tubing completion and work over design and execution.

Introduction to well servicing and stimulation system – Objectives and applications.

**TEXT BOOKS:**

1. Well Completion and Servicing, D. Perrin, Micheal Caron, Georges Gaillot, Editions Technip, 1999.
2. Primer of Well Service, Workover and Completion, Petroleum Extension Service (PETEX), University of Texas at Austin, 1997.
3. Well Testing, John Lee, Society of Petroleum Engineers, 1982.

**REFERENCE BOOKS:**

1. Well Completion Design, Jonathan Bellarby, Elsevier, 2009.
2. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman, Inc., 1986.
3. Advanced Well Completion Engineering, Wan Renpu, Gulf Professional Publishing, 2011.

**Weblinks**

1. <https://www.drillopedia.com/direction-drilling-applications>
2. [https://www.academia.edu/17285077/Well\\_Control\\_Manual](https://www.academia.edu/17285077/Well_Control_Manual)

**INTRODUCTION TO PETROLEUM PRODUCTION ENGINEERING**  
**(OPEN ELECTIVE – II)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VI Semester</b>            | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231PT6O03</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO 1:** Explain about petroleum production system.

**CO 2:** Discuss about reservoir deliverability

**CO 3:** Explain about Choke performance

**CO 4:** Design of transportation system

**CO 5:** Explain about artificial lift methods.

**Mapping of Course Outcomes with Program Outcomes**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | 3     | -     |
| CO2      | 3     | -     |
| CO3      | 3     | -     |
| CO4      | 3     | -     |
| CO5      | 3     | -     |

**UNIT-I**

Petroleum production system - Introduction to Petroleum Industry, Reservoir Engineering, Well Design and Drilling, Production Equipment and Facilities, Production Techniques

**UNIT-II**

Reservoir deliverability - Introduction to Reservoir Deliverability

**UNIT-III**

Choke performance - Well Deliverability-Forecast of well production

**UNIT-IV**

Production decline analysis. Transportation system: Design and Selection

**UNIT-V**

Artificial lift methods: Basics and Design of Sucker rod pumping - Gas lift - Other artificial lift methods.

Production Stimulation: Well problem identification - Matrix acidizing- Hydraulic fracturing-

**TEXT BOOKS:**

1. Petroleum Production Engineering: A computer Assisted Approach, Boyun Guo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books, 2007. 2. Petroleum Production Systems, M. J. Economides, A. Daniel Hill & C. E. Economides, Prentice- Hall, N. J – 07488, 1994.

**REFERENCE BOOKS:**

1. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.
2. The Technology of Artificial Lift Method, Brown, K.E., Volume 1, PennWell Books, 1977.

**Weblinks**

1. <https://www.drillopedia.com/direction-drilling-applications>
2. [https://www.academia.edu/17285077/Well\\_Control\\_Manual](https://www.academia.edu/17285077/Well_Control_Manual)

**CAD LAB****VI Semester****L T P C****Course Code: 231CE6S01****0 1 2 2****Course Outcomes: At the end of the course, the student will be able to****CO1:** Analyze and design determinate structures using structural analysis software.**CO2:** Evaluate and design fixed/continuous beams using computational tools.**CO3:** Model and analyze plane/space frames under dead and live loads using software.**CO4:** Design and detail steel/RCC members (beams, columns, trusses) as per codal provisions**CO5:** Develop foundation design programs using Excel and perform seismic/wind load analysis on buildings.**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO1</b> | 3    | 3    | -    | 2    | 3    | -    | -    | -    | -    | -     | -    | -    |
| <b>CO2</b> | 3    | 3    | 3    | 2    | 3    | -    | -    | -    | -    | -     | -    | -    |
| <b>CO3</b> | 3    | 3    | -    | 2    | 3    | -    | -    | -    | -    | -     | -    | -    |
| <b>CO4</b> | 3    | 3    | 3    | 2    | 3    | -    | -    | -    | -    | -     | -    | -    |
| <b>CO5</b> | 3    | 3    | 3    | 2    | 3    | -    | -    | -    | -    | -     | -    | -    |

**Mapping of Course Outcomes with Program-Specific Outcomes**

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | 3     | -     |
| <b>CO 2</b> | 3     | -     |
| <b>CO 3</b> | 3     | -     |
| <b>CO 4</b> | 3     | -     |
| <b>CO 5</b> | 3     | -     |

**LIST OF EXPERIMENTS**

1. Analysis & Design determinate structures using a software
2. Analysis & Design of fixed & continuous beams using a software
3. Analysis & Design of Plane Frames
4. Analysis & Design of space frames subjected to DL & LL
5. Analysis & Design of residential building subjected to all loads (DL, LL, WL, EQL)
6. Analysis & Design of Roof Trusses
7. Design and detailing of built up steel beam
8. Developing a design program for foundation using EXCEL Spread Sheet
9. Detailing of RCC beam and RCC slab
10. Detailing of Steel built up compression member



**Note:** Drafting of all the exercises is to be carried out using commercially available designing software's.

**Textbooks:**

1. Structural Analysis" by R.C. Hibbeler (Pearson)
2. Design of Steel Structures" by S.K. Duggal (McGraw Hill)

**Reference Books**

1. Finite Element Procedures" by Klaus-Jürgen Bathe (Prentice Hall)
2. Structural Engineering Software: Tools and Applications" by Bungale S. Taranath (CRC Press)

**Weblinks:**

1. <https://nptel.ac.in/courses/112104031>
2. <https://nptel.ac.in/courses/112102101>

## TECHNICAL PAPER WRITING AND IPR

Semester: VI

Course Code: 231MC6T01

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>2</b> | <b>0</b> | <b>0</b> | <b>0</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Understand the structure of the technical paper and its components

**CO2:** Review the literature and acquire the skills to write a technical paper for first submission.

**CO3:** Understand the process and development of IPR.

**CO4:** Create awareness about the scope of patent rights.

**CO5:** Analyze the new developments in IPR include the latest software.

**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | -    | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | 1     |
| <b>CO2:</b> | -    | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | 1     |
| <b>CO3:</b> | -    | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | 1     |
| <b>CO4:</b> | -    | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | 1     |
| <b>CO5:</b> | -    | -    | -    | -    | -    | 2    | 2    | 2    | 2    | 2     | 2     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | -    |
| <b>CO2:</b> | -    | -    |
| <b>CO3:</b> | -    | -    |
| <b>CO4:</b> | -    | -    |
| <b>CO5:</b> | -    | -    |

### Unit - I

#### Planning and preparation

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness. Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

### Unit – II

#### Literature review

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Key skills needed when writing a Title, Abstract, Introduction, a Review of the Literature, the Methods, the Results, the Discussion, and the Conclusions. Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

### Unit – III

#### Process and Development

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario:

International cooperation on Intellectual Property. Procedure for grants of patents, patenting under PCT.

#### **Unit – IV**

##### **Patent Rights**

Scope of Patent Rights. Licensing and transfer of technology, Patent information and databases, Geographical Indications

#### **Unit – V**

##### **New Developments In IPR**

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies.

#### **Text Books:**

1. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press..
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.

#### **Reference Books:**

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman’s book.
3. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
4. Mayall, “Industrial Design”, McGraw Hill, 1992.

#### **Weblinks:**

1. <http://nptel.ac.in/courses/112102101>
2. <https://archive.nptel.ac.in/courses/112/102/112102102/>

## SOFT SKILLS

**Semester: VI**

**L T P C**

**Course Code: 231MC6T02**

**2 0 0 0**

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Solve the problems on Time & Work, Time & Distance by simple methods.

**CO2:** Derive the conclusions, assumptions and arguments from the available information.

**CO3:** Write technical reports and emails for professional communication.

**CO4:** Solve problems on Permutations & Combination, Probability.

**CO5:** Participate confidently in a formal discussion and present themselves effectively.

**CO6:** Comprehend the techniques of skimming and scanning for effective communication.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | -   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 2    | -    | -    |
| CO3   | -   | -   | -   | -   | -   | -   | -   | -   | -   | 3    | -    | -    |
| CO4   | -   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | -   | -   | -   | -   | -   | -   | -   | -   | 3   | -    | -    | -    |
| CO6   | -   | 1   | -   | -   | -   | -   | -   | -   | 1   | 1    | -    | -    |

### APTITUDE:

Number System, LCM & HCF, Ratio & Proportion, Averages, Problems on Ages, Partnership, Percentages, Profit and Loss, Simple Interest, Compound Interest, Time and Work, Pipes and Cisterns, Mixture and Allegations, Time, Speed and Distance, Problems on Trains, Boats and Streams, Mensuration – I, Mensuration - II

### REASONING:

Number Series, Letter Series, Number Analogy, Letter Analogy, Odd Man Out, Logical Sequence of Words, Coding and Decoding, Ranking Test, Alphabet Test, Direction Test, Blood Relations, Calendar, Clocks, Cubes and Dice, Coded Inequalities, Venn Diagrams, Syllogisms, Non - Verbal Reasoning, Seating Arrangement

### VERBAL ABILITY:

Introduction to soft skills, How to improve communication?, Parts of Speech, Mind your language towards better English, Vocabulary Expansion, Written communication skill practice, Grammatical use, Concept of 4 step method for presentation, Present Tense, Grammar in use,

Group discussion, Reading Comprehension, Past Tense, Future Tense, Grammatical use, Self-introduction, Letters, E-Mail & Report writing, Error correction, Effective Communication

**Text Books:**

1. Quantitative Aptitude – Dr. R. S. Aggarwal, S CHAND.
2. A Modern Approach to Verbal and Non-Verbal Reasoning – Dr. R. S. Aggarwal.
3. Quick Learning Objective General English – Dr. R. S. Aggarwal, S CHAND.

**Reference Books:**

1. Quantitative Aptitude – Abhijit Guha Mc Graw Hill Publications
2. Analytical Reasoning – Jaikishan and Premkishan Arihant Publications.
3. A New Approach to Objective English – R. S. Dhillon DGP Publications.

**Web Links:**

1. [www.indiabix.com](http://www.indiabix.com)
2. [www.bankersadda.com](http://www.bankersadda.com)

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**HIGHWAY ENGINEERING LAB****VI Semester****L T P C****Course Code:** 231CE6L02**0 0 3 1.5****Course Outcomes: At the end of the course the student will be able to**

- CO1:** Test aggregates and judge the suitability of materials for the road construction.
- CO2:** Test the given bitumen samples and judge their suitability for the road construction.
- CO3:** Obtain the optimum bitumen content for Bituminous Concrete.
- CO4:** Determine the traffic volume, speed and parking characteristics.
- CO5:** Draw highway cross sections and intersections.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO1</b> | 3    | -    | -    | 1    | 1    | -    | -    | -    | 2    | 2     | -    | 2    |
| <b>CO2</b> | 3    | -    | -    | 1    | 1    | -    | -    | -    | 2    | 2     | -    | 2    |
| <b>CO3</b> | 3    | -    | -    | 1    | 1    | -    | -    | -    | 2    | 2     | -    | 2    |
| <b>CO4</b> | 2    | 1    | -    | 1    | 1    | -    | -    | -    | 2    | 2     | -    | 2    |
| <b>CO5</b> | 3    | 1    | 3    | 1    | 1    | -    | -    | -    | 2    | 2     | -    | 2    |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | -     | 2     |
| <b>CO 2</b> | -     | 2     |
| <b>CO 3</b> | -     | 2     |
| <b>CO 4</b> | -     | 2     |
| <b>CO 5</b> | -     | 2     |

**SYLLABUS:****I. ROAD AGGREGATES:**

1. Aggregate Crushing value Test.
2. Aggregate Impact Test.
3. Specific Gravity and Water Absorption Test.
4. Attrition Test.
5. Abrasion Test.
6. Shape tests

**II. BITUMINOUS MATERIALS:**

1. Penetration Test.
2. Ductility Test.
3. Softening Point Test.
4. Flash and fire point tests.
5. Stripping Test.
6. Viscosity Test.

**III. BITUMINOUS MIX:**

1. Marshall Stability test.

**IV. TRAFFIC SURVEYS:**

1. Traffic volume study at mid blocks.
2. Traffic Volume Studies (Turning Movements) at intersection.
3. Spot speed studies.
4. Parking study.

**V. DESIGN & DRAWING:**

1. Earthwork calculations for road works
2. Drawing of road cross sections
3. Rotary intersection design

**LIST OF EQUIPMENT:**

1. Apparatus for aggregate crushing test.
2. Aggregate Impact testing machine
3. Pycnometers
4. Los angles Abrasion test machine
5. Deval's Attrition test machine
6. Elongation and thickness gauges
7. Bitumen penetration test setup.
8. Bitumen Ductility test setup.
9. Ring and ball apparatus
10. Viscometer.
11. Marshal Mix design apparatus.
12. Enoscope for spot speed measurement.
13. Stop Watches.

**Textbooks:**

1. 'Highway Material Testing Manual' by S.K. Khanna, C.E.G Justo and A. Veeraraghavan, Neam Chan Brothers New Chand Publications, New Delhi.

**Reference Books:**

1. IRC Codes of Practice
2. Asphalt Institute of America Manuals

### 3. Code of Practice of B.I.S.

**Web Links:**

1. <http://nptel.ac.in/courses/105101087/29>
2. <https://civilblog.org/2015/09/12/7-lab-tests-on-aggregate-to-check-quality-for-use-in-road-work/>
3. <https://www.aboutcivil.org/marshall-stability-test-astm-d6927-06-standard.html>



## ENVIRONMENTAL ENGINEERING LAB

VI Semester

**L      T      P      C**

**Course Code: 231CE6L01**

**0      0      3      1.5**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Determine the physical and chemical quality parameters of raw water.
- CO2** Estimate the extent of pollution in the given water sample by comparing it with the IS – 10500 - 2012 drinking water standards.
- CO3** Determine the treatment methods to be followed to supply the water for public consumption.
- CO4** Determine the physical and chemical quality parameters of wastewater
- CO5** Estimate the level of treatment methods to be followed for the given wastewater sample by comparing it with Effluent standards – EPA 1986.

**Mapping of Course Outcomes with Program Outcomes:**

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 1    | -    | 1    | -    | 2    | 2    | 2    | 2    | 1     | -     | 2     |
| <b>CO2</b> | 1    | 1    | -    | 1    | -    | 3    | 2    | 2    | 2    | 1     | -     | 2     |
| <b>CO3</b> | 2    | 1    | -    | 1    | -    | 3    | 2    | 2    | 2    | 1     | -     | 2     |
| <b>CO4</b> | 1    | 2    | -    | 2    | -    | 2    | 3    | 2    | 2    | 1     | -     | 1     |
| <b>CO5</b> | 3    | 1    | -    | 1    | -    | 2    | 1    | 2    | 2    | 1     | -     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 3    |
| <b>CO2</b> | -    | 1    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

**List of Experiments:**

1. To determine the physical properties of the given water samples (colour, odour, temperature and turbidity).
2. To determine pH and acidity of the given water samples
3. To determine total alkalinity of the given water samples
4. To estimate the total, calcium and magnesium hardness in the given water samples
5. To determine total dissolved solids (TDS) and electrical conductivity (EC) of the given water sample.
6. To determine optimum coagulant dose needed in water treatment using Jar test.
7. To estimate the amount of dissolved oxygen (DO) content and biochemical oxygen demand (BOD) of the given water and wastewater samples respectively.
8. To determine the total settleable solids present in the given water sample using Imhoff cone setup
9. To determine the chemical oxygen demand (COD) of the given waste water sample.
10. To determine the total nitrogen and phosphorous content present in the given waste water sample.

**Reference Books:**

1. Chemical analysis of water and soil, KVSG Murali Krishna, Reem publications, 2012.
2. Standard methods of analysis of water and waste water, APHA .
3. Handbook of Water Analyses, Leo M.L. Nollet, Leen S. P. De Gelderis, CRC Press, 2013 3rd Edition, 2012.

**Web Links:**

1. <http://www.fao.org/docrep/X5624E>
2. [http://www.who.int/water\\_sanitation\\_health](http://www.who.int/water_sanitation_health)
3. <https://www.thermofischer.com>>industrial

## PRE-STRESSED CONCRETE

VII Semester

**L      T      P      C**

**Course Code: 231CE7T01**

**3      0      0      3**

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Explain concepts of prestressing.

**CO2:** Estimate losses in prestressed concrete.

**CO3:** Calculate the flexural strength and deflection of prestressed concrete beam.

**CO4:** Design prestressed concrete member for bending, shear, and torsion.

**CO5:** Design of end zone reinforcement for pre tensioned and post tensioned members

### Mapping of Course Outcomes with Program Outcomes:

|     | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-----|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1 | 2    | 2    | -    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |
| CO2 | 2    | 2    | -    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |
| CO3 | 2    | 2    | -    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |
| CO4 | 2    | 2    | 3    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |
| CO5 | 2    | 2    | 3    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|     | PSO1 | PSO2 |
|-----|------|------|
| CO1 | 2    | 3    |
| CO2 | 2    | -    |
| CO3 | 2    | -    |
| CO4 | 3    | -    |
| CO5 | 3    | -    |

### Unit - I

Basic concepts of Prestressing:

Basic concepts of Prestressing – Advantages and Applications of Prestressed Concretes – High Strength Concrete

– Permissible Stresses – Shrinkage – Creep – Deformation Characteristics – High strength Steel  
– Types – Strength

– Permissible Stresses – Relaxation of Stress – Stress Corrosion – Durability – Fire Resistance  
– Cover

Requirements.

Prestressing

Systems:

Introduction – Tensioning devices – Pre-tensioning Systems – Post tensioning Systems – Basic Assumptions in Analysis of prestress and design – Analysis of prestress – Resultant Stresses at a section – pressure line – Concepts of load balancing – Stresses in Tendons – Cracking moment

**Unit – II**

Losses of Pre-stressing:

Losses of Pre-stressing – Loss of Pre-stress in pre-tensioned and post tensioned members –

Elastic shortening of

concrete – shrinkage of concrete – creep of concrete – Relaxation of steel – slip in anchorage – differential shrinkage – bending of members and frictional losses – Total losses allowed for design.

**Unit-III**

Deflections and Flexure Strength:

Importance of control of deflections – Factors influencing – Prediction of short term and long term deflections – Types of flexural failure – Code procedures – Design of sections for flexure.

**Unit – IV**

Design for Shear and Torsion

Shear and Principal Stresses – Design of Shear reinforcements – Codal Provisions – Design for Torsion – Design for Combined bending, shear, and torsion.

**Unit – V**

Transfer of Stresses: Transfer of Prestress in pre tensioned members – Transmission length – Bond stresses – end zone reinforcement – Codal provisions – Anchorage zone Stresses in Post tensioned members – stress distribution in end block – Anchorage Zone reinforcement.

**Text Books:**

1. Prestressed Concrete, Rajagopalan. N, Narosa publications, 2nd Edition, 2006.
2. Prestressed concrete, Srikanth, B. Vanakudu, Khanna Publications, 2018

**Reference Books:**

1. Prestressed Concrete, Ramamrutham S, Publications, 5th Edition, 2013
2. Design of Prestressed Concrete Structures, Lin T.Y. & Ned H. Burns, John Wiley & Sons, 3rd Edition, 2004

**Web Links:**

1. <https://nptel.ac.in/courses/105106118/>
2. <https://lecturenotes.in/subject/245/prestressed-concrete-structures-pcs>
3. <https://nptel.ac.in/courses/105106117/>

## GROUND IMPROVEMENT TECHNIQUES

**VII Semester**

**L T P C**

**Course Code: 231CE7T02**

**3 0 0 3**

**Course Outcomes: At the end of the course the student will be able to**

- CO1:** Explain and compare various in-situ densification methods for both granular and cohesive soils, such as vibration, impact techniques, preloading, and vertical drains.
- CO2:** Analyze and select appropriate dewatering systems like sumps, well points, and electro-osmosis for given soil and groundwater conditions.
- CO3:** Evaluate different soil stabilization techniques using mechanical methods, cement, lime, bitumen, polymers, and industrial wastes, and understand their practical applications.
- CO4:** Explain the principles of reinforced earth structures and soil nailing, and evaluate the functions and mechanisms of reinforcement used in ground improvement.
- CO5:** Demonstrate the use of geosynthetics including geotextiles, geogrids, and geomembranes, by identifying their types, properties, functions, and engineering applications.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO1</b> | 3    | 2    | 2    | -    | 2    | -    | -    | -    | -    | -     | -    |      |
| <b>CO2</b> | 3    | 1    | 2    | -    | 2    | -    | -    | -    | -    | -     | -    |      |
| <b>CO3</b> | 3    | 2    | 2    | 3    | 2    | -    | -    | -    | -    | -     | -    | 1    |
| <b>CO4</b> | 3    | 3    | 2    | -    | 2    | -    | -    | -    | -    | -     | -    | 1    |
| <b>CO5</b> | 3    | 2    | 2    | -    | 2    | 2    | -    | -    | -    | -     | -    |      |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | -     | -     |
| <b>CO 2</b> | -     | -     |
| <b>CO 3</b> | -     | -     |
| <b>CO 4</b> | -     | -     |
| <b>CO 5</b> | -     | -     |

### UNIT-I

In situ densification methods- in situ densification of granular soils- vibration at ground surface and at depth, impact at ground and at depth – insitudensification of cohesive soils – pre loading – vertical drains – sand drains and geo drains – stone columns.

**UNIT-II**

Dewatering–sumps and interceptor ditches –single and multi-stage well points–vacuum well points, horizontal wells – criteria for choice of filler material around drains – electro osmosis.

**UNIT- III**

Stabilization of soils – methods of soil stabilization – mechanical – cement – lime – bitumen and polymer stabilization–use of industrial wastes like fly ash and granulated blast furnace slag.

Grouting – objectives of grouting – grouts and their applications – methods of grouting – stage of grouting–hydraulic fracturing in soils and rocks –post grout tests. Introduction to Liquefaction & its effects & applications.

**UNIT-IV**

Reinforced earth–principles–components of reinforced earth–design principles of reinforced earth walls – stability checks – soil nailing.

**UNIT-V**

Geosynthetics–geotextiles–types–functions, properties and applications – geogrids, geomembranes and gabions - properties and applications.

**TEXT BOOKS:**

1. 'Ground Improvement Techniques' by Purus Hotham Raj, Laxmi Publications, New Delhi.
2. 'Ground Improvement Techniques' by Nihar Ranjan Patro, Vikas Publishing House (p) limited, New Delhi.
3. 'An introduction to Soil Reinforcement and Geosynthetics' by G.L.Siva Kumar Babu, Universities Press.

**REFERENC EBOOKS:**

1. 'Ground Improvement 'by MP Moseley, Blackie Academic and Professional, USA.
2. 'Designing with Geosynthetics 'by RM Koerner, Prentice Hall

**Web Links:**

1. <https://archive.nptel.ac.in/courses/105/108/105108075/>
2. <https://archive.nptel.ac.in/courses/105/105/105105210/>

## EXPANSIVE SOILS (Professional Elective-IV)

**VII Semester**

**L T P C**

**Course Code: 231CE7E01**

**3 0 0 3**

**Course Outcomes:** At the end of the course, student will be able to:

**CO 1:** Identify the expansive soils in the field and laboratory

**CO 2:** Illustrate the methods for the identification of soil structure and clay mineralogy

**CO 3:** Design a suitable foundation for expansive soils

**CO 4:** Discuss construction techniques in expansive soils

**CO 5:** Suggest a suitable method for stabilizing the expansive soils

**CO 6:** Examine the liquefaction problems related to expansive soils

**Mapping of course outcomes with program outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO 5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|------|-----|-----|-----|-----|------|------|------|
| CO1   | 2   | 3   | -   | 2   | 2    | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 2   | 1   | -   | 2   | -    | -   | 3   | -   | -   | -    | -    | -    |
| CO3   | 2   | 2   | 3   | 1   | -    | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 2   | 2   | 1   | 1   | -    | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 3   | 2   | -   | 1   | -    | -   | -   | -   | -   | -    | -    | -    |
| CO6   | 2   | 3   | -   | -   | 2    | -   | 2   | -   | -   | -    | -    | -    |

**Mapping of course outcomes with program Specific Outcomes:**

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | -     | 2     |
| CO2      | -     | 1     |
| CO3      | 3     | 1     |
| CO4      | -     | 1     |
| CO5      | -     | 1     |
| CO6      | -     | 1     |

### UNIT-I:

#### Introduction and Identification:

Expansive soils of India - related civil engineering problems - formation of expansive soils in field - identification of expansive solids in laboratory by X-ray diffraction method and differential thermal analysis.

### UNIT-II:

#### Physical and Chemical Properties

Soil structure and clay mineralogy of expansive soil - atomic bond and molecular bonds - honey comb structure - based exchanges capacity - clay water relation - electrolysis processes.

**UNIT-III:****Foundations**

Foundations on swelling soils - swelling potential and mechanism of volume change - chemical  
composition of black cotton soil - construction techniques in black cotton soil - modern method of construction in under reamed piles for expansive soil.

**UNIT-IV:****Improvement methods**

Stabilization of expansive soils with lime - slag (silica fume and aluminum sludge) – cement-fly ash – chemicals - reinforced earth technique - micro reinforced vegetation -vibro floatation - grouting and soil nailing.

**UNIT-V:****Liquefaction Hazard Mitigation**

Factors affecting the expansive soil - method of assessment for liquefaction - effect instrumentation for monitoring - consolidation of marine clay deposits - expansive soil model of Bingham fluid bounded by porous beds

**Textbooks:**

1. Nelson, J. D., and Miller, D.J. (1992). Expansive Soils, John Wiley and Sons, Inc., New York, 1992.
2. Design Aids in Soil Mechanics and Foundation Engineering – S.R. Kaniraj (Tata McGraw Hill, New Delhi) - 2019
3. Foundation Engineering – Dr. B.J. Kasmalkar (Pune Vidyarthi Griha Prakashan, Pune) - 2012
4. Basic and applied Soil Mechanics (Revised Edition) – Gopal Rajan and Rao A.S.R. (New Age, New Delhi. 2016)

**Reference Books:**

1. Foundation Engineering (2nd Edition) – Peck, R.B., Hanson (W.E. and Thornburn. W.H. Johan Wiley, New York 1991)
2. Soil Engineering in Theory and Practice (Vol. - II) – Alam Singh and G.R. Chowdhary (Asia Publishing House, New Delhi, 2019)

**Web Links:**

1. <https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce38/>
2. <https://nptel.ac.in/content/storage2/courses/105101083/download/lec35.pdf>



## DOCK AND HARBOUR ENGINEERING (Professional Elective – IV)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| VII Semester                  | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE7E02</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Introduce history and classifications of harbours  
**CO2:** Explain the fundamentals of Harbour planning  
**CO3:** Explain the natural forces affecting ports and general design aspects of marine structures  
**CO4:** Describe various navigational aids and dock & repair facilities  
**CO5:** Explain and plan port facilities  
**CO6:** Describe maintenance and protection of port facilities

### Mapping of Course Outcomes with Program Outcomes:

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | -    | -    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 2    | -    | 3    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 2    | -    | -    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | -    | 2    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO6</b> | 2    | -    | 2    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 1    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |
| <b>CO6</b> | 2    | -    |

#### Unit - I

General: History, Advantages and disadvantages of water transportation, Modern trends in water transportation, Elements of water transportation, Historical development in India, Classification of harbours, Ports development in India, Port authorities, Bodies and association Harbour Planning: Selection of site and planning of harbours, Ship characteristics, Characteristics of good harbour, Size of harbour, Classification of harbours

#### Unit – II

Natural Phenomena: Tides – Tidal data analysis, Wind, Water waves, Currents phenomena, Characteristics and effects on marine structures, Littoral drift. Marine Structure: General design aspects, Breakwaters - function, types general design principles, Wharves, Quays – construction of Quay walls, Jetties, Piers, Pier heads, Dolphin, Fenders, Mooring Accessories

**Unit – III**

Navigation Aids: Necessity, Types of navigation aids, Requirement of signals, Fixed and floating navigation aid Docks and Repair Facilities: Harbour docks, Wet docks, Repair docks, Lift docks, Floating docks, Slipways

**Unit – IV**

Port Facilities Classification of ports – Requirements of a good port - Port building facilities, Transit sheds, Warehouses, Cargo handling facility, Services for shipping terminals, Inland port facilities planning

**Unit – V**

Dredging: General, Classification of dredging works, Types of dredgers, Uses of dredged material, Execution of dredging work  
Coastal Protection: Sea wall, Revetment, Bulkhead, Cathodic Protection

**Text Books:**

1. R. Srinivasan and S. C. Rangwala, Harbour, Dock and Tunnel Engineering, 1995, Charotar Pub House, Anand, 2015
2. Docks and Harbour Engineering by Bindra S.P. - Dhanpat Rai & Sons, New Delhi, 2012.

**Reference Books:**

1. Transportation Engineering, Railways, Airports, Docks & Harbours, Srinivasa Kumar R, University Press, Hyderabad, 2020
2. Port Design - Guidelines and recommendations by C. A. Thoresen, Tapir Publications, 2018.
3. Highway, Railway, Airport and Harbor Engineering, Subramanian K. P, Scitech Publications (India) Pvt Limited, Chennai, 2016.

**Web Links:**

1. <https://nptel.ac.in/courses/114/106/114106025/>
2. <https://sites.google.com/a/venusict.org/dha/material>

### RAILWAY ENGINEERING (Professional Elective - IV)

VII Semester

L T P C

Course Code: 231CE7E03

3 0 0 3

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Explain different components of railway track  
**CO2:** Design track gradients as per given requirements  
**CO3:** Discuss various types of tracks turnouts and crossings  
**CO4:** Explain interlocking and signaling systems  
**CO5:** Describe purposes and facilities at Railway Stations  
**CO6:** Explain track maintenance

#### Mapping of Course Outcomes with Program Outcomes:

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | 1    | -    | -    | -    |      | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | -    | 2    | 3    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | -    | 1    | 3    | -    | -    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 1    | -    | -    | -    | -    | 2    | 2    | -    | -    | -     | -     | -     |
| <b>CO6</b> | 1    | -    | -    | -    | -    | 2    | 2    | -    | -    | -     | -     | -     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    | -    |
| <b>CO2</b> | 3    | -    |
| <b>CO3</b> | 1    | -    |
| <b>CO4</b> | 1    | -    |
| <b>CO5</b> | 1    | -    |
| <b>CO6</b> | 1    | -    |

#### Unit - I

Components of Railway Engineering: Permanent way components – Railway Track Gauge - Cross Section of Permanent Way - Functions of various Components like Rails, Sleepers and Ballast –Rail Fastenings – Creep of Rails- Theories related to Creep – Adzing of Sleepers- Sleeper density – Rail joints.

#### Unit – II

Geometric Design of Railway Track: Alignment – Engineering Surveys - Gradients- Grade Compensation- Cant and Negative Super elevation- Cant Deficiency – Degree of Curve – safe speed on curves – Transition curve – Compound curves – Reverse curves – Extra clearance on curves – widening of gauge on curves – vertical curves – cheek rails on curves.

**Unit – III**

Turnouts & Controllers: Track layouts – Switches – Design of Tongue Rails – Crossings – Turnouts – Layout of Turnout – Double Turnout – Diamond crossing – Scissors crossing – Inspection and maintenance of Points and Crossings

**Unit – IV**

Signalling and Interlocking: Objectives of Signalling - Classification of Signals – Fixed Signals - Stop Signals - Signalling Systems – Mechanical Signalling System - Electrical Signalling System - Systems for Controlling Train Movement – Interlocking - Modern Signalling Installations

**Unit – V**

Railway Stations and Yards: Purpose of a Railway Station - Selection of Site for a Railway Station - Facilities Required at Railway Stations – Requirements of a Passenger Station Yard - Classification of Railway Stations - Station Platforms - Types of Yards  
Track Maintenance: Necessity and Advantages of Track Maintenance - Essentials of Track Maintenance - Measuring Equipment and Maintenance Tools for Tracks - Maintenance of Rail Surface

**Text Books:**

1. Railway Engineering, Satish Chandra and M.M. Agrawal, Oxford University Press, New Delhi, 2020.
2. Rangwala, "Railway Engineering", Charotar Publishing House, 2017.

**Reference Books:**

1. Roads, Railways, Bridges & Tunnel Engineering, T.D.Ahuja & G.S.Birdie, 2017
2. Transportation Engineering, Railways, Airports, Docks & Harbours, Srinivasa Kumar R, University Press, Hyderabad, 2020

**Web Links:**

1. <https://nptel.ac.in/courses/105/107/105107123/>
2. <http://www.nptelvideos.in/2012/11/transportation-engineering-ii.html>

**Industrial Waste and Waste Water Engineering  
(Professional Elective – IV)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE7E04</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Distinguish between the quality of domestic and industrial water requirements and wastewater quantity generation.
- CO2:** Illustrate various treatment methods based on characteristics of wastewater
- CO3:** Suggest treatment methods for any industrial wastewater.
- CO4:** Decide the need of common effluent treatment plant for the industrial area in their vicinity
- CO5:** Discuss the manufacturing process of specific industries
- CO6:** Discuss the treatment process of specific industries

**Mapping of Course Outcomes with Program Outcomes:**

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | -    | 1    | -    | -    |      | 3    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | -    | 1    | -    | -    | 3    | 2    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 3    | -    | 1    | -    | -    | 1    | 1    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 1    | -    | 2    | -    | -    | 1    | 2    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 3    | -    | 1    | -    | -    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO6</b> | 1    | -    | -    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |
| <b>CO6</b> | -    | 2    |

**Unit - I**

Industrial water Quantity and Quality requirements:

Introduction to importance of Industrial water requirement, Boiler and cooling waters–Process water for Textiles, Food processing, Brewery Industries, power plants, fertilizers, sugar mills.

**Unit – II**

Miscellaneous Treatment:

Use of Municipal wastewater in Industries – Advanced water treatment – Adsorption, Reverse Osmosis, Ion Exchange, Ultra filtration, Freezing, elutriation, Removal of Iron and Manganese, Removal of Colour and Odour.

**Unit – III**

Basic theories of Industrial Wastewater Management:

Industrial waste survey – Measurement of industrial wastewater Flow-generation rates – Industrial wastewater sampling and preservation of samples for analysis – Wastewater Characterization-Toxicity of industrial effluents- Treatment of wastewater-unit operations and processes-Volume and Strength reduction – Neutralization – Equalization and proportioning- recycling, reuse and resources recovery.

**Unit – IV**

Industrial wastewater disposal management:

Discharges into Streams, Lakes and oceans and associated problems, Land treatment – Common Effluent

Treatment Plants: advantages and suitability, Limitations and challenges- Recirculation of Industrial Wastes- Effluent Disposal Method.

**Unit – V**

Process and Treatment of specific Industries:

Manufacturing Process and origin, characteristics, effects, and treatment methods of liquid waste from Steel plants, Fertilizers, Textiles, Paper and Pulp industries, Oil Refineries, Coal and Gas based Power Plants.

**Textbooks:**

1. Wastewater Treatment by M.N. Rao and A.K. Dutta, Oxford & IBH, New Delhi, 2016
2. Industrial Wastewater Treatment by KVSG Murali Krishna, Reems publications, 2018.

**Reference Books:**

1. Industrial Water Pollution Control by W. Wesley Eckenfelder, Mc- GrawHill, Third Edition, 2015.
2. Wastewater Treatment- Concepts and Design Approach by G.L. Karia & R.A. Christian, Prentice Hall of India, 2018
3. EnviroUnit Operations and Processes in Environmental Engineering by Reynolds. Richard, Cengage Learning, 2019

**Web Links:**

1. <https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce32/>

**Air Pollution Control**  
**(Professional Elective – IV)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE7E05</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO 1:** Interpret the various ambient air quality parameters.

**CO 2:** Examine the plume behavior in prevailing atmospheric conditions.

**CO 3:** Explain the various methods related to sampling and analysis.

**CO 4:** Choose the appropriate air pollution control devices.

**CO 5:** Apply suitable particulate and gaseous control measures for an industry.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO 1  | 2    | 1    | -    | -    | -    | -    | 3    | -    | -    | -     | -    | 2    |
| CO 2  | 3    | 2    | -    | -    | -    | -    | 2    | -    | -    | -     | -    | 3    |
| CO 3  | 1    | 1    | -    | -    | -    | -    | 2    | -    | -    | -     | -    | 2    |
| CO 4  | 1    | 2    | -    | -    | -    | -    | 1    | -    | -    | -     | -    | 3    |
| CO 5  | -    | 2    | -    | -    | -    | -    | 1    | -    | -    | -     | -    | 3    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO 1     | -     | 1     |
| CO 2     | -     | 2     |
| CO 3     | -     | 1     |
| CO 4     | -     | 2     |
| CO 5     | -     | 2     |

## UNIT I

### **Air Pollution:**

Definition – Sources and classification of Air Pollutants –indoor air quality – Effects of air pollution on health of Human & Animals, vegetation & materials, Global effects of air pollution - Carbon Credits and Carbon Trade.

## UNIT II

### **Meteorology and Air Pollution:**

Factors influencing air pollution – Temperature lapse rate and atmospheric stability – wind rose –Plume behaviour – Mixing depths – Plume rise and dispersion – prediction of air quality – box model – Gaussian model – Dispersion coefficient – Application of tall chimney for pollutant dispersion.

**UNIT III****Control of Particulate Pollutants:**

Sampling and analysis of air pollutants– Properties of particulate pollution – particle size distribution – control mechanism –Dust removal equipment – Design and operation of settling chambers, cyclones, wet dust scrubbers, fabric filters and ESP.

**UNIT IV****Control of Gaseous Pollutants:**

Process and equipment for the removal of gaseous pollutants by chemical methods – Design and operation of absorption and adsorption equipment- combustion and condensation equipment.

**UNIT V****Control of Air and Noise Pollution:**

Noise pollution and control – Definition – significance in general – sources, measurement - effects and control measures. Air pollution control: Environmental friendly fuels – In plant control measures, process changes, methods of removal and recycling – Air Pollution legislation – Automobile pollution, odour pollution, flares and control – Emission standards.

**Text books:**

4. Air Pollution, M.N.Rao and H.V.N.Rao, Tata McGraw Hill Comapany.
5. Air pollution and Control, Prof.K.V.S.G. Muralikrishna, Kaushal Publications-Kakinada.
6. Fundamentals of air pollution engineering, Richard C Flagan and John H Seinfeld, Prentice hall Inc,

**Reference books:**

3. An introduction to Air pollution, R.K.Trivedy and P.K. Goel, B.S. Publications, 2003.
4. Air Pollution control–A design approach, C David Cooper and F.C. Alley, 4<sup>th</sup> Edition

**Web Links:**

4. <https://nptel.ac.in/courses/103107084>
5. <http://www.moef.nic.in/report/0203>
6. <http://home.iitk.ac.in/~anubha/APC>



### WATERSHED MANAGEMENT (Professional Elective – IV)

VII Semester

L T P C

Course Code: 231CE7E06

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Explain the objectives and characteristics of water shed management.
- CO2** Classify the types of soil erosion and control methods
- CO3** Explain different water harvesting techniques
- CO4** Explain different water harvesting techniques
- CO5** Organize the land and drought management techniques

**Mapping of Course Outcomes with Program Outcomes:**

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 1    | -    | -    | -    | -    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 1    | -    | -    | -    | -    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 1    | -    | -    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 2    | -    | -    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | -    | 2    | -    | -    | 2    | 2    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | -    |
| <b>CO2</b> | -    | 1    |
| <b>CO3</b> | -    | -    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 1    |

**Unit - I**

Introduction:

Concept of watershed development – objectives of watershed development – need for watershed development – integrated and multidisciplinary approach for watershed management.

Characteristics of Watershed:

Size – shape – physiography – slope – climate – drainage – land use – vegetation – geology and soils – hydrology and hydrogeology – socio-economic characteristics – basic data on watersheds.

**Unit – II**

Principles of Erosion:

Types and causes of erosion – factors affecting erosion– estimation of soil loss due to erosion- Universal soil loss equation.

Measures to Control Erosion:

Contour techniques – ploughing – furrowing – trenching – bunding – terracing – gully control – check dams – rock-fill dams – brushwood dam – Gabion.

### **Unit – III**

Water Harvesting:

Techniques of rain water harvesting – rain water harvesting from roof top – surface flow harvesting – subsurface flow harvesting – stop dams – farm ponds and dugout ponds – percolation tanks.

### **Unit – IV**

Land Management:

Land use and Land capability classification – management of forest – agricultural – grassland and wild land – land grading operation –reclamation of saline and alkaline soils. Drought Management: Drought assessment and classification – drought analysis techniques – drought mitigation planning.

### **Unit – V**

Watershed Modelling:

Data of watershed for modelling – application and comparison of watershed models – model calibration and validation – advances of watershed models.

### **Text Books:**

1. Watershed Management, Das MM and M.D Saikia, PHI Learning Pvt. Ltd., 2013.
2. Land and Water Management, Murthy.VVN, Kalyani Publications, 2007
3. Watershed Management, Murthy J V S, New Age International Publishers, 2006.

### **Reference Books:**

1. Water Resource Engineering, Wurbs R A and James R A, Prentice Hall Publishers, 2002
2. Watershed Hydrology, Black P E, Prentice Hall, 1996

### **Web Links:**

1. [https://www.ct.gov/deep/cwp/view.asp?a=2719&q=325622&depNav\\_GID=1654](https://www.ct.gov/deep/cwp/view.asp?a=2719&q=325622&depNav_GID=1654)
2. [http://agritech.tnau.ac.in/agriculture/agri\\_majorareas\\_watershed\\_watershedmgt.html](http://agritech.tnau.ac.in/agriculture/agri_majorareas_watershed_watershedmgt.html)

## Design of Tall Buildings (Professional Elective-V)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| VII Semester                  | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE7E07</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Explain different types of concrete used in construction of tall buildings.

**CO2:** Calculate different types of loads acting on buildings

**CO3:** Summarize the behaviour of various structural systems

**CO4:** Analyze various structural systems for tall buildings.

**CO5:** Design various structural systems for tall buildings.

**CO6:** Analyze stability of structural members in tall buildings

### Mapping of Course Outcomes with Program Outcomes:

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | 1    | -    | -    | -    |      | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | 3    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO6</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 3    | -    |
| <b>CO5</b> | 3    | -    |
| <b>CO6</b> | 3    | -    |

#### Unit - I

Design Philosophies and Materials: Introduction-Modern concepts High performance concrete  
Fibre reinforced concrete – Lightweight concrete – Self compacting concrete.

#### Unit – II

Gravity and Lateral Loading: Dead load, live load, impact load, construction load, and sequential loading – Wind loading – Static and dynamic approach analytical method – Wind tunnel experimental methods – Earthquake loading – Equivalent lateral load analysis – Response spectrum method –Combination of loads.

**Unit – III**

Behaviour of Structural Systems: Factors affecting the growth – Height and structural form – behavior of braced frames – Rigid frames – in-filled frames – Shear walls – Coupled shear walls – Wall – Frames

**Unit – IV**

Analysis and Design: Modelling for approximate analysis – Accurate analysis and reduction techniques – Analysis of structures as an integral unit – Analysis for member forces – Drift and twist – Computerized 3D analysis – Design for differential movement – Creep and Shrinkage effects – Temperature effects and fire Resistance.

**Unit – V**

Stability Analysis: Overall buckling analysis of frames, wall – Frames – Approximate methods – Second order effect of gravity loading P–Delta Effects – Simultaneous first order and P-Delta analysis Translational instability  
- Torsional instability – Effect of stiffness of members and foundation rotation in stability of structures.

**Textbooks:**

1. Building Structures-Analysis and Design, Bryan Stafford Smith and Alex Coull, Tall, John Wiley and Sons, Inc, 2019.
2. Structural Analysis and Design of Tall Buildings, Taranath B.S, McGraw-Hill, 2021.
3. Structural Concepts and Systems for Architects and Engineers, Lin T.Y. and Burry D. Stotes, John Wiley, Van Nostrand Reinhold Co Publishers, 2017

**Reference Books:**

1. Analysis of Tall & complex structures, FENG FU, BH Publications, 2018
2. Design of Tall Buildings, Mark Srkisian, Routledge Publishers, 2019.

**Web Links:**

1. <http://www.madehow.com/Volume-6/Skyscraper.html>
2. <https://www.bdcnetwork.com/5-innovations-high-rise-building-design>
3. <https://theconstructor.org/structural-engg/high-rise-structures/5/>

## ADVANCED FOUNDATION ENGINEERING (Professional Elective – V)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| VII Semester                  | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE7E08</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Compute the safe bearing capacity of footings subjected to vertical and inclined loads
- CO2:** Understand the advanced methods of settlement computations and proportion foundation footings
- CO3:** Explain the ultimate bearing capacity of mat foundations
- CO4:** Explain earth retaining structures and its components
- CO5:** Analyse load carrying capacity of pile foundations
- CO6:** Discuss foundations in expansive soils

### Mapping of Course Outcomes with Program Outcomes:

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | 1    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 3    | 2    | -    | 2    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 3    | 2    | -    | 2    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 3    | 2    | -    | 2    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | 1    | -    | 2    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO6</b> | 2    | 1    | -    | 2    | -    | 1    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |
| <b>CO6</b> | -    | 2    |

### Unit - I

Bearing capacity & settlement analysis of foundations:

Bearing capacity of Foundations using general bearing capacity equation - Meyerhorns, Brinch Hansen's and Vesic's methods — Bearing capacity of Layered soils - Strong layer over weak layer, weak layer on strong layer

— Bearing capacity of foundations on a top of slope — Bearing capacity of foundations at the edge of the slope. Settlement analysis: Immediate settlement of footings resting on granular soils -

Schmertmann & Hartman method - De Beer and Martens method - Immediate settlement in clays - Janbu's method correction for consolidation settlement using Skempton and Bjerrum's method - Correction for construction period.

**Unit – II**

Mat foundations:

Mat foundations Purpose and types of isolated and combined footings — Mats/ Rafts — Proportioning of footings

— Ultimate bearing capacity of mat foundations allowable bearing capacity of mats founded in clays and granular soils — compensated rafts.

**Unit – III**

Earth retaining structures:

Earth-retaining structures — cantilever sheet piles — anchored bulkheads — fixed and free earth support

methods design of anchors — braced excavations — function of different components — forces in ties stability against bottom heave.

**Unit – IV**

Pile foundations:

Pile foundations single pile versus group of piles load-carrying capacity of pile groups negative skin friction (NSF) -settlement of pile groups in sands and clays — laterally loaded piles in granular soils — Reese and Matlock method laterally loaded piles in cohesive soils — Davisson and Gill method — Broms' analysis

**Unit – V**

Foundation in expansive soils:

Foundations in expansive soils — definitions of swell potential and swelling pressure determination of free swell index factors affecting swell potential and swelling pressure foundation practices sand cushion method CNS layer filled piers and belled piers — under-reamed piles — moisture control methods.

**Textbooks:**

1. Basic and applied soil mechanics' by GopalRanjan and ASR Rao, New Age, 2018 Publishers, 2016

**Reference Books:**

1. Foundation Analysis and Design' by JE Bowles, John Wiley, 1996
2. Foundation Design' by WC Teng, Prentice Hall Publishers, 1962

**Web Links:**

1. <https://nptel.ac.in/courses/105108069>
2. [https://onlinecourses.nptel.ac.in/noc22\\_ce32/preview](https://onlinecourses.nptel.ac.in/noc22_ce32/preview)

### Traffic Engineering (Professional Elective – V)

VII Semester

L T P C

Course Code: 231CE7E09

3 0 0 3

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Identify traffic stream characteristics and studies
- CO2:** Explain traffic capacity and level of service.
- CO3:** Solve various parking problems and manage traffic regulations
- CO4:** Illustrate measures for Road safety
- CO5:** Design traffic signal cycle
- CO6:** Design Rotary Island capacity

#### Mapping of Course Outcomes with Program Outcomes:

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 1    | 2    | -    | -    | -    |      | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 3    | 2    | -    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 1    | 2    | 3    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO6</b> | 1    | 2    | 3    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 3    | -    |
| <b>CO6</b> | 3    | -    |

#### Unit – I

Traffic Characteristics Measurement and Analysis:

Basic traffic Characteristics - Speed, Volume and Concentration. Relationship between Flow, Speed and Concentration. Traffic Measurement and Analysis - Volume Studies - Objectives, Methods; Speed studies – Objectives, Definition of Spot Speed, time mean speed and space mean speed; Methods of conducting speed studies; Presentation of speed study data; Head ways and Gaps; Critical Gap; Gap acceptance studies.

**Unit – II**

Highway Capacity and Level Of Service:

Basic definitions related to capacity; Level of service concept; Factors affecting capacity and level of service; Computation of capacity and level of service for two lane highways, Multilane highways and freeways.

Parking Analysis:

Types of parking facilities – On-street parking and Off-street Parking facilities; Parking studies and analysis- Parking Inventory Study, Parking Usage Study By Patrolling, Questionnaire Survey, Cordon Surveys; Evaluation of parking parameters; Parking accumulation, Parking Load, Parking Turnover, Parking Index, Parking Volume

**Unit – III**

Traffic Safety:

Traffic Safety -Accident studies and analysis; Causes of accidents - The Road, The vehicle, The road user and the Environment; Engineering, Enforcement and Education measures for the prevention of accidents

**Unit – IV**

Traffic Signals:

Traffic Signals –Types of Signals; Principles of Phasing; Timing Diagram; Design of Isolated Traffic Signal by Webster method, Warrants for signalization. Signal Coordination - Signal Coordination methods, Simultaneous, Alternate, Simple progression and Flexible progression Systems.

**Unit – V**

Traffic and Environment:

Detrimental effects of Traffic on Environment, Air pollution; Noise Pollution; Measures to curtail

environmental degradation due to traffic. Sustainable Transportation: Sustainable modes, Transit Oriented Development, ITS based benefits for Environment.

**Text Books:**

1. Traffic Engineering and Transport Planning, Kadiyali, L.R., Khanna Publishers, New Delhi, 2016.
2. Fundamentals of Transportation Engineering, Papacostas, C.S., Prentice-Hall, India, 2015.

**Reference Books:**

1. Transportation Engineering-An Introduction C.JothiKhisty, Prentie Hall Publications, 2015.
2. Highway Capacity Manual, Transportation Research Board, USA

**Web Links:**

1. <https://nptel.ac.in/downloads/105101008/>
2. <https://www.civil.iitb.ac.in/tvm/nptel/ceTseLn.html>.



**SUSTAINABLE WATER RESOURCES DEVELOPMENT**  
(Professional Elective – V)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE7E10</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Role of different agencies in S.W.R.D
- CO2:** Discuss the details of ground water aquifers and zones
- CO3:** Elaborate the concept of watershed management
- CO4:** Explain the methods of rainwater harvesting
- CO5:** Application of remote sensing and GIS in delineation of surface water bodies and wetlands
- CO6:** Application of GIS in hydrological, land and soil moisture mapping

**Mapping of Course Outcomes with Program Outcomes:**

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | 1    | -    | -    | -    |      | 2    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | 1    | -    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 2    | 1    | -    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 2    | -    | -    | 1    | -    | -    | 2    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | -    | -    | 1    | 3    | -    | 2    | -    | -    | -     | -     | -     |
| <b>CO6</b> | 2    | -    | -    | 1    | 3    | -    | 2    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 1    |
| <b>CO2</b> | -    | 1    |
| <b>CO3</b> | -    | 1    |
| <b>CO4</b> | -    | 1    |
| <b>CO5</b> | 2    | -    |
| <b>CO6</b> | 2    | -    |

**Unit – I**

Scope of S.W.R.D, Necessity of S.W.R.D, Role of various agencies in S.W.R.D: -

Agriculturists - Meteorologists

- Geologists - Industrialists - Scientists - Biologists - Water quality Control (Authority) - Mechanical Engg. - Electrical Engg. - Economists - Social workers- NGO's - Politicians - General Public

**Unit – II**

Hydrologic Cycle and its components, Groundwater: source, importance, type of groundwater aquifers, groundwater zones, types of wells, concept, location, and importance. Artificial recharge of groundwater, direct and indirect methods.

**Unit – III**

Concept of watershed, Characteristic of watershed, size, shape, physiography, slope, climate, drainage, land use, vegetation, geology, hydrology, hydrogeology, socioeconomics. Watershed management & people's participation.

**Unit – IV**

Necessity of Rainwater harvesting, Importance of Rainwater harvesting, Rainwater harvesting methods - Check dams. - Nala / Gully plugging - Percolation tank. - Khet-talawadi - Roof harvesting - Vegetation and plantation.

Groundwater development, water logging, desalination

**Unit – V**

Applications of remote sensing and GIS in –delineation of surface water bodies and wetlands, hydrological modelling, hydrological hazard mapping, land use and land cover mapping, soil moisture mapping

**Text Books:**

1. Sustainable Water Resources Management, Chandra S.P. Ojha , Rao Y. Surampalli , 2017
2. Ground water assessment, Development & management, K.R. Karanth, Tata Mc Graw Hill Pub. Co. Ltd., New Delhi, 2015.
3. Sustainable water management and technologies edition 1 (2017), Daniel H. Chen, CRC press.

**Reference Books:**

1. Ground water H.M.Ragunath New Age international Ltd., New Delhi, 2007
2. Hydrology & Water Resources Engg. S.K.Garg Khanna Pub., Delhi, 2010.
3. Sharma, R.K. and Sharma, T.K. (2000) A Textbook of Hydrology and Water Resources Engineering. 5th Edition, DhanpatRai Publications (P) Ltd., New Delhi

**Web Links:**

1. [https://www.researchgate.net/publication/317595495\\_Groundwater\\_Resource\\_Evaluation\\_Management](https://www.researchgate.net/publication/317595495_Groundwater_Resource_Evaluation_Management)
2. <https://guj-nwrws.gujarat.gov.in/showpage.aspx?contentid=1&lang=english>

## ENVIRONMENTAL IMPACT ASSESSMENT (Professional Elective – V)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| VII Semester                  | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE7E12</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Explain the basic concepts of EIA
- CO2:** Classify the various EIA methodologies
- CO3:** Explain the systematic procedure of assessment of impacts of developmental activities on various sectors of environment.
- CO4:** Describe the concept of risk assessment in EIA
- CO5:** Apply the knowledge of EIA to day-to-day activities

### Mapping of Course Outcomes with Program Outcomes:

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | -    | -    | -    | -    | -    | 1    | 3    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | -    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 2    | 2    | -    | -    | -    | 3    | 3    | 1    | -    | -     | -     | -     |
| <b>CO4</b> | -    | -    | -    | -    | -    | 1    | 3    | 2    | -    | -     | -     | 2     |
| <b>CO5</b> | -    | -    | -    | -    | -    | 1    | 3    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | -    |
| <b>CO2</b> | -    | -    |
| <b>CO3</b> | -    | -    |
| <b>CO4</b> | -    | -    |
| <b>CO5</b> | -    | -    |

### Unit - I

Basic concepts of Environmental Impact Assessment:

Elements of EIA, factors affecting EIA, Initial environmental Examination, life cycle analysis, Preparation of Environmental Base map, Classification of environmental parameters, role of stakeholders in the EIA preparation, stages in EIA, EIS and EMP

### Unit – II

Environmental Impact Assessment Methodologies:

Introduction, Criteria for the selection of EIA Methodology, E I A methods, Ad-hoc methods, Check lists, Matrix method, Network analysis method, Environmental Media Quality Index method, Overlay method, Cost/benefit analysis.

### Unit – III

Impact of Developmental Activities on soil, water, air and biological environment:

Introduction and Methodology, Delineation of study area, Identification of activities, Procurement of relevant quality of the sample, Impact prediction, Assessment of Impact

significance, Identification and Incorporation of mitigation measures, Systematic approach in assessment of Impact of development Activities on Vegetation and wildlife.

#### **Unit – IV**

Environmental Risk Assessment and Risk management in EIA:

Treatment of uncertainty, key stages in performing an Environmental Risk Assessment, advantages of Environmental Risk Assessment, Application of remote sensing and GIS for EIA.

#### **Unit – V**

Environmental Legislation and Environmental Audit:

EIA notification by Ministry of Environment and Forest (Govt. of India), provisions and procedure for environmental clearance, Environmental legislation objectives, Evaluation of Audit data and preparation of Audit report. Post Audit activities, Concept of ISO and ISO 14000.

Case studies and Preparation of Environmental impact assessment statement for various Industries.

#### **Text Books:**

1. Environmental Impact Assessment Methodologies, Y. Anjaneyulu, B.S. Publication, Sultan Bazar, Hyderabad, 2011
2. Environmental Impact Assessment, Canter Larry W, McGraw-Hill education Edi 1996

#### **Reference Books:**

1. Environmental Science and Engineering, J. Glynn and Gary W. Hein Ke – Prentice Hall Publishers, 1988
2. Environmental Science and Engineering, Suresh K. Dhaneja – S.K. Katania & Sons Publication, New Delhi, 2013
3. Environmental Pollution and Control, Dr H.S. Bhatia – Galgotia Publication (P) Ltd., Delhi, 2018

#### **Web Links:**

1. <https://nptel.ac.in/courses/120108004>

## SOLID AND HAZARDOUS WASTE MANAGEMENT (Professional Elective V)

**VII Semester**

**L T P C**

**Course Code: 231CE7E13**

**3 0 0 3**

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO 1:** Interpret the composition and characteristics of municipal solid waste.

**CO 2:** Illustrate different methods of collection of municipal solid waste.

**CO 3:** Choose the criteria for selection of land fill.

**CO 4:** Classify the solid waste and select suitable composting facility.

**CO 5:** Apply different methods of treatment and disposal for Hazardous wastes.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO 1  | 2    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO 2  | 1    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO 3  | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO 4  | -    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO 5  | -    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO 1     | -     | 2     |
| CO 2     | -     | -     |
| CO 3     | -     | 3     |
| CO 4     | -     | -     |
| CO 5     | -     | 1     |

## UNIT I

### Introduction:

Definition of solid waste – waste generation sources and types of solid waste –sampling and characterization – Determination of composition of Municipal Solid Waste –Onsite storage and handling of solid waste – Future changes in waste composition, major legislation, monitoring responsibilities.

## UNIT II

### Collection and Transport of Solid Waste:

Type and methods of waste collection systems–analysis of collection system – Optimization of collection routes– alternative techniques for collection system.

Transfer and Transport:

Need for transfer operation –transport means and methods – transfer station types and design requirements – Separation, processing and transformation of solid waste.

**UNIT III****Processing and Disposal:**

Unit operations used for separation and processing – Materials recovery facilities – Source reduction and waste minimization – Metal Separation & Recovery – Waste transformation through combustion and composting – anaerobic methods for materials recovery and treatment – Energy recovery – Incinerators.

Landfills:

Site selection, design and operation, drainage and leachate collection systems – designated waste landfill remediation.

**UNIT IV****Hazardous Waste Management:**

Definition and identification of hazardous wastes-sources and characteristics – hazardous wastes in Municipal Waste – Occupational health hazards and public health – Hazardous waste regulations – minimization of Hazardous Waste – compatibility, handling and storage of hazardous waste – collection and transport. E-waste: sources, collection, treatment and reuse.

**UNIT V****Hazardous waste treatment and Design:**

Hazardous waste treatment technologies – Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste –Solidification, chemical fixation and encapsulation, incineration - Hazardous waste landfills - Site selection, design and operation – remediation of hazardous waste disposal sites.

**Text books:**

1. Integrated Solid Waste Management, George Tchobanoglous, McGraw Hill Publication, 1993.
2. Hazardous Waste Management, Charles A. Wentz, McGraw Hill Publication, 1995.
3. Solid and Hazardous Waste Management, PM Cherry, CBS Publishers & Distributors, 2016

**Reference books:**

1. Introduction to Transportation Planning, Bruton M.J. Hutchinson of London, 2<sup>nd</sup> edition 2001
2. 'Metropolitan Transportation Planning' by Dicky, J.W., Tata McGraw Hill. 2<sup>nd</sup> edition, 2000

**Web Links:**

1. [https://www.researchgate.net/publication/262536356\\_Solid\\_and\\_Hazardous\\_Waste\\_Management](https://www.researchgate.net/publication/262536356_Solid_and_Hazardous_Waste_Management)
2. <https://www.cartercenter.org/resources/pdfs/health/ephti/library>
3. [https://www.rand.org/content/dam/rand/pubs/commercial\\_books](https://www.rand.org/content/dam/rand/pubs/commercial_books)

**URBAN HYDROLOGY**  
**(Professional Elective - V)**

VII Semester

L T P C

Course Code: 231CE7E11

3 0 0 3

**Course Outcomes:** At the end of the Course, Student will be able to:

**CO1:** Illustrate the importance of urban hydrological cycle

**CO2:** Discuss urban wastes and runoff options for waste disposal

**CO3:** Apply the rational method and NRCS curve number approach for estimating runoff quality and quantity in urban drainage systems

**CO4:** Describe the various elements of drainage systems

**CO5:** Differentiate the different storm water drainage structures and best practices in storm water management

**CO6:** Explain the various concepts required in the preparation of master drainage plans

**Mapping of Course Outcomes with Program Outcomes:**

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 1    | -    | -    | -    |      | 3    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 3    | 1    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 2    | 1    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 3    | 1    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 3    | 1    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |
| <b>CO6</b> | 3    | 1    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |
| <b>CO6</b> | 2    | -    |

**Unit - I**

Introduction:

Urban Hydrological Cycle, Effects of Urbanizations on Catchment Hydrology, Need for Urban Drainage System, Planning Objectives, Interaction of Urban and Surrounding Areas. Urban Wastes and Urban Runoff Options for Waste Disposal, Separate and Combined Systems open Channels and closed Conduits

**Unit – II**

Urban drainage systems:

Time of concentration - peak flow estimation approaches - rational method - NRCS curve number approach - runoff quantity and quality - wastewater and storm water reuse - major and minor systems and surface water runoff management

**Unit – III**

Elements of drainage systems:

Open channel - underground drains - appurtenances - pumping - and source control, ground water recharge

**Unit – IV**

Analysis and Management:

Stormwater drainage structures - design of Storm water network- Best Management Practices– detention and retention facilities - swales - constructed wetlands - models available for storm water management

**Unit – V**

Master drainage plans:

Operation and Maintenance of Urban Drainage Systems. Interaction of Urban Drainage and Solid waste Management, Cleansing of Sewers and Drains, Repairs and Maintenance, Planning

**Text Books:**

1. Manual on Drainage in Urbanised area, Geiger.W.F, J.Marsalek, W.J.Rawls and F.C.Zuidema, 1987
2. Urban Hydrology, Hall.M.J, Elsevier Applied Science Publisher, 1984 .
3. Hydrology, Quantity and Quality Analysis, Wanielista. M.P and EaglinWiley and Sons, 1997.

**Reference Books:**

1. Urban water cycle processes and interactions, Marsalek et.al 2006
2. Hydrologic Engineering, Rahman.MS, Arya.D.S, Goel.N.K, Dharmy. A.P, 2011

**Web Links:**

1. Urban\_hydrology\_note.pdf
2. Nptel.ac.in/downloads/105101002/3



## INDUSTRIAL WASTEWATER MANAGEMENT

### (Open Elective-III)

|                        |          |          |          |          |
|------------------------|----------|----------|----------|----------|
| VII Semester           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| Course Code: 231CE7O01 | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Distinguish between the quality of domestic and industrial water requirements and wastewater quantity generation.
- CO2:** Illustrate various treatment methods based on characteristics of waste water
- CO3:** Suggest treatment methods for any industrial wastewater.
- CO4:** Decide the need of common effluent treatment plant for the industrial area in their vicinity
- CO5:** Explain the treatment methods of liquid waste from various industries.

Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | 1    | -    | -    | 2    | 3    | -    | -    | -     | -     | -     |
| CO2   | 2    | -    | 1    | -    | -    | 3    | 2    | -    | -    | -     | -     | -     |
| CO3   | 3    | -    | 1    | -    | -    | 1    | 1    | -    | -    | -     | -     | -     |
| CO4   | 1    | -    | 2    | -    | -    | 1    | 2    | -    | -    | -     | -     | -     |
| CO5   | 3    | -    | 1    | -    | -    | 2    | -    | -    | -    | -     | -     | -     |

Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO2 |
|--------|-------|------|
| CO1    | -     | 1    |
| CO2    | -     | 1    |
| CO3    | -     | 1    |
| CO4    | -     | 1    |
| CO5    | -     | 1    |

### Unit - I

Industrial water Quantity and Quality requirements:

Boiler and cooling waters–Process water for Textiles, Food processing, Brewery Industries, power plants, fertilizers, sugar mills.

**Unit – II**

Miscellaneous Treatment:

Use of Municipal wastewater in Industries – Advanced water treatment – Adsorption, Reverse Osmosis, Ion Exchange, Ultra filtration, Freezing, elutriation, Removal of Iron and Manganese, Removal of Colour and Odour

**Unit – III**

Basic theories of Industrial Wastewater Management:

Industrial waste survey – Measurement of industrial wastewater Flow-generation rates –

Industrial wastewater sampling and preservation of samples for analysis – Wastewater Characterization-Toxicity of industrial effluents-Treatment of wastewater-unit operations and processes-Volume and Strength reduction – Neutralization – Equalization and proportioning-recycling, reuse, and resources recovery.

**Unit – IV**

Industrial wastewater disposal management:

Discharges into Streams, Lakes and oceans and associated problems, Land treatment – Common Effluent Treatment Plants: advantages and suitability, Limitations, and challenges- Recirculation of Industrial Wastes-Effluent Disposal Method

**Unit – V**

Process and Treatment of specific Industries:

Manufacturing Process and origin, characteristics, effects, and treatment methods of liquid waste from Steel plants, Fertilizers, Textiles, Paper and Pulp industries, Oil Refineries, Coal and Gas based Power Plants.

**Text Books:**

1. Wastewater Treatment by M.N. Rao and A.K. Dutta, Oxford & IBH, New Delhi, 2016
2. Industrial Wastewater Treatment by KVSG Murali Krishna.

**Reference Books:**

1. Industrial Water Pollution Control by W. Wesley Eckenfelder, Mc- GrawHill, Third Edition, 2015
2. Wastewater Treatment- Concepts and Design Approach by G.L. Karia & R.A. Christian, Prentice Hall of India

**Web Links:**

1. <https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce32/>
2. <https://www.un-ihe.org/online-course-industrial-effluent-treatment>

**BASICS OF RS&GIS**  
**(Open Elective-III)**

VII Semester

L T P C

Course Code: 231CE7O02

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Explain the evolution of Remote Sensing and GIS, the energy interactions in the atmosphere and earth surface features.

**CO2:** Elaborate on photogrammetry and various satellites.

**CO3:** Interpret the images for preparation of thematic maps.

**CO4:** Develop GIS based raster and vector data models.

**CO5:** Explain navigation applications based on GCS and GPS systems.

Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | 1    | -    | 1    | -    |      | -    | 2    | -    | -     | -     | -     |
| CO2   | 2    | 1    | -    | 1    | -    | -    | -    | 2    | -    | -     | -     | -     |
| CO3   | 2    | 1    | -    | 1    | -    | -    | -    | 2    | -    | -     | -     | -     |
| CO4   | 3    | 2    | -    | 1    | -    | -    | -    | 2    | -    | -     | -     | -     |
| CO5   | 3    | 2    | -    | 1    | -    | -    | -    | 2    | -    | -     | -     | -     |

Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

### Unit - I

History and Basic Concept of Remote Sensing:

Introduction to remote sensing: Evolution of Remote Sensing- use of hot air balloons, pigeons and platforms of remote sensing, low-medium-high altitude imaging.

Basic concepts of remote sensing: Electromagnetic spectrum and its interaction with atmosphere, energy interaction with the earth surfaces characteristics of remote sensing systems.

**Unit – II**

Photogrammetry; Aerial and Terrestrial; photo interpretation. Sensors; Radar imaging; colour scanners; thematic mapper. Introduction to space agencies - IRS, Landsat, SPOT, Cartosat, Ikonos, Envisat etc. sensors, sensor resolutions (spatial, spectral, radiometric and temporal).

**Unit – III**

Geographic Information System:

Introduction to GIS; Components of a GIS, Geospatial Data: Spatial Data and Attribute data, Joining Spatial and Attribute data.

Image interpretation:

Introduction, elements of visual image interpretations, digital image processing- image pre-processing, image enhancement, image classification, supervised classification, unsupervised classification using GIS Environs.

**Unit – IV**

Data Models: Vector data model: Representation of simple features – Topology and its importance; coverage and its data structure, Shape file; Relational Database, Raster Data Model: Elements of the Raster data model, Types of Raster Data, Raster Data Structure, Data conversion

**Unit – V**

Coordinate Systems:

Geographic Coordinate System: Approximation of the Earth, Datum; Map Projections: Types of Map Projections-Map projection parameters, commonly used Map Projections. Global positioning system and various navigation applications.

**Text Books:**

1. Textbook of Remote Sensing and Geographical Information Systems, by Anji M. Reddy · 2018, BS Publications.
2. Remote Sensing and GIS, Basudev Bhatta, Oxford Publishers 2015

**Reference Books:**

1. Basics of Remote sensing & GIS by S. Kumar, Laxmi Publications.
2. Introduction to Geographic Information System, Kang-Tsung Chang, McGraw- Hill 2015.

**Web Links:**

1. [http://geology.wlu.edu/harbor/geol260/lecture\\_notes/notes.html](http://geology.wlu.edu/harbor/geol260/lecture_notes/notes.html)
2. <https://lecturenotes.in/subject/572/remote-sensing-and-gis-rsg>

**SAFETY ENGINEERING****(Open Elective-III)**

VII Semester

**L T P C****Course Code: 231CE7003****3 0 0 3****Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Develop management plans to prevent accidents in construction Industry.  
**CO2:** Prepare plans to safe guard workers in construction of high risk Buildings.  
**CO3:** Ensure safety while operating construction machinery.  
**CO4:** Outline safety plans for demolition of buildings.  
**CO5:** Prepare fire safety plans for a given building.

Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 2    | -    | -    | 1    |      | -    | -    | 1    | -     | -     | -     |
| CO2   | 2    | 3    | -    | -    | 2    | -    | -    | -    | 1    | -     | -     | -     |
| CO3   | 1    | 2    | -    | -    | 1    | -    | -    | 2    | -    | -     | -     | 2     |
| CO4   | 2    | 2    | -    | -    | 1    | -    | -    | 2    | -    | -     | -     | 2     |
| CO5   | 2    | 2    | -    | -    | 1    | -    | -    | -    | 1    | -     | -     | -     |

Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

**Unit - I**

Accidents Causes and Management Systems:

Problems impeding safety in construction industry- causes of fatal accidents, types and causes of accidents related to various construction activities, human factors associated with these accident – construction regulations, contractual clauses – Pre contract activates, preconstruction meeting - design aids for safe construction – permits to work – quality assurance in construction - compensation – Recording of accidents and safety measures – Education and training.

**Unit – II**

Hazards of Construction and Prevention:

Excavations, basement and wide excavation, trenches, shafts – scaffolding , types, causes of accidents, scaffold inspection checklist – false work – erection of structural frame work, dismantling – tunneling – blasting, pre blast and post blast inspection – confined spaces – working on contaminated sites – work over water – road works – power plant constructions – construction.

**Unit – III****Working At Heights:**

Fall protection in construction OSHA 3146 – OSHA requirement for working at heights, Safe access and egress – safe use of ladders- Scaffoldings , requirement for safe work platforms, stairways, gangways and ramps – fall prevention and fall protection , safety belts, safety nets, fall arrestors, controlled access zones, safety monitoring systems – working on fragile roofs, work permit systems, height pass – accident case studies.

**Unit – IV****Construction Machinery:**

Selection, operation, inspection and testing of hoisting cranes, mobile cranes, tower cranes, crane inspection checklist - builder's hoist, winches, chain pulley blocks – use of conveyors – concrete mixers, concrete vibrators – safety in earth moving equipment, excavators, dozers, loaders, dumpers, motor grader, concrete pumps, welding machines, use of portable electrical tools, drills, grinding tools, manual handling scaffolding, hoisting cranes – use of conveyors and mobile cranes – manual handling.

**Unit – V****Safety in Demolition Work:**

Safety in demolition work, manual, mechanical, using explosive - keys to safe demolition, pre survey inspection, method statement, site supervision, safe clearance zone, health hazards from demolition - Indian standard - trusses, girders and beams – first aid – fire hazards and preventing methods – interesting experiences at the construction site against the fire accidents.

**Fire Safety:**

Fire –fire load-control and institutional fire protection systems, Fire Hydrant and extinguishers, Electrical Hazards, protection and interlock- Discharge rod and earthing device, safety in the use of portable tools. Emergency planning and preparedness. Marking of Route Fire Exist.

**Text Books:**

1. 'Safety in the Build Environment' by Jnathea D.Sime, London, 2010
2. 'Reliability Maintenance and Safety Engineering, by Gupta A K, Laxmi Publications, New Delhi.

**Reference Books:**

1. 'Construction hazard and Safety Hand book' by Hudson, R., Butter Worth's, 1985.
2. 'Construction Safety Hand Book'by V.J.Davies and K.Thomasin,Thomas Telford Ltd., London, 1990.

**Web Links:**

1. [nptel.ac.in/courses/105103093/](https://nptel.ac.in/courses/105103093/)
2. [nptel.ac.in/courses/105103093/22](https://nptel.ac.in/courses/105103093/22)

## BATTERY MANAGEMENT SYSTEMS AND CHARGING STATIONS (OPEN ELECTIVE-III)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EE7O01</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1** Describe the construction and operation of different batteries for EV applications
- CO2** Describe charging algorithms of different batteries and balancing methods of battery packs
- CO3** Describe the different kinds of infrastructure needed in the charging stations
- CO4** Describe the requirements of battery management and their maintenance.
- CO5** Explain the modelling of batteries

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | 3    | 2    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | 3    | 2    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 2    | 2    | 3    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 2    | 2    | 3    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | 2    | 3    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      |      |
| <b>CO2</b> |      |      |
| <b>CO3</b> |      |      |
| <b>CO4</b> |      |      |
| <b>CO5</b> |      |      |

### UNIT – I

#### EV Batteries

Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel. Lead Acid Batteries: Lead acid battery basics, special characteristics of lead acid batteries, battery life and maintenance, Li-ion batteries. Nickel-based Batteries: Nickel cadmium, Nickel metal hydride batteries. Sodium-Based Batteries: Introduction, sodium sulphur batteries, sodium metal chloride (Zebra) batteries. Lithium Batteries: Introduction, the lithium polymer battery, lithium ion battery

**UNIT – II****Battery Charging Strategies**

Charging algorithms for a single battery: Basic terms for charging performance evaluation and characterization, CC charging for NiCd/NiMH batteries, CV charging for lead acid batteries, CC/CV charging for lead acid and Li-ion batteries, MSCC charging for lead acid, NiMH and Li-ion batteries, TSCC/CV charging for Li-ion batteries, CVCC/CV charging for Li-ion batteries, Pulse charging for lead acid, NiCd/NiMH and Li-ion batteries, Charging termination techniques, Comparisons of charging algorithms and new development; Balancing methods for battery pack charging: Battery sorting Overcharge for balancing, Passive balancing, Active balancing.

**UNIT – III****Charging Infrastructure**

Domestic Charging Infrastructure, Public charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

**UNIT – IV****Battery-Management-System Requirements**

Battery-pack topology, BMS design requirements, Voltage sense, Temperature sense, Current sense, Contactor control, Isolation sense, Thermal control, Protection, Charger control, Communication via CAN bus, Log book, SOC estimation, Energy estimation, Power estimation, Diagnostics.

**UNIT – V****Battery Modelling**

General approach to modelling batteries, simulation model of rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of NiCd battery model, Simulation examples.

**Text Books:**

- 1 Energy Systems for Electric and Hybrid Vehicles by K.T. Chau, IET Publications, First edition, 2016.
- 2 Battery Management Systems Vol. – II Equivalent Circuits and Methods, by Gregory L.Plett, Artech House publisher, First edition 2016.

**Reference Books:**

- 1 Electric and hybrid vehicles: design fundamentals, 2nd edition, husain iqbal, crc press
- 2 Lithium-Ion Batteries: Fundamentals and Applications (Electrochemical Energy Storage and Conversion) 1st Edition by Yuping Wu

**Web Links:**

- 1 <https://www.hydroquebec.com/data/electrification-transport/pdf/technical-guide.pdf>
- 2 <https://www.youtube.com/watch?v=eQX-iobIYmw>



## CONCEPT OF SMART GRID TECHNOLOGY (OPEN ELECTIVE-III)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EE7O02</b> | 3        | 0        | 0        | 3        |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Explain the concepts of smart grid and its issues in interconnection.
- CO2** Explain various smart grid technologies and its usage in smart applications.
- CO3** Describe the concepts of smart substations.
- CO4** Analyze micro grids and distributed generation systems.
- CO5** Describe the different technologies in smart grid.

Mapping of Course Outcomes with Program Outcomes:

|            | <b>PO 1</b> | <b>PO 2</b> | <b>PO 3</b> | <b>PO 4</b> | <b>PO 5</b> | <b>PO 6</b> | <b>PO 7</b> | <b>PO 8</b> | <b>PO 9</b> | <b>PO 10</b> | <b>PO 11</b> | <b>PO 12</b> |
|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|--------------|--------------|
| <b>CO1</b> | 2           | 3           | 1           | -           | -           | -           | -           | -           | -           | -            | -            | -            |
| <b>CO2</b> | 2           | 3           | 1           | -           | -           | -           | -           | -           | -           | -            | -            | -            |
| <b>CO3</b> | 2           | 2           | 1           | -           | -           | -           | -           | -           | -           | -            | -            | -            |
| <b>CO4</b> | 2           | 3           | 1           | -           | -           | -           | -           | -           | -           | -            | -            | -            |
| <b>CO5</b> | 2           | 3           | 1           | -           | -           | -           | -           | -           | -           | -            | -            | -            |

Mapping of Course Outcomes with Program Specific Outcomes:

|            | <b>PSO1</b> | <b>PSO2</b> |
|------------|-------------|-------------|
| <b>CO1</b> | -           | -           |
| <b>CO2</b> | -           | -           |
| <b>CO3</b> | -           | -           |
| <b>CO4</b> | -           | -           |
| <b>CO5</b> | -           | -           |

### Unit – I

**Introduction to Smart Grid:** Evolution of Electric Grid - Concept of Smart Grid - Definitions - Need of Smart Grid - Functions of Smart Grid - Opportunities & Barriers of Smart Grid - Difference between conventional & smart grid - Concept of Resilient & Self-Healing Grid - Present development & International policies on Smart Grid.

**Unit – II**

**Smart Grid Technologies: Part 1:** Introduction to Smart Meters - Real Time Pricing - Smart Appliances - Automatic Meter Reading (AMR) - Outage Management System (OMS) - Plug in Hybrid Electric Vehicles (PHEV) - Vehicle to Grid - Smart Sensors - Home & Building Automation - Phase Shifting Transformers -Net Metering.

**Unit – III**

**Smart Grid Technologies: Part 2:** Smart Substations - Substation Automation - Feeder Automation. Geographic Information System (GIS) - Intelligent Electronic Devices (IED) & their application for monitoring & protection.

Smart storage like Battery Energy Storage Systems (BESS) - Super Conducting Magnetic Energy Storage Systems (SMES) - Pumped Hydro - Compressed Air Energy Storage (CAES)

**Unit – IV**

**Micro grids and Distributed Energy Resources:** Concept of micro grid - need & applications of microgrid - formation of microgrid - Issues of interconnection - protection & control of microgrid - Integration of renewable energy sources - Demand Response.

**Unit – V**

**Information and Communication Technology for Smart Grid:** Advanced Metering Infrastructure (AMI) - Home Area Network (HAN) - Neighborhood Area Network (NAN) - Wide Area Network (WAN).

**Text Books:**

1. Integration of Green and Renewable Energy in Electric Power Systems - by Ali Keyhani - Mohammad N. Marwali - Min Dai Wiley - 2009.
2. The Smart Grid: Enabling Energy Efficiency and Demand Response - by Clark W. Gellings - Fairmont Press - 2009.

**Reference Books:**

1. The Advanced Smart Grid: Edge Power Driving Sustainability:1 by Andres Carvallo - John Cooper - Artech House Publishers July 2011
2. Smart Grid: Technology and Applications - by Janaka B. Ekanayake - Nick Jenkins - Kithsiri Liyanage - Jianzhong Wu - Akihiko Yokoyama - Wiley publishers - 2012.

**Web Links:**

1. <https://nptel.ac.in/courses/108104052/>
2. <https://nptel.ac.in/downloads/108101040/>
3. <https://nptel.ac.in/courses/108101040/>

**FINITE ELEMENT METHODS****(Open Elective-III)****Semester: VII****L T P C****Course Code: 231ME7O01****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Understand the concepts behind variational methods and weighted residual methods in FEM.
- CO2:** Solve bar and truss problems
- CO3:** Solve beam problems.
- CO4:** Apply suitable boundary conditions for 2D stress analysis and develop the formulation for axi-symmetric problems and higher order iso-parametric elements.
- CO5:** Evaluate the concepts of steady state heat transfer analysis and dynamic analysis.

**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 2    | 2    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 3    | 2    | 2    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 3    | 2    | 2    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 3    | 2    | 2    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 3    | 2    | 2    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | -    |
| <b>CO2:</b> | -    | -    |
| <b>CO3:</b> | -    | -    |
| <b>CO4:</b> | -    | -    |
| <b>CO5:</b> | -    | -    |

**Unit - I**

Introduction:

Introduction to finite element method, stress and equilibrium, strain–displacement relations, stress–strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy, one-dimensional problems. Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations

**Unit -II**

Bar element formulation, Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.

Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations.

**Unit - III**

Analysis of Beams: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

**Unit - IV**

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axisymmetric problems. Higher order and iso-parametric elements: One dimensional, quadratic and cubic elements in natural coordinates, two dimensional four node iso-parametric elements and numerical integration.

**Unit – V**

Steady state heat transfer analysis: one dimensional analysis of a fin.

Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis

**Text Books:**

- 1 Introduction to Finite Elements in Engineering, T.R. Chandrupatla and A.D. Belegundu, PHI publications, 4th Edition, 2011.
- 2 A First Course in the Finite Element Method, Daryl L. Logan, Cengage Learning India Private Limited, 6th edition, 2017.

**Reference Books:**

- 1 An Introduction to the Finite Element Method, J.N. Reddy, McGraw Hill Education, 4th Edition, 2020.
- 2 Concepts and Applications of Finite Element Analysis, Cook et al, Wiley Publications, 4th edition, 2007.
- 3 Engineering Thermodynamics, P. Chattopadhyay, Oxford University Press, 1<sup>st</sup> edition, 2011.
- 4 Refrigeration and Air-conditioning, CP Arora, , McGraw Hill, 4<sup>th</sup> edition 2021.

**Weblinks:**

- 1 <https://nptel.ac.in/courses/112/104/112104193/>
- 2 <https://nptel.ac.in/courses/112/104/112104205/>

## INTRODUCTION TO MECHATRONICS

### (Open Elective-III)

**Semester: VII**

**L      T      P      C**

**Course Code: 231ME7O02**

**3      0      0      3**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Describe mechatronics systems and various types of sensors and transducers.
- CO2:** Demonstrate knowledge of solid-state devices, analog circuits, and MEMS applications
- CO3:** Explain the components and operation of hydraulic, pneumatic, electro-pneumatic, electro-hydraulic, mechanical, and electrical actuating system
- CO4:** Discuss digital electronics, microcontrollers, PLCs, and their applications in control systems.
- CO5:** Apply system interfacing, data acquisition, system response, and mechatronics design trends.

#### Mapping of Course Outcomes with Program Outcomes:

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 2    | -    | -    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 2    | -    | -    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 2    | -    | -    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 2    | -    | 1    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 2    | -    | -    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | 2    | -    |
| <b>CO2:</b> | 1    | -    |
| <b>CO3:</b> | 1    | -    |
| <b>CO4:</b> | 2    | -    |
| <b>CO5:</b> | 2    | -    |

#### Unit - I

Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

#### Unit -II

Solid state electronic devices, PN junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications.

**Unit - III**

Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems.

**Unit - IV**

Digital electronics and systems, digital logic control, microprocessors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

**Unit – V**

System and interfacing and data acquisition, DAQS, SCADA, A-D and D-A conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends.

**Text Books:**

- 1 Mechatronics Integrated Mechanical Electronics Systems/KP Ramachandran & G K Vijaya Raghavan/WILEY India Edition/2008
- 2 Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005

**Reference Books:**

- 1 Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
- 2 Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
- 3 Mechatronics System Design / Devdas Shetty/Richard/Thomson.
- 4 Mechatronics/M. D. Singh/J. G. Joshi/PHI.

**Weblinks:**

- 1 <https://www.electronicshub.org/different-types-sensors/>
- 2 [https://en.wikipedia.org/wiki/Solid-state\\_electronics](https://en.wikipedia.org/wiki/Solid-state_electronics)
- 3 <http://www.htl-worldwide.com/the-difference-between-pneumatic-hydraulic-and-electrical-actuators/>
- 4 <https://www.worldscientific.com/worldscibooks/10.1142/10193>

## PRODUCT DESIGN AND DEVELOPMENT

### (Open Elective-III)

**Semester: VII**

**L      T      P      C**

**Course Code: 231ME7003**

**3      0      0      3**

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Apply creative thinking skills for idea generation

**CO2:** Translate conceptual ideas into clear sketches.

**CO3:** Able to identify causes of failure through fault free analysis and perform failure analysis

**CO4:** Test a product under thermal, vibration, electrical and combined environments.

**CO5:** Know how to design for manufacturability

#### Mapping of Course Outcomes with Program Outcomes:

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 3    | -    | 1    | -    | 2    | -    | -    | -    | -    | -     | -     | 2     |
| <b>CO3:</b> | 3    | 3    | -    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 3    | 2    | -    | 2    | -    | -    | 2    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 3    | -    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | 2    | -    |
| <b>CO2:</b> | 2    | -    |
| <b>CO3:</b> | 2    | -    |
| <b>CO4:</b> | 2    | -    |
| <b>CO5:</b> | 2    | -    |

#### Unit - I

##### Product design process:

Design Process Steps, Morphology of Design. Problem Solving and Decision Making: Problem-Solving Process, Creative Problem Solving, Invention, Brainstorming, Morphological Analysis, Behavioral Aspects of Decision Making, Decision Theory, Decision Matrix, Decision Trees.

##### MODELING AND SIMULATION:

Triz, Role of Models in Engineering Design, Mathematical Modeling, Similitude and Scale Models, Computer Simulation, Geometric Modeling on Computer, Finite-Element Analysis.

**Unit -II****Product management:**

The operation of product management: Customer focus of product management, product planning process. Levels of strategic planning, Wedge analysis, Opportunity search, Product life cycle Life cycle theory practice.

**Product development:**

Managing new products, generating ideas, Sources of product innovation, Selecting the best ideas, political dimension of product design, Managing the product launch and customer feedback.

**Product managers and manufacturing:**

Need for effective relationships, Impact of manufacturing processes on product decisions, Prototype planning, Productivity potentials, Management of product quality, Customer service levels.

**Unit - III****Risk and reliability:**

Risk and Reliability: Risk and Society, Hazard Analysis, Fault Tree Analysis. Failure Analysis and Quality: Causes of Failures, Failure Modes, Failure Mode and Effect Analysis, FMEA Procedure, Classification of Severity, Computation of Criticality Index, Determination of Corrective Action, Sources of Information, Copyright and Copying. Patent Literature.

**Unit - IV****Product testing:**

Thermal, vibration, electrical, and combined environments, temperature testing, vibration testing, test effectiveness. Accelerated testing and data analysis, accelerated factors. Weibull probability plotting, testing with censored data.

**Unit – V****Design for manufacturability:**

Maintenance Concepts and Procedures, Component Reliability, Maintainability and Availability, Isolation in design and Self-Diagnostics. Product Design for Safety, Product Safety and User S Concepts, Examples of Safe Designs.

**Design standardization and cost reduction:**

Standardization Methodology, Benefits of Product Standardization; International, National, Association and Company Level Standards; Parts Modularization

**Text Books:**

- 1 Engineering Design, George E. Dieter, McGraw-Hill
- 2 Product Integrity and Reliability in Design, John W. Evans and Jillian Y. Evans, Springer Verlag.

**Reference Books:**

- 1 The Product Management Handbook, Richard S. Handscombe, McGraw-Hill
- 2 New Product Design, Ulrich Eppinger
- 3 Product Design, Kevin Otto.

**Weblinks:**

- 1 [https://onlinecourses.nptel.ac.in/noc21\\_me83/preview](https://onlinecourses.nptel.ac.in/noc21_me83/preview)
- 2 <https://www.youtube.com/watch?v=HN9GtL21rb4&t=6s>



**ADVANCED MATERIALS****(Open Elective-III)****Semester: VII****L T P C****Course Code: 231ME7O04****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Explain the materials science and engineering concepts of varied materials to understand the correlations between structure and properties.
- CO2:** Apply the concept of strengthening mechanisms to assess the properties of special metallic materials and alloys.
- CO3:** Apply the concept of strengthening mechanisms to assess the properties of polymers and composite materials.
- CO4:** Analyze the role of functional & smart materials in the contemporary applications covered in diverse fields of engineering and technology.
- CO5:** Explain advances in nanomaterials applications in varied fields with a special focus on safety, sustainability, and environmental considerations.

**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 3    | 2    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 3    | 2    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | 3    |
| <b>CO2:</b> | -    | 3    |
| <b>CO3:</b> | -    | 3    |
| <b>CO4:</b> | -    | 3    |
| <b>CO5:</b> | -    | 3    |

**Unit - I**

Introduction to Materials Science and Engineering:

Introduction to materials and their classifications (metals, polymers, ceramics, composites), Atomic structure and bonding in materials, Crystal structures and defects, Mechanical properties of materials (stress, strain, hardness), Thermal, electrical, and magnetic properties, Phase diagrams and transformations.

**Unit -II**

Advance metallic materials &amp; alloys:

Types of metallic alloys and their applications, Heat treatment and alloying techniques, Strengthening mechanisms (grain size, work hardening, alloying), Special metallic materials (shape memory alloys, superalloys), Corrosion and wear resistance in stainless steels.

**Unit - III****Polymer and Composite Materials**

Classification of polymers and their properties, Polymer processing techniques, Composite materials: types, fabrication, and properties, Reinforcement materials (fibers, nanoparticles), Applications in aerospace, automotive, biomedical fields, Environmental considerations and recyclability.

**Unit – IV****Functional and Smart materials**

Piezoelectric, ferroelectric, and magneto strictive materials, Shape memory alloys and polymers, Thermochromic and photochromic materials, Self-healing and self-cleaning materials, Applications in sensors, actuators, and smart systems.

**Unit – V****Nanomaterials and Future Trends in Materials Science**

Nanomaterials: synthesis, characterization, and properties, Carbon nanotubes and graphene, Nanocomposites and their applications, Ethical, safety, and environmental considerations, Emerging trends: 2D materials, biomaterials, and sustainable materials.

**Text Books:**

- 1 R. Balasubramaniam, "Callister's Materials Science and Engineering," 2<sup>nd</sup> Edition, Wiley, 2009.
- 2 G. E. Dieter, "Mechanical Behavior of Materials," 3rd Edition, McGraw-Hill, 1986.

**Reference Books:**

- 1 L. M. Nieckele, "Advanced Materials: Properties, Processing, and Applications," CRC Press, 2019.
- 2 R. W. Cahn and P. Haasen (Eds.), "Physical Metallurgy," 4th Edition, Elsevier, 1996.
- 3 S. C. Sharma, "Advanced Materials and Their Applications," Dhanpat Rai Publishing Company, 2018.
- 4 V. Raghavan, "Materials Science and Engineering," PHI Learning, 2014.

**Weblinks:**

- 1 <https://ocw.mit.edu/courses/3-051j-materials-for-biomedical-applications-spring-2006/>
- 2 [https://www.youtube.com/playlist?list=PLbRMhDVUMngdzwQyMgoUgdaGBqi\\_p4nVM](https://www.youtube.com/playlist?list=PLbRMhDVUMngdzwQyMgoUgdaGBqi_p4nVM)
- 3 <https://www.coursera.org/specializations/materials-science-for-advanced-technological-applications>

**Smart Manufacturing**  
**(Open Elective-III)**

**Semester: VII****L T P C****Course Code: 231ME7005****3 0 0 3****Course Outcomes: At the end of the Course, students will be able to:**

- CO1:** Learn about smart manufacturing systems' components and handle them more effectively in the context of Industry 4.0
- CO2:** Develop an understanding of smart machines and smart sensors
- CO3:** Apply IoT to Industry 4.0, and they can make a system tailor-made as per the requirements of the industry
- CO4:** Develop an understanding of the concepts of Digital Twin to apply Artificial Intelligence and Machine Learning concepts in Manufacturing
- CO5:** Explain the concepts of AR/VR and Metaverse platform

**Mapping of Course Outcomes with Program Outcomes:**

|      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1: | 2    | 2    | 1    | -    | 2    | 2    | -    | -    | -    | -     | -     | 2     |
| CO2: | 2    | 2    | 1    | -    | 2    | 2    | -    | -    | -    | -     | -     | 2     |
| CO3: | 2    | 2    | 1    | -    | 2    | 2    | -    | -    | -    | -     | -     | 2     |
| CO4: | 2    | 2    | 1    | -    | 2    | 2    | -    | -    | -    | -     | -     | 2     |
| CO5: | 2    | 2    | 1    | -    | 2    | 2    | -    | -    | -    | -     | -     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|      | PSO1 | PSO2 |
|------|------|------|
| CO1: | 2    | 0    |
| CO2: | 2    | 0    |
| CO3: | 2    | 0    |
| CO4: | 2    | 0    |
| CO5: | 2    | 0    |

**UNIT – 1**

**Concepts of Smart Manufacturing:** Definition and key characteristics of smart manufacturing, corporate adaptation processes, manufacturing challenges, challenges vs technologies, Stages in smart manufacturing. Minimizing six big losses in manufacturing with Industry 4.0, and their benefits.

**UNIT – 2**

**Smart Machines and Smart Sensors:** Concept and Functions of a Smart, Machine Salient features and Critical Subsystems of a Smart Machine, Smart sensors; smart sensors ecosystem, need, benefits and applications of sensors in industry, Introduction to IoT, IIoT, and Cyber physical systems, Sensing for Manufacturing Process in IIoT, Block Diagram of an IIoT Sensing Device, Sensors in IIoT Applications, Smart Machine Interfaces,

### UNIT – 3

**IoT connectivity for Industry 4.0:** Industrial communication requirement and its infrastructure, an overview of different types of networks, mesh network in industrial IoT, IoT protocols and the internet, TCP/IP (transmission control protocol/internet protocol) model, IoT connectivity standards: common protocols, application layer protocols, internet/network layer protocols, physical layer IoT protocols, choosing the right IoT connectivity protocol.

### UNIT – 4

**Digital Twin:** Introduction, applications of digital twins, impact zones of digital twins in manufacturing (factories/plants and OEMs), advantages of digital twins, basic steps of digital twin technology

**Machine Learning (ML) and Artificial Intelligence (AI) in Manufacturing:** Introduction, benefits and applications of ML in industries, common approaches of ML; supervised and unsupervised, semi-supervised and reinforced ML.

### UNIT – 5

Metaverse – Basic concepts, AR/VR, Social Metaverse, Industrial Metaverse, How Web 3.0 is changing the Internet, Asset Classes Inside the Metaverse, Land, Coins, Characters/ Avatars, Skins, Utility, Industries Disrupted by the Metaverse, Smart wearables.

#### Text Books:

- 1 Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008
- 2 Tom M. Mitchell, Machine Learning, McGraw Hill, 2013
- 3 Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.
- 4 Aurélien Géron, Hands on Machine Learning with Scikit-Learn and TensorFlow [Concepts, Tools, and Techniques to Build Intelligent Systems], Published by O'Reilly Media, 2017
- 5 S. Kaushik, Artificial Intelligence, Cengage Learning India,

#### Reference Books:

- 1 Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
- 2 Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012.
- 3 M.C. Trivedi, A Classical Approach to Artificial Intelligence, Khanna Publishing House, New Delhi, 2018.

- 4 Artificial Intelligence and Machine Learning, Principles and applications by Vinod Chandra S.S., Anand Hareendran S., PHI 2011.

**Web links:**

- 1 [https://onlinecourses.nptel.ac.in/noc25\\_cs91/preview](https://onlinecourses.nptel.ac.in/noc25_cs91/preview)
- 2 [https://onlinecourses.nptel.ac.in/noc25\\_cs147/preview](https://onlinecourses.nptel.ac.in/noc25_cs147/preview)
- 3 [https://onlinecourses.nptel.ac.in/noc25\\_cs146/preview](https://onlinecourses.nptel.ac.in/noc25_cs146/preview)

## DISCRETE TIME SIGNAL PROCESSING

### (Open Elective-III)

|                        |          |          |          |          |
|------------------------|----------|----------|----------|----------|
| VII Semester           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| Course Code: 231EC7001 | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Summarize Discrete Time Signals and Systems.
- CO2** Illustrate the functionality of fourier series and fourier transform
- CO3** Apply DFT properties to evaluate the given sequence.
- CO4** Make use of FFT Algorithms for DFT computation.
- CO5** Interpret the basic structures of FIR and IIR digital filters.
- CO6** Extend the single rate digital signal processing to multirate digital signal processing

**Mapping of Course Outcomes with Program Outcomes:**

| CO / PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1     | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2     | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3     | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4     | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5     | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO6     | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | -     | -     |
| CO2      | -     | -     |
| CO3      | -     | -     |
| CO4      | -     | -     |
| CO5      | -     | -     |
| CO6      | -     | -     |

### Unit - I

#### Introduction to Digital Signal Processing:

Discrete time signals & sequences, linear shift invariant systems, stability, and causality. Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems.

### Unit – II

#### Discrete Fourier Series & Fourier Transforms:

Properties of discrete Fourier series, DFS representation of periodic sequences, Discrete Fourier transforms: Properties of DFT, linear convolution of sequences using DFT, Computation of DFT.

### **Unit – III**

#### **Fast Fourier Transforms:**

Fast Fourier Transforms (FFT) - Radix-2 Decimation-in-Time and Decimation-in-Frequency FFT Algorithms, Inverse FFT.

### **Unit – IV**

#### **Realization Of Digital Filters:**

Review of Z-transforms, Applications of Z-transforms, solution of difference equations - digital filters, Block diagram representation of linear constant-coefficient difference equations, Basic structures of IIR systems, Transposed forms, Basic structures of FIR systems, System function.

### **Unit – V**

#### **Multirate Digital Signal Processing:**

Decimation, Interpolation, Sampling rate conversion, Implementation of sampling rate conversion.

#### **Text Books:**

1. Digital Signal Processing, Principles, Algorithms and Applications: John G. Proakis, Dimitris G. Manolakis, Pearson Education/PHI, 2007.
2. Discrete Time Signal Processing, A. V. Oppenheim and R. W. Schaffer, PHI, 2010

#### **Reference Books:**

1. Fundamentals of Digital Signal Processing using MATLAB, Robert J. Schilling, Sandra L. Harris, Thomson, 2007.
2. Digital Signal Processing, P. Ramesh Babu, SciTech Publications, 6th Edition, 2014.
3. Digital Signal Processing, Tarun Kumar Rawat, Oxford University Press, 1st Edition, 2015.
4. Multirate Systems and Filter Banks, P. P. Vaidyanathan, Pearson, 1st Edition.

#### **Web Links:**

1. [https://www.tutorialspoint.com/digital\\_signal\\_processing/index.htm](https://www.tutorialspoint.com/digital_signal_processing/index.htm)
2. <https://nptel.ac.in/courses/117/102/117102060/> (Digital Signal Processing - Video course, Coordinator  
BY Prof. S.C. Dutta Roy Department of Electrical Engineering IIT Delhi)

## IC APPLICATIONS (Open Elective-III)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EC7002</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Construct Op Amps using the differential amplifier and other improvement circuits.
- CO2** Explain parameters related to measurement of Op-Amp characteristics.
- CO3** Construct the circuits for different linear applications using Op-Amp.
- CO4** Develop circuits for non-linear applications using Op-Amp.
- CO5** Construct the circuits for different Data conversion and Filtering applications using Op-Amp.
- CO6** Compare different digital logic families.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | 1    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| CO2   | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| CO3   | 2    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 2     |
| CO4   | 2    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 2     |
| CO5   | 2    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 2     |
| CO6   | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | -    | -    |
| CO2    | -    | -    |
| CO3    | -    | -    |
| CO4    | -    | -    |
| CO5    | -    | -    |
| CO6    | -    | -    |

### Unit - I

**Introduction to Integrated Circuits:** Integrated Circuits Types, Classification, Package Types, Temperature ranges and Power supplies. Differential Amplifier-DC And AC analysis of differential amplifier configurations, circuits for improving CMRR, Necessity of swamping resistors, Cascaded Differential Amplifier Stages and Level translator.



## Unit – II

**Characteristics of Op-Amps:** Block Diagram of a Op-Amp, Pin diagram, symbolic representation and features of 741IC, Ideal and practical characteristics of an Op-Amp, Equivalent circuit of an Op-Amp, Define the terms input offset voltage and current, input bias current, CMRR, Slew Rate, PSRR, etc, Virtual ground concept, DC characteristics, AC characteristics and Measurement of Op-Amp parameters.

## Unit – III

**Linear and Non-Linear Applications of Op- Amps:** Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier, AC amplifier, V to I, I to V converters, Buffers. Non-Linear Applications-Comparators, Multivibrators, Triangular and Square wave generators, Log and Anti- log Amplifier, Precision rectifiers.

## Unit – IV

**D-A and A-D Converters:** Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, and IC 1408 DAC, Different types of ADCs parallel Comparator type ADC, counter type ADC, Successive Approximation ADC and dual slope ADC. DAC and ADC Specifications.

Active Filters: Introduction, Butter worth filters – 1st order, 2nd order LPF, HPF filters. Band pass, Band reject and All pass filters.

## Unit – V

**Digital Logic Families and Interfacing:** Introduction to logic families, CMOS logic, CMOS steady state and dynamic electrical behavior, CMOS logic families. Bipolar logic, transistor-transistor logic, TTL families, CMOS/TTL interfacing, low voltage CMOS logic and interfacing, Emitter coupled logic.

### Text Books:

1. Op Amps and Linear Integrated Circuits, Ramakant A. Gayakwad, 4<sup>th</sup> Edition, PHI, Pearson Education, 2003.
2. Linear Integrated Circuits–D. Roy Chowdhury, New Age International (p) Ltd, 2nd Edition, 2003.
3. Digital Design Principles & Practices – John F. Wakerly, PHI/ Pearson Education Asia, 4th Ed.,

### Reference Books:

1. Design with Operational Amplifiers & Analog Integrated Circuits–Sergio Franco, McGrawHill, 1988
2. OPAMPS and Linear Integrated Circuits concepts and Applications, James MFiore, Cengage Learning India Ltd.
3. Operational Amplifiers & Linear Integrated Circuits–R.F. Coughlin & Fredrick Driscoll, PHI, 6th Edition.
4. Fundamentals of Digital Logic with VHDL Design- Stephen Brown, Zvonko Vranesic, McGrawHill, 3<sup>rd</sup> Edition.

**Web Links:**

1. <http://nptel.ac.in/courses/117108038/Prof.GunashekaranM.K/IIScBangalore>
2. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-01sc-introduction-to-electrical-engineering-and-computer-science-i-spring-2011/unit-3-circuits/op-amps>

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## PRINCIPLES OF EMBEDDED SYSTEMS

### (Open Elective-III)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EC7O03</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Summarize the building blocks of an embedded system.
- CO2** Interpret the hardware modules required to design an embedded system.
- CO3** Infer the firmware design approaches for an embedded system.
- CO4** Illustrate the hardware integration with firmware.
- CO5** Outline the process of embedded system development.
- CO6** Choose the tools for embedded system implementation and testing.

#### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO6   | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |
| CO6    | -     | -     |

### Unit - I

Introduction: Embedded system-Definition, History of Embedded systems, classification of embedded systems, major application areas of embedded systems, purpose of embedded systems, the typical embedded system-core of the embedded system, Memory, Sensors and Actuators, Communication Interface, Characteristics of an embedded system, Quality attributes of embedded systems, Application-specific and Domain-Specific examples of an embedded system.

**Unit – II**

Embedded Hardware Design: Analog and digital electronic components, I/O types and examples, Serial communication devices, Parallel device ports, Wireless devices, Timer and counting devices, Watchdog timer, Real time clock, multi processors architectures.

**Unit – III**

Embedded Firmware Design: Embedded Firmware design approaches, Embedded Firmware development

languages, Interrupt sources, ISR concept, Interrupt servicing mechanism, Multiple interrupts, DMA, Device driver programming, Concepts of C versus Embedded C.

**Unit – IV**

Real Time Operating System: Operating system basics, Types of operating systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling, Task communication, Task synchronization.

Hardware Software Co-Design:

Fundamental Issues in Hardware Software Co-Design, Computational models in embedded design, Hardware software Trade-offs, Integration of Hardware and Firmware.

**Unit – V**

Embedded System Development: The integrated development environment, Types of files generated on cross-compilation, Deassembler/ Decompiler, Simulators, Emulators and Debugging, Target hardware debugging, Boundary Scan, Embedded Software development process and tools.

Embedded System Implementation and Testing: The main software utility tool, CAD and the hardware, Translation tools-Pre-processors, Interpreters, Compilers and Linkers, Debugging tools, Quality assurance and testing of the design, Testing on host machine.

**Text Books:**

1. Embedded Systems, Shibu.K. V, Tata McGraw Hill Education Private Limited, 2013.
2. Embedded Systems-Architectures, Programming and Design, Raj Kamal, Tata McGraw Hill Publications.

**Reference Books:**

1. Embedded System Design, Frank Vahid and Tony Givargis, John Wiley Publications, 2013.
2. Hardware Software Co-Design Principles and Practice, J. Staunstrup, Springer Publications
3. Embedded Systems Architecture, Tammy Noergaard, Elsevier Publications, 2013.

**Web Links:**

1. <https://www.iitk.ac.in/tkic/workshop/sensors-and-actuators/ppt/sandeep.pdf>
2. [http://www.artistembedded.org/docs/Events/2006/ChinaSchool/1\\_ESIntroduction.pdf](http://www.artistembedded.org/docs/Events/2006/ChinaSchool/1_ESIntroduction.pdf)

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**CYBER SECURITY****(Open Elective-III)**

VII Semester

**L T P C****Course Code:** 231CS7O01**3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Explain the cyber security and security management methods to maintain security protection**CO2:** Illustrate the nature of secure software development and operating systems.**CO3:** Summarize the Network management and cloud computing security issues.**CO4:** Analyze the data privacy techniques and data management.**CO5:** Illustrate the legal and social issues related to cyber security.**Mapping of Course Outcomes with Program Outcomes:**

| CO / PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1     | 3    | 1    | -    | -    | 2    | -    | -    | 2    | -    | -     | -     | -     |
| CO2     | 2    | 3    | -    | 2    | 2    | -    | -    | -    | -    | -     | -     | -     |
| CO3     | 1    | 2    | -    | 2    | 3    | -    | -    | -    | -    | -     | -     | -     |
| CO4     | 1    | 2    | -    | 3    | 2    | -    | -    | -    | -    | -     | -     | -     |
| CO5     | 2    | 1    | -    | 2    | -    | -    | -    | 3    | -    | -     | -     | -     |
| CO6     | 3    | 1    | -    | -    | 2    | -    | -    | 2    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO / PSO | PSO1 | PSO2 |
|----------|------|------|
| CO1      | -    | -    |
| CO2      | -    | -    |
| CO3      | -    | -    |
| CO4      | -    | -    |
| CO5      | -    | -    |
| CO6      | -    | -    |

**Unit - I**

Introduction: Introduction to Computer Security, Threats, Harm, Vulnerabilities, Controls, Authentication, Access Control, and Cryptography, Authentication, Access Control, Cryptography. Programs and Programming: Unintentional (Non-malicious) Programming Oversights, Malicious Code—Malware, Countermeasures.

**Unit – II**

Web Security: User Side, Browser Attacks, Web Attacks Targeting Users, Obtaining User or Website Data, Email Attacks. Operating Systems Security: Security in Operating Systems, Security in the Design of Operating Systems, Rootkit.

**Unit – III**

Network Security: Network Concepts, Threats to Network Communications, Wireless Network Security, Denial of Service, Distributed Denial-of-Service Strategic Defenses: Security Countermeasures, Cryptography in Network Security, Firewalls, Intrusion Detection and Prevention Systems, Network Management . Cloud Computing and Security: Cloud Computing Concepts, Moving to the Cloud, Cloud Security Tools and Techniques, Cloud Identity Management, Securing IaaS.

**Unit – IV**

Privacy: Privacy Concepts, Privacy Principles and Policies, Authentication and Privacy, Data Mining, Privacy on the Web, Email Security, Privacy Impacts of Emerging Technologies, Where the Field Is Headed. Management and Incidents: Security Planning, Business Continuity Planning, Handling Incidents, Risk Analysis, Dealing with Disaster.

**Unit – V**

Legal Issues and Ethics: Protecting Programs and Data, Information and the Law, Rights of Employees and Employers, Redress for Software Failures, Computer Crime, Ethical Issues in Computer Security, Incident Analysis with Ethics Emerging Topics: The Internet of Things, Economics, Computerized Elections, Cyber Warfare.

**Text Books:**

1. Pfleeger, C.P., Security in Computing, Prentice Hall, 5th edition.
2. Schneier, Bruce. Applied Cryptography, Second Edition, John Wiley & Sons.

**Reference Books:**

1. Rhodes-Ousley, Mark. Information Security: The Complete Reference, Second Edition, Information Security Management: Concepts and Practice, McGrawHill.
2. Whitman, Michael E. and Herbert J. Mattord. Roadmap to Information Security for IT and Infosec Managers. Boston, MA: Course Technology.
3. Information Security, Mark Rhodes, Ousley, 2 nd edition, MGH.

**Web Links:**

1. <https://www.edx.org/micromasters/ritx-cybersecurity>.
2. <https://www.coursera.org/specializations/cyber-security>.
3. <https://www.nptel.ac.in/courses/106105031/>.
4. <http://bedford-computing.co.uk/learning/wp-content/uploads/2016/08/>
5. <https://www.wileyindia.com/cyber-security-understanding-cybercrimescomputer-forensics-and-legal-perspectives.html>

### INTERNET OF THINGS (Open Elective-III)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| VII Semester                  | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231IT7O01</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1:** Explain the fundamental concepts of internet of things.
- CO2:** Illustrate diversified layered architectures and design principles for IoT/M2M.
- CO3:** Identify appropriate network layer protocols used in IoT
- CO4:** Illustrate the scope of data organizing and business models and process.
- CO5:** Describe the role of bigdata, cloud computing and data analytics in a typical IoT system.

#### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 2   | 2   | 1   | -   | 1   | -   | -   | -   | -   | -    | -    | -    |
| CO3   | 2   | 2   | 1   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 2   | 1   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 3   | 1   | -   | -   | 1   | -   | -   | -   | -   | -    | -    | -    |

#### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 1    | -    |
| CO2    | 1    | -    |
| CO3    | 2    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

#### UNIT-I:

**The Internet of Things:** An Overview of Internet of things, Internet of Things Technology, behind IoTs Sources of the IoTs, M2M Communication, Examples of IoTs, Design Principles for Connected Devices.

#### UNIT-II:

Modified OSI Stack for the IoT/M2M Systems, ETSI M2M domains and High- level capabilities, Communication Technologies, Data Enrichment and Consolidation and Device Management Gateway Ease of designing and affordability.

#### UNIT-III:

Design Principles for the Web Connectivity for connected-Devices, Web Communication protocols for Connected Devices, Message Communication protocols for Connected Devices, Web Connectivity for connected-Devices.

**UNIT-IV:**

Data Acquiring, Organizing and Analytics in IoT/M2M, Applications /Services /Business Processes, IOT/M2M Data Acquiring and Storage, Business Models for Business Processes in the Internet of Things, Organizing Data, Transactions, Business Processes, Integration and Enterprise Systems.

**UNIT-V:**

Data Collection, Storage and Computing Using a Cloud Platform for IoT/M2M Applications/Services, Data Collection, Storage and Computing Using cloud platform Everything as a service and Cloud Service Models, IOT cloud-based services using the Xively (Pachube/COSM), Nimbits and other platforms Sensor, Participatory Sensing, Actuator, Radio Frequency Identification, and Wireless, Sensor Network Technology, Sensors Technology, Sensing the World.

**Text Books:**

1. Internet of Things: Architecture, Design Principles And Applications, Rajkamal, McGraw Hill Higher Education.
2. Vijay Madiseti, Arshdeep Bahga, Internet of Things A Hands-On- Approach, 2014

**Reference Books:**

1. An Introduction to Internet of Things, Connecting devices, Edge Gateway and Cloud with Applications, Rahul Dubey, Cengage, 2019. Adrian McEwen, Designing the Internet of Things, Wiley Publishers, 2013.
2. IoT Fundamentals, Networking Technologies, Protocols and Use Cases for the Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetette, rob Barton, Jerome Henry, CISCO, Pearson, 2018.
3. Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, Wiley.

**Web Links:**

1. [https://onlinecourses.nptel.ac.in/noc21\\_cs17/preview](https://onlinecourses.nptel.ac.in/noc21_cs17/preview)
2. <https://arduino makerspace.com/iot-projects-using-arduino/>
3. <https://www.coursera.org/specializations/iot>



## Computer Networks (Open Elective-III)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231AM7O01</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1:** Identify different types of network topologies, protocols and the layers of the OSI and TCP/IP models
- CO2:** Recognize the data link layer design issues and various protocols used for data transmission
- CO3:** Describe MAC Sublayer and how a network can detect and correct transmission errors
- CO4:** Classify and compare the major routing and congestion control algorithms
- CO5:** Describe the functionality of TCP and UDP and summarize the various Application layer protocols such as http, DNS, and HTTP

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 1    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 3    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 1    | 2    | 2    | 3    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 3    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | POS1 | POS2 |
|------------|------|------|
| <b>CO1</b> | -    | -    |
| <b>CO2</b> | -    | -    |
| <b>CO3</b> | -    | -    |
| <b>CO4</b> | -    | -    |
| <b>CO5</b> | -    | -    |

### UNIT-I

**Introduction:** Computer network and components, Types of Computer Networks, Network Software, Reference Models: OSI Reference Model, TCP/IP Reference Model, Comparison between OSI and TCP/IP Models; Example Networks: The ARPANET, Internet., Transmission Media, Guided and Un-guided media.

### UNIT-II

**Data Link Layer:** Data Link Layer Design Issues: Services Provided to Network Layer, Framing, Error Control and Flow Control; Error Detection and Correction: Error Correcting Codes, Error Detecting Codes; Elementary Data Link Protocols, Sliding Window Protocols: One-Bit Sliding Window Protocol, Protocol Using Go Back N and Selective Repeat.

**UNIT-III**

**The Medium Access Control Sublayer (MAC):** Channel Allocation Problem: Static Channel Allocation, Dynamic Channel Allocation; Multiple Access Protocol: ALOHA, Carrier Sense Multiple Access Protocols, Collision-Free Protocols, Limited Contention Protocol.

**UNIT-IV**

**The Network Layer:** Network Layer Design Issues, Routing Algorithms: The Optimality Principle, Shortest Path Routing, Flooding, Distance Vector Routing, Link State Routing, Hierarchical Routing, Congestion Control Algorithms: General Principles of Congestion Control, Congestion Prevention Policies. The Network Layer in Internet-The IP Protocol, IP Address IPV4, IPV6.

**UNIT – V**

**The Transport Layer:** Services Provided to Upper Layer; Elements of Transport Protocols: Connection Establishment, Connection Release; The Internet Transport Protocols: UDP and TCP Protocol, TCP Connection Establishment, TCP Connection Release.

**The Application Layer:** DNS- Domain Name System, Electronic Mail: Architecture and Services, The World Wide Web: Architectural Overview; Web documents: Static Web Document, Dynamic Web Document; Hyper Text Transfer Protocol (HTTP).

**Text Books:**

- 1 Andrew S. Tanenbaum, Computer Networks, 5th Edition, Pearson Education, 2016.
- 2 Behrouz A Forouzan, Data Communications and Networking, 4th Edition, McGraw-Hill- 2006

**Reference Books:**

- 1 S Keshav, An Engineering approach to computer Networking, 2nd Edition, Pearson Education
- 2 J.F.Kurose, K.W.Ross, Computer Networking a Top-Down approach featuring the internet, 2nd Edition, Pearson Education.

**Web Links:**

- 1 <https://nptel.ac.in/courses/106105081>
- 2 <https://www.coursera.org/learn/fundamentals-network-communications>
- 3 [nptel.ac.in/courses/106/106/106106091/](https://nptel.ac.in/courses/106/106/106106091/)

## ELECTRICAL EQUIPMENT IN MINES

### (Open Elective-III)

|                        |   |   |   |   |
|------------------------|---|---|---|---|
| VII Semester           | L | T | P | C |
| Course Code: 231MI7O01 | 3 | 0 | 0 | 3 |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Explain about power systems used in mines.
- CO2:** Analyze various earthing methods used in mines.
- CO3:** Summarize various electrical equipments used in mines.
- CO4:** Discuss about the instrumentation and control systems used in mines
- CO5:** Analyze about intrinsic safety.

#### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 2    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

#### Unit - I

Mine power supply

Choice of voltage, surface and underground supply: Tariff Computation, standards of lighting and method of illumination in open cast and underground Mine Cables- types, Construction details, installation of cables through shaft and other locations, fault location, cable jointing, care and maintenance, Gate-end boxes and switch gears. Principles of flame-proof enclosures

#### Unit – II

Earthing

Earthing Methods, protective devices, overload, under-voltage earth leakage, D.C. Supply-rectifiers, storage batteries.

**Unit – III****Electrical Equipment**

Mining transformers used in mines, lighting transformer, no load-on-load operations, losses and efficiency and voltage regulation. A.C. and D.C. Motors speed-torque characteristics, starting, braking, speed control, drives for haulage. ventilation fans, pumps, compressors, electrical locomotives, winders, Introduction to thyristor device, flame proof and intrinsic safety.

**Unit – IV**

Control and instrumentation Open and closed loop system, remote control, sequence control, winder control of open cast mine equipment, sensor for measurement of various operational, environmental and safety parameters in underground and open cast mines.

**Unit – V****Communication and data transmission**

Mine telephone system, signaling system, LAN, WAN

Intrinsically – safe circuit – methods of attaining intrinsic safety, zener safety barriers and their application. Indian electricity Act and rules 1956 as applied to mines.

**Text Books:**

1. Electrical equipment in Mines by H.Cotton
2. Electrtechnology mining by N.Merinovic

**Reference Books:**

1. Amitosh Dey, Heavy Earth Moving Machinery, Lovely Prakashan Publications, Dhanbad, 2000.
2. Walker, S.C., Mine Winding and Transport, Elsevier, 1988. 7.
3. Alemgren G., Kumar U., and Vagenas N., Mine Mechanisation and Automation, A.A., Balkema Publication, 1993.

**Web Links:**

1. [http://mineportal.in/upload-study-material.php?imgaaa=1 &imagenam e= MINE%20MACHINERY\\_243.pdf](http://mineportal.in/upload-study-material.php?imgaaa=1 &imagenam e= MINE%20MACHINERY_243.pdf)
2. [http://mineportal.in/assets/study\\_material/Locomotive\\_Haulage\\_221\\_mineportal.pdf](http://mineportal.in/assets/study_material/Locomotive_Haulage_221_mineportal.pdf)

## WATER HARVESTING AND SOIL CONSERVATION STRUCTURES

(Open Elective-III)

VII Semester

**L      T      P      C**

**Course Code: 231AG7001**

**3      0      0      3**

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Recommend the short term and long-term runoff harvesting at appropriate places in watershed.

**CO2:** Design criteria and cost estimation of farm ponds.

**CO3:** Explain the functions of soil erosion control structures.

**CO4:** Apply the concept hydraulic jump, runoff measuring structures and various permanent gully control structures.

**CO5:** Estimate the load analysis on various components of soil conservation structures.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | 2    | -    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 1    | -    | -    | -    | 1    | 1    | -    | -    | -    | -     | 1     | -     |
| CO3   | 2    | 1    | -    | -    | 1    | 1    | -    | -    | -    | -     | -     | -     |
| CO4   | 2    | 1    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 2    | 1    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | 3     | -     |
| CO2    | 3     | -     |
| CO3    | 3     | -     |
| CO4    | 3     | -     |
| CO5    | 3     | -     |

### Unit - I

Water harvesting -principles, importance and uses. Water harvesting techniques – classification based on source, storage and use. Runoff harvesting – short-term and long-term techniques. Short-term harvesting techniques - contour bunds, semicircular hoop, trapezoidal bunds, graded bunds, rock catchment and ground catchment. Long term harvesting techniques- purpose and design criteria

### Unit – II

Structures - farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes. Farm pond - components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction. Percolation pond - site selection, design and construction details. Design considerations of nala bunds.

**Unit – III**

Soil erosion control structures - introduction, classification and functional requirements. Design of Gabion structures. Permanent structures for soil conservation and gully control – check dams, drop, chute and drop inlet spillways - design requirements, planning for design, design procedures - hydrologic, hydraulic and structural design and stability analysis.

**Unit – IV**

Hydraulic jump and its application. Drop spillway - applicability, types - straight drop, box-type inlet spillways - description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions.

Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway - description, functional use and design criteria.

**Unit – V**

Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension.

**Text Books:**

1. Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
2. Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

**Reference Books:**

1. Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
2. Schwab, G.O., D.D. Fangmeier, W.J. Elliot, R.K. Frevert. 1993. Soil and Water Conservation Engineering. 4th Edition, John Wiley and Sons Inc. New York.

**Web Links:**

1. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=125071>
2. <http://ecoursesonline.iasri.res.in/course/view.php?id=54>
3. <https://nptel.ac.in/courses/126/105/126105012/>
4. <https://www.fao.org/land-water/water/water-management/water-storage/en/>

## BIG DATA ANALYTICS

### (Open Elective-III)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231DS7O01</b> | 3        | 0        | 0        | 3        |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Illustrate big data challenges in different domains.
- CO2:** Use various techniques for mining data stream.
- CO3:** Demonstrate Building blocks of Hadoop.
- CO4:** Choose map reduce approach to solve big data Problems.
- CO5:** Make use of Pig and Hive to structure and work with big Data.
- CO6:** Make use of Spark tool to work with bigdata.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 3   | 2   | -   | 1   | 2   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO2</b> | 2   | 3   | -   | 1   | 2   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO3</b> | 2   | 1   | -   | 3   | 2   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO4</b> | 3   | 2   | -   | 2   | 2   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO5</b> | 2   | 3   | -   | 2   | 2   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO6</b> | 2   | 2   | -   | 1   | 3   | -   | -   | -   | -   | -    | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    |      |
| <b>CO2</b> | -    |      |
| <b>CO3</b> | -    |      |
| <b>CO4</b> | -    |      |
| <b>CO5</b> | -    |      |
| <b>CO6</b> | -    | 2    |

### Unit– I

Introduction: Introduction to bigdata: Introduction to Big Data Platform, Challenges of Conventional Systems, Intelligent data analysis, Nature of Data, Analytic Processes and Tools, Analysis vs Reporting.

### Unit– II

Stream Processing: Mining data streams: Introduction to Streams Concepts, Stream Data Model and Architecture, Stream Computing, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting One ness in a Window, Decaying Window, Real time Analytics Platform (RTAP) Applications.

**Unit–III**

Introduction to Hadoop: Hadoop: History of Hadoop, the Hadoop Distributed File System, Components of Hadoop Analyzing the Data with Hadoop, Scaling Out, Hadoop Streaming, Design of HDFS, Java interfaces to HDFS Basics, Developing a Map Reduce Application, How Map Reduce Works, Anatomy of a Map Reduce Job run, Failures, Job Scheduling, Shuffle and Sort, Task execution, Map Reduce Types and Formats, Map Reduce Features Hadoop environment.

**Unit– IV**

Pig: Hadoop Programming Made Easier: Admiring the Pig Architecture, Going with the Pig Latin Application Flow, Working through the ABCs of Pig Latin, Checking out the Pig Script Interfaces, Scripting with Pig Latin.

Working with Hive Data Types, Creating and Managing Data bases and Tables, Seeing How the Hive Data Manipulation Language Works with examples, Querying and Analyzing Data.

**Unit– V**

Spark: Installing Spark, Spark applications, Jobs, stages and Tasks, Resilient Distributed datasets, Shared Variables, Anatomy of a Spark job run.

**Text Books:**

1. Hadoop: The Definitive Guide, Tom White, 4<sup>th</sup> Edition, O'reilly, 2012.
2. Hadoop for Dummies, Dirkde Roos, PaulC.Zikopoulos, RomanB.Melnyk, Bruce Brown, Rafael Coss, John Wiley& Sons, 2014.
3. Anand Raja ramanand Jeffrey David Ullman, "Mining of Massive Datasets", CUP, 2012

**Reference Books:**

1. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley& sons, 2012.
2. Paul Zikopoulos, Dirkde Roos, Krishnan Parasuraman, Thomas Deutsch, James Giles, David Corrigan, "Harness the Power of Big Data: The IBM Big Data Platform", Tata Mc Graw Hill Publications, 2012.
3. Arshdeep Bahga and Vijay Madisetti, "Big Data Science& Analytics: A Hands On Approach", VPT, 2016.
4. Learning Spark: Lightning Fast Big Data Analysis Paper back, Holden Karau

**Web Links:**

1. Hadoop: <http://hadoop.apache.org/>
2. Hive: <https://cwiki.apache.org/confluence/display/Hive/Home>
3. <http://nptel.ac.in/courses/106106142/>
4. <https://hortonworks.com/tutorial/how-to-process-data-with-apache-hive/>
5. <https://databricks.com/spark/getting-started-with-apache-spark>



**PIPELINE ENGINEERING**  
**(OPEN ELECTIVE-III)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231PT7O01</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Illustrate Fluid physical properties and flow in pipes
- CO 2:** Derive the single phase fluid flow equations
- CO 3:** Determine the flow regime and pressure drop calculations.
- CO 4:** Estimation of pressure loss across control valves
- CO 5:** Explain the design aspects of subsea and buried pipelines.

**Mapping of Course Outcomes with Program Outcomes**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | 3     | -     |
| CO2      | 3     | -     |
| CO3      | 3     | -     |
| CO4      | 3     | -     |
| CO5      | 3     | -     |

**Unit-I:**

**Fluid flow and piping:** Bernoulli's theorem, Fluid physical properties, Flow in pipes and Reynolds number, Pressure loss due to friction, Friction factor and effect of pipe roughness, Equivalent length of valves and fittings, Compressibility of gas.

**Unit-II:**

**Single Phase Flow:** Transmission line gas flow - Isothermal flow, flow equation: The AGA equations, The Weymouth equation, Panhandle A equation, Panhandle B equation; Low Pressure gas flow; Plant piping gas flow.

**Unit-III:**

**Two Phase Flow:** Flow regime determination; Pressure drop calculation- Frictional component, Elevation component; Liquid Holdup.  
Liquid Slugging- Purpose of separators, Mechanism of slug generation, Slug catchers, Pigging.

**Unit-IV:**

**Pipe, Fittings and Valves:** Usual industry pipe sizes and classes practice, total line pressure drop. Pressure drop in fittings, valves, connections. Incompressible fluid, use of k factors, validity of k values. Laminar flow, piping systems, resistance and flow coefficients of valves, nozzles and orifices.

Alternate calculation basis for piping system friction head loss: liquids, equivalent feet concept. Friction pressure drop for non-viscous liquids. Estimation of pressure loss across control valves: Usage of various methods. Friction loss for water flow in pipe system

Pipe flow system with liquid of specific gravity other than water; Friction pressure drop for compressible fluid flow; Pressure drop for vapor system, alternate solution to compressible flow problems, friction drop for air, steam flow using Babcock formula.

**Unit-V:**

Sonic conditions, limiting flow of gases and vapors, gas flow through sharp-edged orifice, sonic velocity and friction drop for compressible natural gas in long pipelines. Complex pipe system handling natural gas, factors of safety for design basis. Design aspects of subsea and buried pipelines; Material selection.

**Text Book:**

1. GPSA Engineering Data Book, Volume 2, 12 Edition, 2003.
2. Ludwig's Applied Process Design for Chemical and Petrochemical Plants, Volume 1, 4<sup>th</sup> Edition, A. Kayode Coker, Elsevier, 2007
3. Piping and Pipeline Calculations Manual, Construction, Design, Fabrication and Examination, Philips Ellenberger, Elsevier, 2010.

**Reference Books:**

1. Liquid pipeline hydraulics; E. Sashi Menon; Marcel Dekker Inc.; 2004.
2. Gas-pipe hydraulics; E. Sashi Menon; CRC Press-Taylor & Francis Publications; 2005.
3. Flow of fluids, Crane, 7<sup>th</sup> edition, 1988

## INTRODUCTION TO SEISMIC METHODS (OPEN ELECTIVE-III)

**VII Semester**

**L T P C**

**Course Code: 231PT7002**

**3 0 0 3**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Illustrate the Geophysical exploration methods
- CO 2:** Differentiate between Seismic Refraction and Seismic Reflection
- CO 3:** Explain the application of seismic refraction method.
- CO 4:** Estimation of Seismic Reflection methods and its applications
- CO 5:** Explain the recent advances in seismic methods.

### Mapping of Course Outcomes with Program Outcomes

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      |       |       |
| CO2      |       |       |
| CO3      |       |       |
| CO4      |       |       |
| CO5      |       |       |

#### UNIT-I:

**Introduction to Geophysical methods:** used in oil Industry with emphasis on seismic methods and their historical back ground , basic concepts and the present status of these methods in the industry.

#### UNIT-II:

**Historical back ground of seismic methods:** Different types of these methods namely Seismic Refraction, Seismic Reflection, and well seismic methods, Different types of seismic waves.

**UNIT-III:**

**Seismic refraction methods:** Geometry of a Refracted wave, single layer and two layer case. Recording instruments & energy sources- Corrections to refraction data Interpretation. Application of seismic refraction method in calculating statics for application in reflection survey.

**UNIT IV**

**Seismic Reflection methods:** Geometry of reflected ray path: Single horizontal reflector- The reflection seismograph and seismogram (Seismic traces)- Importance of seismic reflection survey over seismic refraction survey technique.

Field procedures & principles- Receivers and sources. Field Layouts. Time corrections applied to seismic data- Data processing - Introduction to 2D & 3D data acquisition. - Common depth point (CDP) profiling & stacking- data interpretation of reflection data for identification of drillable structures. Marking of reflectors (different lithologic units in the subsurface, construction of time and depth structures maps and calculation of reserves based on these identified structures. AVO and seismic inversions.

**UNIT V:**

Brief introduction to recent advances in seismic methods namely 4D seismic methods, Virtual Reality Centers for interpretation. Well seismic shooting for velocity determination and Vertical Seismic Profiling (VSP) and their importance

**Text Books:**

1. Introduction to Geophysical Prospecting, Milton B. Dobrin, and Carl H. Savit, 4<sup>th</sup> Edition, McGraw Hill, 1988.
2. Outlines of Geophysical Prospecting: A Manual for Geologists, M.B. Ramachandra Rao, EBD Educational Pvt Ltd., 1993.
3. Field Geophysics, John Milsom and Asger Eriksen, 4<sup>th</sup> Edition, John Wiley, 2011.

**Reference Books:**

1. Elements of Geology: Oil and Gas Exploration Techniques, J. Guillemot, Technip 1991.
2. Fundamentals of Geophysics, Lowri, W., Cambridge University Press. (1997).
3. Applied Geophysics, Telford, W. M, Geldart L.P., Sheriff, R.E., Keys, D.A. (1990).

## INTRODUCTION TO ARTIFICIAL LIFT METHODS (OPEN ELECTIVE-III)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231PT7O03</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Illustrate the Purpose of artificial lift selection
- CO 2:** Explain about Sucker rod lift system and its advantages and disadvantages
- CO 3:** Differentiate between continuous and intermittent gas lift advantages and limitations.
- CO 4:** Explain about design process of Electrical submersible pumps
- CO 5:** Apply the skills for the selection and type of artificial lift method.

### Mapping of Course Outcomes with Program Outcomes

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | 3     | -     |
| CO2      | 3     | -     |
| CO3      | 3     | -     |
| CO4      | 3     | -     |
| CO5      | 3     | -     |

### UNIT-I

**Introduction:** Definition and Purpose of artificial lift selection-Reservoir pressure and well productivity-reservoir fluids-Types of artificial lift.

### UNIT-II

**Sucker Rod lift:** Sucker rod lift system-polished rod motion-load to the pumping unit-pump deliverability and power requirement-sucker rods-steel sucker rods-pony rods-FRP sucker rods-Non-API sucker rods-criteria for rod string design, advantages and limitations-Trouble shooting sucker rod lift installation.

**UNIT-III**

**Gas lift:** Gas lift system-gas compression requirements sonic flow-subsonic flow- volumetric efficiency-stage compression-gas lift valve design-selection of gas lift valves-pilot valve continuous and intermittent gas lift advantages and limitations.

**UNIT-IV**

**Electrical submersible pumps:** Electrical submersible pumps. (ESP)- Principle - hydraulic piston pumping-ESP design-ESP advantages and limitations.

**UNIT -V**

**Hydraulic Jet pumping:** Hydraulic Jet pumping-selection of jet pump-advantages and disadvantages.

**Selection of artificial lift method:** artificial lift method selection-gas lift vs pump assisted lift installation and replacement of artificial lift-maintenance of artificial lift.

**Text books:**

1. Petroleum Production engineering: A computer assisted approach, Boyun GUO, William C. Lyons, Ali Ghalambor, Elsevier Science and Technology books 2007.
2. Petroleum Engineering Handbook-Production Operations Engineering, Volume 4, Joe Dunn Clegg and Larry W. Lake, SPE, 2014.

**Reference Books:**

1. Petroleum production systems, M.J. Economides, A. Daniel Hill & C. E. Economides, Prentice-Hall, N.J-07488, 1994.
2. The Technology of Artificial Lift Method, Brown, K.E, Volume 1-4, Penn Well Books, Tulsa, Oklahoma, 1977.
3. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University, 2014.

## BASICS OF SOIL MECHANICS (Open Elective-IV)

VII Semester

L T P C

Course Code: 231CE7004

3 0 0 3

**Course Outcomes:** At the end of the Course, Student will be able to:

**CO1:** Explain physical properties of soil and its determination

**CO2:** Determine the various index properties and the classification of soil

**CO3:** Assess the stress developed due to various loads and soil conditions

**CO4:** Explain the various compaction methods and the determination of permeability

**CO5:** Explain the concept of consolidation, compressibility and settlement calculation

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | 2    | -    | -    | -    | 1    | -    | -    | -    | 2     | -     | -     |
| CO2   | 1    | 3    | -    | -    | -    | -    | -    | 2    | -    | 1     | -     | -     |
| CO3   | 1    | 2    | -    | -    | -    | -    | -    | 2    | -    | 1     | -     | -     |
| CO4   | 1    | 2    | -    | -    | -    | -    | -    | 2    | -    | 1     | -     | -     |
| CO5   | 1    | 2    | -    | -    | -    | 1    | -    | -    | -    | 2     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

### Unit - I

#### Physical Properties of Soil:

Three phase system - phase diagram - physical properties Functional Relationships between physical properties-determination of water content, specific gravity, In-situ density-Relative density

### Unit – II

**Plasticity Characteristics of soil:** Consistency, Atterberg's limits and their determination liquid limit, plastic limit, shrinkage limit - Index Properties-Activity-Free swell index. Soil Classification: Soil classification- need and criteria for soil classification-IS Particle size classification-Classification tests-grain size analysis - hydrometer analysis- grain size distribution curve - Unified Soil Classification- Indian Standard Soil classification- Coarse grained soils- Fine grained soils-Plasticity chart.

**Unit – III**

**Effective stress:** Stresses due to self-weight-total, neutral and effective stresses – Pressure diagrams under different soil conditions. Stresses due to applied loads: Boussinesq theory-Concentrated load-Strip footing- circular footing- Rectangular footing-Newmark's influence chart - Pressure bulb-Significant depth Westergaard's theory - 2:1 distribution method

**Unit – IV**

**Compaction:** Principle of compaction, OMC and MDD, Lab tests-IS light weight and heavy weight compaction tests, Factors affecting compaction - zero air void line-Effect of compaction on engineering

properties of soils - Field compaction control – Proctor's Needle.

Permeability and Seepage: types of soil water, Permeability-Darcy's law-Factors effecting permeability- laboratory tests-Average permeability of stratified soils. Seepage pressure critical hydraulic gradient -quick sand condition.

**Unit – V**

**Consolidation:** Definition and significance-mechanism-Terzaghi's soil-spring analogy -lab consolidation test

– e-log p curve-Coefficient of compressibility-coefficient of volume change-compression index- determination of consolidation settlement – Terzaghi's theory of 1D consolidation-Time-settlement calculations. Determination of coefficient of consolidation-time fitting methods – Pre-consolidation pressure- normally consolidated and over consolidated clays-secondary consolidation.

**Text Books:**

1. Arora, K.R. (2019), "Soil Mechanics and Foundation Engineering", Standard Publishers, Delhi
2. Gopal Ranjan and Rao, A.S.R., "Basic and Applied Soil Mechanics", New Age Ltd. International Publisher New Delhi (India) 2016

**Reference Books:**

1. Craig, R.F. (2019), "Soil Mechanics", McGraw hill, New Delhi
2. Narasinga Rao, B.N.D. (2015), Soil Mechanics and Foundation Engineering, Wiley Publishers

**Web Links:**

1. <http://nptel.ac.in/courses/105103097/>



## CONSTRUCTION MATERIALS AND EQUIPMENTS (Open Elective-IV)

VII Semester

L T P C

Course Code: 231CE7O05

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Explain the tests on stones, cement and aggregates.

**CO2:** Explain the concepts of strength and durability testing on mortar and concrete.

**CO3:** Compare the properties of most common and advanced building materials.

**CO4:** Selection of Automation techniques in construction industry.

**CO5:** Analyze benefits of robotics versus conventional construction equipment.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | -    | 3    | -    | -    |      | -    | -    | -    | -     | -     | -     |
| CO2   | 1    | 2    | 1    | 3    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | -    | 1    | -    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 1    | 2    | 1    | 3    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | -    | 1    | -    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | 3     |
| CO2    | -     | 3     |
| CO3    | -     | 3     |
| CO4    | -     | 3     |
| CO5    | -     | 3     |

### Unit - I

**Stones, Bricks and Concrete Blocks:** Stone as building material–Criteria for selection– Tests on stones– Deterioration and Preservation of stone work – Bricks – Classification – Manufacturing of clay bricks – Tests on bricks–Compressive Strength–Water Absorption– Efflorescence–Bricks for special use–Refractory bricks–Cement, Concrete blocks– Light weight concrete blocks. Nano Aggregate – RCA ( Recylcd Concrete Aggregate) – RCCA.

### Unit – II

**Lime, Cement, Aggregate and Mortar:** Lime–Preparation of lime mortar–Cement–Ingredients– Manufacturing process–Types and Grades – Properties of cement and Cement mortar – Hydration – Compressive strength –Tensile strength–Fineness– Soundness and consistency–Setting time–Industrial byproducts–Fly ash – Aggregates – Natural stone aggregates – Crushing strength – Impact strength – Flakiness Index– Elongation Index – Abrasion Resistance –Grading–Sand Bulking.

Concrete Ingredients – Manufacturing Process – Batching plants – RMC – Properties of fresh concrete – Slump – Flow and compaction Factor – Properties of hardened concrete – Compressive, Tensile and shear strength – Modulus of rupture – Tests – Mix specification – Mix proportioning – BIS method – High Strength Concrete and HPC – Self compacting Concrete – Other types of Concrete – Durability of Concrete.

### Unit – III

**Modern materials:** Glass–Ceramics–Sealants for joints–Fibre glass reinforced plastic–Clay products– Refractories–Composite materials–Types–Applications of laminar composites–Fibre textiles– Geo membrane sand Geotextiles for earth reinforcement.

### Unit – IV

**Introduction:** Unique features of construction equipment, Need of construction Equipment, past history. Construction equipment: Capacity, Feasibility, owning and operating cost and Productivity of Different Equipment: Excavators, Pavers, Plastering machines; Pre-stressing jacks and grouting equipment; Cranes and Hoists, Concrete Batching Plants, etc.

### Unit – V

**Automation in Construction Industry:** Need and Benefit of automation: Automation in Canal lining, Automation in Construction of Highway, Automation in concrete technology. Robotics in Construction: Use of robots for construction activities like Brick laying, Demolition, Material Handling, Structural steel cutting, Rebar tying/bending, Form work mould making, 3D printing- print complex, layered, parts and objects of homes, buildings, bridges and roads.

### Text Books:

1. Varghese.P.C, "Building Materials", PHI Learning Pvt. Ltd, New Delhi, 2018.
2. Rajput.R.K., "Engineering Materials", S.Chand and Company Ltd., 2018.

### Reference Books:

1. Jagadish.K.S, "Alternative Building Materials Technology", New Age International, 2017.
2. Gambhir.M.L., & Neha Jamwal., "Building Materials, products, properties and systems", Tata McGraw Hill Education Pvt.Ltd, New Delhi, 2019.

### Web Links:

1. <https://nptel.ac.in/courses/105/102/105102012/>
2. <https://nptel.ac.in/courses/105/106/105106176/>

## NATURAL DISASTER MANAGEMENT & MITIGATION (Open Elective-IV)

VII Semester

L T P C

Course Code: 231CE7O06

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Explain the aspects of disaster management and adopt remedial measures**CO2:** Explain disaster risk assessment and coping measures.**CO3:** Explain the vulnerability conditions**CO4:** Assess the impact of hazards on structures**CO5:** Adopt the rehabilitation procedures**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | 2    | -    | -     | -     | -     |
| CO2   | -    | 1    | -    | -    | -    | 3    | -    | 2    | -    | -     | -     | -     |
| CO3   | -    | 1    | -    | -    | -    | -    | -    | 2    | -    | -     | -     | -     |
| CO4   | 2    | -    | -    | -    | -    | 3    | -    | 2    | -    | -     | -     | -     |
| CO5   | 2    | -    | -    | -    | -    | 3    | -    | 2    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

**Unit - I**

Introduction Concept of Disaster Management. Types of Disasters. Disaster mitigating agencies and their organizational structure at different levels.

**Unit – II**

Overview of Disaster Situations in India Vulnerability of profile of India and Vulnerability mapping including disaster – prone areas, communities, places. Disaster preparedness – ways and means; skills and strategies; rescue, relief reconstruction. Case Studies: Lessons and Experiences from Various Important Disasters in India and Biological disasters – SARS-spread and transmissstions -pandemic, endemic and epidemic.

**Unit – III**

Flood and Drought Disaster Raising flood damage, assessing flood risk, flood hazard assessment, flood impact assessment, flood risk reduction options. Drought and development, relief management and prevention, drought mitigation and management- integrating technology and people.

**Unit – IV**

Landslide and Earthquake Disaster Land slide hazards zonation mapping and geo environmental problems associated with the occurrence of landslides. The use of electrical resistivity method in the study of landslide. Causes and effects of earthquakes. Secondary effects. Criteria for earthquake resistant design.

**Unit – V**

Cyclone and Fire Disaster Cyclone occurrence and hazards. Cyclone resistant house for coastal areas. Disaster resistant construction role of insurance sector. Types of fire. Fire safety and firefighting method, fire detectors, fire extinguishers. Rehabilitation: Rehabilitation programmes, Management of Relief Camp.

**Text Books:**

1. Disaster Management, RB Singh (Ed), Rawat Publications, 2000.
2. Disaster Management Future Challenges and Opportunities, Jagbir Singh, I.K International publishing house

**Reference Books:**

1. Natural Hazards in the Urban habitat by Iyengar, CBRI, Tata McGraw Hill
2. Natural Disaster management, Jon Ingleton (Ed), Tulor Rose, 1999

**Web Links:**

1. <https://www.youtube.com/watch?v=2v7N5a3tLgE>
2. <https://www.youtube.com/watch?v=5KtVocJfVGw>

## Concepts of Power Quality

### (Open Elective-IV)

**VII Semester**

**L T P C**

**Course Code: 231EE7003**

**3 0 0 3**

**Course Outcomes: At the end of the course, student will be able to:**

- CO1** Differentiate between different types of power quality problems and sources of voltage sag, voltage swell.
- CO2** Explain about the sources of transient over voltages in a power system.
- CO3** Explain about the Long – Duration Voltage Variations and Flickering.
- CO4** Analyse the Harmonic distortion and solutions and their indices.
- CO5** Explain the concepts of distributed generation technologies.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 1    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | -    | -    |
| CO2    | -    | -    |
| CO3    | -    | -    |
| CO4    | -    | -    |
| CO5    | -    | -    |

## UNIT – I

### Introduction - Terms & Definitions

Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations – Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power frequency variations – Voltage Sags – Voltage Swell.

**UNIT – II****Transient Over Voltages:**

Sources of Transient Over voltages - Principles of Over voltage protection- Devices for Over voltage protection – Utility Capacitor Switching Transients - Utility System Lightning Protection – Managing Ferro resonance – Switching Transient Problems with Loads.

**UNIT – III****Long – Duration Voltage Variations:**

Principles of regulating the voltage – Device for voltage regulation – Utility voltage regulator application – Capacitor for voltage regulation – End-user capacitor application – Regulating utility voltage with distributed resources – Flicker.

**UNIT – IV****Harmonic distortion and solutions:**

Voltage distortion vs. Current distortion –Harmonic indices: THD - TDD and True Power Factor– Sources of harmonics – Effect of harmonic distortion – Impact on capacitors, transformers, motors and meters – Concept of Point of common coupling – Passive and active filtering – Numerical problems.

**UNIT – V****Distributed Generation and Monitoring:**

Resurgence of distributed generation – DG technologies – Interface to the utility system – Power quality issues and operating conflicts – DG on low voltage distribution networks.

**Monitoring:**

Power quality monitoring and considerations – Historical perspective of PQ measuring instruments – PQ measurement equipment – Assessment of PQ measuring data.

**Text Books:**

- 1 Electrical Power Systems Quality - Dugan R C - McGranaghan M F – Santoso S - and Beaty H W - Second Edition - McGraw–Hill - 2012 - 3rd edition.
- 2 Electric power quality problems – M.H.J.Bollen IEEE series-Wiley india publications – 2011.

- 3 Power Quality Primer - Kennedy B W - First Edition - McGraw–Hill - 2000.

**Reference Books:**

- 1 Understanding Power Quality Problems: Voltage Sags and Interruptions - Bollen M HJ - First Edition - IEEE Press; 2000.
- 2 G. T, Heydt, "Electric Power Quality", Stars in a Circle Publications, 1991  
Power System Harmonics - Arrillaga J and Watson N R - Second Edition - John Wiley & Sons - 2003.
- 3 Electric Power Quality control Techniques - W. E. Kazibwe and M. H. Sendaula – Van Nostrand Reinhold - New York.
- 4 Harmonics and Power Systems –Franciso C.DE LA Rosa–CRC Press (Taylor & Francis).

**Web Links:**

- 1 <https://nptel.ac.in/courses/108107157>
- 2 [https://onlinecourses.nptel.ac.in/noc21\\_ee103/preview](https://onlinecourses.nptel.ac.in/noc21_ee103/preview)

## INTELLIGENT CONTROL SYSTEMS

### (OPEN ELECTIVE-IV)

**Semester: VII****L      T      P      C****Course Code: 231EE7O04****3      0      0      3****Course Outcomes: At the end of the course, student will be able to:**

- CO1** To explain the fundamental concepts and components of Robotics systems.
- CO2** To explain direct & inverse kinematics of robots.
- CO3** Identify and classify different types of sensors and actuators used in robotics applications.
- CO4** To do control of robotics systems.
- CO5** To deploy programming and artificial intelligence techniques for robotics systems.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 2    | 2    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | -    |
| <b>CO2</b> | -    | -    |
| <b>CO3</b> | -    | -    |
| <b>CO4</b> | -    | -    |
| <b>CO5</b> | -    | -    |

**UNIT – I****Introduction to Intelligent Control**

Intelligent control, Hierarchical control architectures, Review of classical and modern control system.

**UNIT – II****Study on Digital, Fuzzy, Neural and Genetic control Algorithms**

Digital control systems, Rule based systems, Study of Mamdani and Takagi-Sugeno Fuzzy



logic control system, Study of Neural networks control system, Study of Genetic Algorithm for intelligent system control.

### **UNIT – III**

#### **Analysis of Hybrid Control Systems**

Study and design of various hybrid intelligent techniques for intelligent system control, Application of intelligent system control on various engineering fields.

### **UNIT – IV**

#### **Sensors and Actuators in Intelligent Control**

Comprehensive study of various segments of intelligent system control, Use of various sensors and actuators in intelligent control system.

### **UNIT – V**

#### **Application of Robots with Intelligent Control**

Use of Robots and various mobile robot in the field of intelligent control, Engineering application of intelligent system control in various fields.

#### **Text Books:**

- 1 Stuart Russell, Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson Higher Education & Professional Group, Kindle Edition: 2025 , 2021
- 2 David L. Poole, Alan K. Mackworth, Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, Kindle Edition: 2025 , 2025

#### **Reference Books:**

- 1 Thrishantha Nanayakkara (Author), Ferat Sahin (Author), Mo Jamshidi (Author), Intelligent Control Systems with an Introduction to System of Systems Engineering, Kindle Edition: 2025, CRC Press , 2025
- 2 Mordechai Ben-Ari, Francesco Mondada, Elements of Robotics, Springer, Kindle Edition: 2025 , 2025

#### **Web Links:**

- 1 <https://archive.nptel.ac.in/courses/108/104/108104049/>

## OPTIMIZATION TECHNIQUES

(Open Elective-IV)

**Semester: VII**

**L      T      P      C**

**Course Code: 231ME7O06**

**3      0      0      3**

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Understand the classical optimization techniques

**CO2:** Learn numerical methods for optimization

**CO3:** Get insights into genetic algorithm and its variants

**CO4:** Know the applications of optimization in mechanical engineering

**CO5:** Understand the concept of reliability

**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 2    | 2    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 3    | 3    | 2    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 3    | 2    | 2    | -    | -    | -    | 1    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 2    | 1    | 2    | -    | 1    | -    | 1    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | 1    |
| <b>CO2:</b> | -    | 1    |
| <b>CO3:</b> | -    | 1    |
| <b>CO4:</b> | -    | 1    |
| <b>CO5:</b> | -    | 1    |

### Unit - I

Classical Optimization Techniques: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions, merits and demerits of classical optimization techniques.

### Unit -II

Numerical Methods for Optimization: Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, Pattern search methods, conjugate method, types of penalty methods for handling constraints, advantages of numerical methods

**Unit - III**

**Genetic Algorithm (GA) :** Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA,

**Genetic Programming (GP):** Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP. **Multi-Objective GA:** Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems

**Unit – IV**

Applications Of Optimization In Design And Manufacturing Systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

**Unit – V**

**Reliability:** Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, hazard analysis.

**Text Books:**

- 1 Engineering Optimization by S.S.Rao, 3<sup>rd</sup> edition, New Age Publishers,2013, **ISBN13 978-8122427233**
- 2 Reliability Engineering by L.S.Srinath, East west publishers,2005, **ISBN13 978-8176710480**

**Reference Books:**

- 1 Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
- 2 Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers
- 3 Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers
- 4 An Introduction to Reliability and Maintainability Engineering by CE Ebeling, Waveland Printers Inc., 2009

**Weblinks:**

- 1 [https://onlinecourses.nptel.ac.in/noc21\\_me10/preview](https://onlinecourses.nptel.ac.in/noc21_me10/preview)
- 2 <https://www.coursera.org/learn/operations-research-modeling>

## ADVANCED MANUFACTURING PROCESSES

### (Open Elective-IV)

**Semester: VII**

**L      T      P      C**

**Course Code: 231ME7O07**

3      0      0      3

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Explain the working principle of various nonconventional machining processes and their applications.  
**CO2:** Explain the working principles of additive manufacturing methods.  
**CO3:** Understand various surface treatment techniques and processing of ceramics.  
**CO4:** Gain the knowledge on advanced coating processes.  
**CO5:** Describe various fabrication methods for microelectronic devices.

#### Mapping of Course Outcomes with Program Outcomes:

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | -    | -    | -    | 1    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 3    | -    | -    | -    | 1    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 3    | -    | -    | -    | 1    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 3    | -    | -    | -    | -    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 3    | -    | -    | -    | 1    | 2    | -    | -    | -    | -     | -     | -     |

#### Mapping Course Outcomes with Program Specific Outcomes:

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | 2    | -    |
| <b>CO2:</b> | 2    | -    |
| <b>CO3:</b> | 2    | -    |
| <b>CO4:</b> | 2    | -    |
| <b>CO5:</b> | 2    | -    |

#### Unit - I

**Advanced Machining Processes:** Introduction, AJM, WJM, EDM, ECM, LBM, EBM, & PAM – principle, working, advantages, limitations, Process Parameters & capabilities and applications.

#### Unit -II

**Additive Manufacturing:** Working principles, methods- stereo lithography, LENS, LOM, laser sintering, fused deposition method, applications and limitations, direct and indirect rapid tooling techniques.

**Unit - III**

**Surface Treatment:** Scope, cleaners, methods of cleaning, surface coating types, electro forming, chemical vapour deposition, physical vapour deposition, thermal spraying methods, ion implantation, diffusion coating, ceramic and organic methods of coating, and cladding methods.

**Processing of Ceramics:** Applications, characteristics, classification, processing of particulate ceramics, powder preparations, consolidation, hot compaction, drying, sintering, and finishing of ceramics, areas of application.

**Unit - IV**

**Processing of Composites:** Composite layers, particulate and fiber reinforced composites, elastomers, reinforced plastics, processing methods for MMC, CMC, polymer matrix composites.

**Processing of Nanomaterials:** Introduction, top-down vs bottom-up techniques, ball milling, lithography, plasma arc discharge, pulsed laser deposition, sputtering, sol-gel, molecular beam epitaxy.

**Unit – V****Fabrication of Microelectronic Devices:**

Crystal growth and wafer preparation, film deposition, oxidation, lithography, bonding and packaging, reliability and yield, printed circuit boards, surface mount technology, integrated circuit economics.

**Text Books:**

- 1 Manufacturing Engineering and Technology, Serope Kalpakjian and Steven R. Schmid, Pearson Education, 8<sup>th</sup> Edition, 2023.
- 2 Process and Materials of Manufacturing, R. A. Lindburg, Prentice Hall India Learning Private Limited, 4<sup>th</sup> Edition, 1990.

**Reference Books:**

- 1 Advanced Machining Processes, V. K. Jain, Allied Publications, 2002.
- 2 Introduction to Nanoscience and Nano Technology, K. K. Chattopadhyay & A. N. Banerjee, PHI Learning, 2009.
- 3 MEMS & Micro Systems Design and Manufacture, Tai Run Hsu, McGraw Hill Education, 1st edition, 2017.
- 4 Introduction to Manufacturing Processes, John A Schey, McGraw-Hill Education, 3rd edition, 1999.

**Weblinks:**

- 1 <https://archive.nptel.ac.in/courses/112/107/112107077/> .
- 2 <https://archive.nptel.ac.in/courses/112/103/112103306/>
- 3 <https://archive.nptel.ac.in/courses/112/105/112105053/>
- 4 <https://home.iitk.ac.in/~mohite/ae681.html>
- 5 <https://archive.nptel.ac.in/courses/113/104/113104102/>
- 6 <https://archive.nptel.ac.in/courses/103/106/103106075/>

## TOTAL QUALITY MANAGEMENT

### (Open Elective-IV)

**Semester: VII**

**L      T      P      C**

**Course Code: 231ME7O08**

**3      0      0      3**

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Explain the quality management philosophies and frameworks.

**CO2:** Explain quality costs and leadership.

**CO3:** Explain the concepts of customer focus, continuous quality improvement and supplier partnership

**CO4:** Apply various TQM tools to improve management processes

**CO5:** Calculate process capability index in TQM process

### Mapping of Course Outcomes with Program Outcomes:

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 3    | 1    | 3    | 3    | 2    | 2    | 3    | 2    | 3     | 1     | 1     |
| <b>CO2:</b> | 3    | 2    | 3    | 2    | 2    | 1    | 2    | 1    | 3    | 2     | 2     | 2     |
| <b>CO3:</b> | 3    | 3    | 2    | 1    | 3    | 2    | 3    | 1    | 1    | 1     | 2     | 2     |
| <b>CO4:</b> | 3    | 2    | 2    | 2    | 1    | 3    | 2    | 2    | 2    | 1     | 3     | 3     |
| <b>CO5:</b> | 3    | 1    | 2    | 1    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | -    |
| <b>CO2:</b> | -    | -    |
| <b>CO3:</b> | -    | -    |
| <b>CO4:</b> | -    | -    |
| <b>CO5:</b> | -    | -    |

### Unit - I

Introduction: Definition of Quality, Factors effecting quality, Quality management, Quality Dimensions, four phases of quality, Total Quality, Salient features of Total Quality Management (TQM)-definition of TQM, Elements of TQM, Principles of TQM, Pillars of TQM, Traditional Approach and TQM Approach. Characteristics of TQM: TQM Enablers, Approaches, relevance, Barriers to TQM Implementation

### Unit -II

Quality costs: Cost classification, Basic cost of quality. Applications and Importance of quality cost. Quality leadership: Quality of leadership, Quality of successful leader, leadership for TQM, Deming Philosophy, Contributions of Gurus of TQM

### Unit - III

Customer Focus: Customer Complaints and suggestions, panels, Customer satisfaction, Customer

Perception of Quality, Customer driven quality circles, Customer focus and activities, needs and expectations, Organizations action from the customer point of view.

Continuous Quality Improvement - Juran Trilogy, PDCA Cycle, Kaizen- kaizen suggestion's, program introduction at workplace, principles of kaizen. Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development

#### **Unit - IV**

TQM Tools: Bench marking - Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) - House of Quality, QFD Process, Benefits. Taguchi Quality Loss Function.

Total Productive Maintenance (TPM) - Concept, Improvement Needs, FMEA -Stages of FMEA, the seven tools of quality, Process Capability- Concept, Methods of calculating process capability, Process capability index, Concept of six sigma.

#### **Unit – V**

Need for ISO9000-ISO9001-2008 Quality System- Elements, documentation Quality Auditing– QS9000-ISO14000-Concepts, Requirements and Benefits–TQM, Implementation in manufacturing and service sectors.

#### **Text Books:**

- 1 Total Quality Management, Dale HB ester field, Pearson,4th Edition 2015
- 2 Total Quality Management,K.C.Arora,S.K.Kataria&sons,NewDelhi,2016
- 3 Total Quality Management, Subburaj Ramaswamy, TataMcgraw HillPublishing Company Ltd., 2005

#### **Reference Books:**

- 1 Management Quality-Concepts and Tasks, Narayana V and Sreenivasan N.S.,New age publishers;1st edition(1January2005).
- 2 Statistical Quality Control, SeventhEdition, RichardS.Leavenworth & Eugene LodewickGrant,7th Edition,TataMcgrawHill,2015
- 3 Total QualityManagement, Subburaj Ramasamy, TataMcGrawHill Publishing CompanyLtd., NewDelhi, 2005.

#### **Web links:**

- 1 <https://nptel.ac.in/courses/110/105/110105039/>
- 2 <https://nptel.ac.in/courses/110/104/110104085/>
- 3 <https://nptel.ac.in/courses/110/104/110104080/#>

## OPERATIONS MANAGEMENT

(Open Elective-IV)

VII Semester

**L    T    P    C**

**Course Code: 231ME7009**

**3    0    0    3**

**Course Outcomes: At the end of the course, student will be able to**

**CO1** Formulate and solve real industrial problems using Graphical and Simplex methods

**CO2** Interpret Transportation and sequencing problems

**CO3** Solve replacement problems and analyze queuing models

**CO4** Solve game theory and deterministic inventory problems

**CO5** Interpret Statistics knowledge to design problems

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|--------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1    | 2    | 1    | 1    | -    | -    | 2    | -    | -    | -    | -     | 1     | 1     |
| CO2    | 1    | 1    | 1    | -    | -    | 1    | -    | -    | -    | -     | 1     | 1     |
| CO3    | 3    | 2    | 1    | -    | -    | 1    | -    | -    | -    | -     | 1     | 1     |
| CO4    | 2    | 1    | 1    | -    | -    | 2    | -    | -    | -    | -     | 1     | 1     |
| CO5    | 2    | 1    | 1    | -    | -    | 2    | -    | -    | -    | -     | 1     | 1     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO 2 |
|--------|------|-------|
| CO1    |      | 2     |
| CO2    |      | 2     |
| CO3    |      | 2     |
| CO4    |      | 2     |
| CO5    |      | 2     |

### UNIT – 1

**INTRODUCTION** - definition– characteristics and phases – types of operation research models – applications.

Linear programming: Problem formulation – graphical solution – simplex method – artificial variables techniques -two–phase method, big-M method – duality principle.

### UNIT – 2



**TRANSPORTATION PROBLEM:** Formulation – optimal solution, unbalanced transportation problem – degeneracy, assignment problem – formulation – optimal solution - variants of assignment problem- travelling salesman problem.

**SEQUENCING** – Introduction – flow –shop sequencing –  $n$  jobs through two machines –  $n$  jobs through three machines – job shop sequencing – two jobs through ‘m’ machines.

### UNIT – 3

**REPLACEMENT THEORY:** Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.

**GAME THEORY:** Introduction – mini. max (max. mini) – criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points –  $2 \times 2$  games – dominance principle –  $m \times 2$  &  $2 \times n$  games -graphical method.

### UNIT – 4

**WAITING LINES:** Introduction – single channel – poisson arrivals – exponential service times – with infinite population and finite population models– multichannel – poisson arrivals – exponential service times with infinite population single channel.

**PROJECT MANAGEMENT:** Basics for construction of network diagram, Program Evaluation and Review Technique (PERT), Critical Path Method (CPM) – PERT Vs. CPM, determination of floats- Project crashing and its procedure.

### UNIT – 5

**RELIABILITY:** Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, hazard analysis

#### Text Books:

1. Operations Research-An Introduction/Hamdy A Taha/Pearson publishers
2. Operations Research –Theory & publications / S.D.Sharma Kedarnath/McMillan publishers India Ltd

#### References:

1. Introduction to O.R/Hiller & Libermann/TMH
2. Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.
3. Operations Research: Methods & Problems / Maurice Saseini, ArthurYaspan& Lawrence Friedman/Wiley
4. Operations Research / R.Pannerselvam/ PHI Publications.
5. Operations Research / Wagner/ PHI Publications.

#### Web Links:

1. <https://nptel.ac.in/courses/110/106/110106062/>
2. <https://ocw.mit.edu/courses/sloan-school-of-management/15-760a-operations-management-summer-2002/>

**(Open Elective-IV)****Semester: VII****L T P C****Course Code: 231ME7O10****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Understand the classification of Energy and importance of Energy Conservation.**CO2:** Illustrate energy auditing methodologies**CO3:** Understand Material and Energy balance and carry out Material and energy balance**CO4:** Determine Energy Performance assessment of equipment**CO5:** Perform financial analysis for determining simple payback period**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 2    | 1    | 1    | 3    | 2    | 3    | 2    | 2    | 3     | 1     | 1     |
| <b>CO2:</b> | 3    | 2    | 2    | 2    | 2    | 2    | 2    | 3    | 3    | 2     | 3     | 3     |
| <b>CO3:</b> | 3    | 3    | 2    | 3    | 2    | 3    | 1    | 2    | 2    | 2     | 2     | 2     |
| <b>CO4:</b> | 3    | 2    | 3    | 2    | 1    | 1    | 2    | 2    | 1    | 1     | 1     | 1     |
| <b>CO5:</b> | 3    | 2    | 1    | 2    | 1    | 2    | 1    | 1    | 2    | 1     | 2     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | -    |
| <b>CO2:</b> | -    | -    |
| <b>CO3:</b> | -    | -    |
| <b>CO4:</b> | -    | -    |
| <b>CO5:</b> | -    | -    |

**Unit - I**

INTRODUCTION: Classification of Energy – Primary and Secondary Energy, Commercial Energy and Noncommercial Energy and Renewable & Non-renewable energy; Various forms of Energy – potential (stored energy) and kinetic(working) energy; Basics of Electrical energy and thermal energy; Energy and Environment; Energy Conservation and its importance.

**Unit -II**

ENERGY MANAGEMENT: Definition and objectives of Energy Management, Energy Audit – types and methodology; need for energy audit; energy auditing methodology; Benchmarking energy performance; Maximizing system efficiency; Energy Audit Instruments.

**Unit - III**

MATERIAL AND ENERGY BALANCE: Basic principles of material and energy balance; Sankey diagram and its use; Material balances; Energy balances; Carrying out material and energy balance.

**Unit - IV**

ENERGY PERFORMANCE ASSESSMENT: Purpose and parameters of performance of (a) boilers, (b) furnaces, (c) turbines, (d) fans and blowers, (e) pumps, (f) compressors and (g) lighting. Detailed performance analysis of boilers and pumps.

**Unit – V**

PERFORMING FINANCIAL ANALYSIS: Introduction, fixed and variable costs, Interest charges, simple pay-back period, discounted cash flow methods- Net Present Value method and Internal rate of return method; Factors affecting analysis

**Text Books:**

- 1 General Aspects of Energy Management & Energy Audit,, National Certificate Examination for Energy Managers and Energy Auditors, National Productivity Council of India
- 2 Energy Performance Assessment for Equipment and Utility systems, National Certificate Examination for Energy Managers and Energy Auditors, National Productivity Council of India

**Reference Books:**

- 1 Murphy, W.R. , Mckay, G. (1982) 'Energy Management ', London: Butterworth-Heinemann
- 2 K. Smith, C.B. (Ed. 4) (1981). 'Energy Management Principles : applications, benefits, savings', Amsterdam : Pergamon Press
- 3 Witte, L. C. (1988), ' Industrial energy management and utilization ', Washington: Hemisphere Pub. Corp

**Web links:**

- 1 <https://sustainabilityeducationacademy.com/free-online-energy-audit-course/>
- 2 <https://coursevania.com/courses/introduction-to-energy-auditing/>
- 3 <https://www.cdgtraining.com/courses/Certified-Energy-Auditor-CEA-Course-66f78d2e6560e62a1e6ef941>

## FUNDAMENTALS OF IMAGE PROCESSING

### (Open Elective-IV)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EC7004</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Infer the fundamental components of digital image processing.
- CO2** Illustrate image enhancement techniques.
- CO3** Compare image restoration techniques.
- CO4** Infer the color image processing methods.
- CO5** Make use of morphological operators for image processing.
- CO6** Interpret image segmentation techniques.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO6   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |
| CO6    | -     | -     |

### Unit - I

**Introduction:** Introduction to Image Processing, Fundamental steps in digital image processing, components of an image processing system, image sensing and acquisition, image sampling and quantization, some basic relationships between pixels, an introduction to the mathematical tools used in digital image processing.

**Unit – II**

**Image Enhancement and Restoration:** Background, Some basic intensity transformation functions, histogram processing, fundamentals of spatial filtering, smoothing spatial filters, sharpening spatial filters, combining spatial enhancement methods, A model of the image degradation/restoration process, Noise models, Inverse filtering, Minimum mean square error (Wiener) filtering.

**Unit – III**

**Color image processing:** color fundamentals, color models, pseudo color image processing, basics of full color image processing, color transformations, smoothing and sharpening, noise in color images.

**Unit – IV**

**Morphological Image Processing:** Preliminaries, Erosion and dilation, opening and closing, basic morphological algorithms for boundary extraction, thinning, gray-scale morphology, Segmentation using morphological watersheds

**Unit – V**

**Image segmentation:** Fundamentals, point, line, edge detection, thresholding, and region – based segmentation, Image segmentation based on color.

**Text Books:**

1. R. C. Gonzalez and R. E. Woods, Digital Image Processing, 3rd edition, Prentice Hall, 2008.
2. Anil K.Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India, 9th Edition, Indian Reprint, 2002.

**Reference Books:**

1. Jayaraman, S. Esakkirajan, and T. Veerakumar,” Digital Image Processing”, Tata McGraw-Hill Education, 2011
2. B.Chanda, D.Dutta Majumder, “Digital Image Processing and Analysis”, PHI, 2009.

**Web Links:**

1. <http://www.imageprocessingplace.com/>.
2. [http://nptel.ac.in/courses/117105079/\(Prof.P.K.Biswas,IIT, Kharagpur\)](http://nptel.ac.in/courses/117105079/(Prof.P.K.Biswas,IIT, Kharagpur))
3. <https://sisu.ut.cc/imageprocessing/avaleht>
4. <https://www.coursera.org/learn/digital#ratings> (Fundamentals of digital image and video processing, Aggelos K. Katsaggelos, University of North western )
5. <https://www.coursera.org/courses?languages=en&query=image+processing>

## SENSORS AND ACTUATORS (Open Elective-IV)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EC7006</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Classify various sensors/transducers based on their applications.
- CO2** Categorize various types of Resistive, Inductive and Capacitive Sensors.
- CO3** Analyze various approaches, procedures and results related to Thermal sensors.
- CO4** Analyze various approaches, procedures and results related to Magnetic sensors.
- CO5** Examine the radiation sensors based on their characteristics.
- CO6** Apply Smart Sensors in the field of Communication, Automation and Manufacturing

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 1    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 2    | 3    | 2    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 2    | 3    | 2    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 2    | 3    | 2    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 2    | 3    | 2    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO6   | 2    | 2    | 3    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |
| CO6    | -     | -     |

### Unit - I

Sensors / Transducers:

Principles – Classification – Parameters – Characteristics – Environmental Parameters (EP) – Characterization.

Mechanical and Electromechanical Sensors: Introduction – Resistive Potentiometer – Strain Gauge – Resistance Strain Gauge – Semiconductor Strain Gauges -Inductive Sensors: Sensitivity and Linearity of the Sensor –Types-Capacitive Sensors:– Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors.

**Unit – II**

Thermal Sensors:

Introduction – Gas thermometric Sensors – Thermal Expansion Type Thermometric Sensors – Acoustic Temperature Sensor – Dielectric Constant and Refractive Index thermo sensors – Helium Low Temperature Thermometer – Nuclear Thermometer – Magnetic Thermometer – Resistance Change Type Thermometric Sensors –Thermo emf Sensors– Junction Semiconductor Types– Thermal Radiation Sensors –Quartz Crystal Thermoelectric Sensors – NQR Thermometry – Spectroscopic Thermometry – Noise Thermometry – Heat Flux Sensors.

Magnetic sensors: Introduction – Sensors and the Principles Behind – Magneto-resistive Sensors – Anisotropic Magneto resistive Sensing – Semiconductor Magneto resistors– Hall Effect and Sensors – Inductance and Eddy Current Sensors– Angular/Rotary Movement Transducers – Synchros – Synchro- resolvers - Eddy Current Sensors – Electromagnetic Flow meter – Switching Magnetic Sensors SQUID Sensor

**Unit-III**

Radiation Sensors:

Introduction – Basic Characteristics – Types of Photo sensistors /Photo detectors– X-ray and Nuclear Radiation Sensors– Fiber Optic Sensors.

Electro analytical Sensors: Introduction – The Electrochemical Cell – The Cell Potential – Standard Hydrogen Electrode (SHE) – Liquid Junction and Other Potentials – Polarization – Concentration Polarization– Reference Electrodes - Sensor Electrodes – Electro ceramics in Gas Media. Radiation Sensors –Quartz Crystal Thermoelectric Sensors – NQR Thermometry – Spectroscopic Thermometry – Noise Thermometry – Heat Flux Sensors.

**Unit – IV**

Smart Sensors:

Introduction – Primary Sensors – Excitation – Amplification – Filters – Converters – Compensation– Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface – The Automation

Sensors-Applications: Introduction – On-board Automobile Sensors (Automotive Sensors)– Home Appliance Sensors – Aerospace Sensors — Sensors for Manufacturing –Sensors for environmental Monitoring.

**Unit – V**

Actuators:

Pneumatic and Hydraulic Actuation Systems- Actuation systems – Pneumatic and hydraulic systems - Directional Control valves – Presure control valves – Cylinders - Servo and proportional control valves – Process control valves – Rotary actuators

Mechanical Actuation Systems- Types of motion – Kinematic chains – Cams – Gears – Ratchet and pawl – Belt and chain drives – Bearings – Mechanical aspects of motor selection

Electrical Actuation Systems- Electrical systems -Mechanical switches – Solid-state switches Solenoids – D.C. Motors – A.C. motors – Stepper motors

**Text Books:**

1. D. Patranabis – “Sensors and Transducers” –PHI Learning Private Limited.
2. W. Bolton – “Mechatronics” –Pearson Education Limited.

**Reference Books:**

1. Sensors and Actuators – D. Patranabis – 2nd Ed., PHI, 2013.
2. Hardware Software Co-Design Principles and Practice, J. Staunstrup, Springer Publications
3. Embedded Systems Architecture, Tammy Noergaard, Elsevier Publications, 2013.

**Web Links:**

1. <https://www.iitk.ac.in/tkic/workshop/sensors-and-actuators/ppt/sandeep.pdf>
2. <https://www.hella.com/techworld/ae/Technical/Sensors-and-actuators-204/>
3. <https://www.leanix.net/en/blog/iot-devices-sensors-and-actuators-explained>

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## INTRODUCTION TO MACHINE LEARNING

### (Open Elective-IV)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CS7O02</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Explain the fundamental usage of the concept Machine Learning system with an emphasis on statistical learning
- CO2:** Demonstrate various regression techniques and linear models for binary classification
- CO3:** Analyze the role of Ensemble Learning Methods and Support Vector Machines in Machine Learning
- CO4:** Illustrate the Clustering Techniques and Dimensionality Reduction Models in Machine Learning
- CO5:** Discuss the Neural Network Models and Fundamentals concepts of Deep Learning

#### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 1    | -    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 2    | 2    | 1    | -    | 3    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 1    | 2    | 1    | 3    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 1    | 3    | 1    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 2    | 1    | 1    | -    | 3    | -    | -    | -    | -    | -     | -     | -     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

#### Unit - I

Introduction- Artificial Intelligence, Machine Learning, Deep learning, Types of Machine Learning Systems, Main Challenges of Machine Learning. Statistical Learning: Introduction, Supervised and Unsupervised Learning, Training and Test Loss, Tradeoffs in Statistical Learning, Estimating Risk Statistics, Sampling distribution of an estimator, Empirical Risk Minimization.

**Unit – II**

Supervised Learning(Regression/Classification):Basic Methods: Distance based Methods, Nearest Neighbours, Decision Trees, Naive Bayes, Linear Models: Linear Regression, Logistic Regression, Generalized Linear Models, Support Vector Machines, Binary Classification: Multiclass/Structured outputs, MNIST, Ranking.

**Unit – III**

Ensemble Learning and Random Forests: Introduction, Voting Classifiers, Bagging and Pasting, Random Forests, Boosting, Stacking.Support Vector Machine: Linear SVM Classification, Nonlinear SVM ClassificationSVM Regression, Naïve Bayes Classifiers.

**Unit – IV**

Unsupervised Learning Techniques: Clustering, K-Means, Limits of K-Means, Using Clustering for Image Segmentation, Using Clustering for Preprocessing, Using Clustering for Semi-Supervised Learning, DBSCAN, Gaussian Mixtures. Dimensionality Reduction: The Curse of Dimensionality, Main Approaches for Dimensionality Reduction, PCA, Using Scikit-Learn, Randomized PCA, Kernel PCA.

**Unit – V**

Neural Networks and Deep Learning: Introduction to Artificial Neural Networks with Keras, Implementing MLPs with Keras, Installing TensorFlow 2, Loading and Preprocessing Data with TensorFlow.

**Text Books:**

1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Publications, 2019
2. Data Science and Machine Learning Mathematical and Statistical Methods,Dirk P. Kroese, Zdravko I. Botev, Thomas Taimre, Radislav Vaisman,25th November 2020

**Reference Books:**

1. Machine Learning Probabilistic Approach, Kevin P. Murphy, MIT Press, 2012.
2. Stephen Marsland, “Machine Learning -An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
3. Andreas C. Müller and Sarah Guido “Introduction to Machine Learning with Python: A Guide for Data Scientists”, Oreilly

**Web Links:**

1. <https://www.deeplearning.ai/machine-learningyearning/>
2. <https://www.cse.huji.ac.il/~shais/UnderstandingMachineLearning/index.html>
3. [https://onlinecourses.nptel.ac.in/noc21\\_cs24/preview](https://onlinecourses.nptel.ac.in/noc21_cs24/preview)
4. <https://www.udemy.com/course/machinelearning/>

## CLOUD COMPUTING

### (Open Elective-IV)

**VII Semester**

**L      T      P      C**

**Course Code: 231IT7002**

**3      0      0      3**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Explain cloud computing concepts, service models (IaaS, PaaS, SaaS), and deployment models (public, private, hybrid).
- CO2:** Analyze cloud-enabling technologies including distributed computing, virtualization, and SOA.
- CO3:** Evaluate virtualization technologies and container platforms such as Docker and Kubernetes.
- CO4:** Assess the major challenges in cloud computing, including security, interoperability, and fault tolerance.
- CO5:** Describe advanced cloud topics like serverless computing, IoT integration, and DevOps practices.

#### Mapping of Course Outcomes with Program Outcomes:

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1     | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2     | 2   | 3   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO3     | 2   | 2   | 3   | 2   | 2   | -   | -   | -   | -   | -    | -    | -    |
| CO4     | 2   | 3   | -   | 3   | 2   | 1   | 1   | -   | -   | -    | -    | -    |
| CO5     | 3   | 2   | 2   | 2   | 2   | -   | -   | -   | -   | 1    | 1    | 1    |

#### Mapping of Course Outcomes with Program Specific Outcomes:

| CO \ PSO | PSO1 | PSO2 |
|----------|------|------|
| CO1      | -    | -    |
| CO2      | -    | -    |
| CO3      | -    | -    |
| CO4      | -    | -    |
| CO5      | -    | -    |

**UNIT – I****Introduction to Cloud Computing Fundamentals**

Cloud computing at a glance, defining a cloud, cloud computing reference model, types of services (IaaS, PaaS, SaaS), cloud deployment models (public, private, hybrid), utility computing, cloud computing characteristics and benefits, cloud service providers (Amazon Web Services, Microsoft Azure, Google App Engine).

**UNIT – II****Cloud Enabling Technologies**

Ubiquitous Internet, parallel and distributed computing, elements of parallel computing, hardware architectures for parallel computing (SISD, SIMD, MISD, MIMD), elements of distributed computing, Inter-process communication, technologies for distributed computing, remote procedure calls (RPC), service-oriented architecture (SOA), Web services, virtualization.

**UNIT – III****Virtualization and Containers**

Characteristics of virtualized environments, taxonomy of virtualization techniques, virtualization and cloud Computing, pros and cons of virtualization, technology examples (XEN, VMware), building blocks of containers, container platforms (LXC, Docker), container orchestration, Docker Swarm and Kubernetes, public cloud VM (e.g. Amazon EC2) and container (e.g. Amazon Elastic Container Service) offerings.

**UNIT-IV****Cloud computing challenges**

Economics of the cloud, cloud interoperability and standards, scalability and fault tolerance, energy efficiency in clouds, federated clouds, cloud computing security, fundamentals of computer security, cloud security architecture, cloud shared responsibility model, security in cloud deployment models.

**UNIT –V****Advanced concepts in cloud computing**

Serverless computing, Function-as-a-Service, serverless computing architecture, public cloud (e.g. AWS Lambda) and open-source (e.g. OpenFaaS) serverless platforms, Internet of Things (IoT), applications, cloud-centric IoT and layers, edge and fog computing, DevOps, infrastructure-as-code, quantum cloud computing.

**Text Books:**

1. Mastering Cloud Computing, 2<sup>nd</sup> edition, Rajkumar Buyya, Christian Vecchiola, Thamarai Selvi, Shivananda Poojara, Satish N. Srirama, Mc Graw Hill, 2024.
2. Distributed and Cloud Computing, Kai Hwang, Geoffery C. Fox, Jack J. Dongarra, Elsevier, 2012.

**Reference Books:**

1. Cloud Computing, Theory and Practice, Dan C Marinescu, 2<sup>nd</sup> edition, MK Elsevier, 2018.
2. Essentials of cloud Computing, K. Chandrasekhran, CRC press, 2014.
3. Online documentation and tutorials from cloud service providers (e.g., AWS, Azure, GCP)

**Weblinks:**

1. <https://docs.aws.amazon.com>
2. <https://learn.microsoft.com/en-us/azure/>
3. <https://cloud.google.com/docs>
4. <https://nptel.ac.in/courses/106106129>
5. <https://nptel.ac.in/courses/106105167>

**DRILLING & BLASTING****(Open Elective-IV)****VII Semester****L T P C****Course Code: 231MI7O02****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Differentiate between explosives.**CO2:** Use blasting accessories along with monitoring and assessment.**CO3:** Analyse problems associated with open cast blasting and mitigation**CO4:** Analyse problems associated with underground blasting and mitigation.**CO5:** Assess blasting in metal mines**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 1    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 1    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 1    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

**Unit - I**

Drilling:

Drillability, mechanics of drilling, major types of drilling machines, Principles of drilling, Types of drill, Drillrods and drill bits -Types and applications, Exploratory and Production Drilling.

**Unit – II**

Explosives and Blasting Accessories:

Mechanism of blasting, Explosives- types and properties. Selection of explosives, Handling and storage of explosives. Types of initiating systems – Electrical Detonators, Detonating Fuse, Detonating Relays, NONEL, Electronic Detonators, Blasting accessories, exploders. Blast Design in Surface and Underground Mines.

**Unit – III**

Drilling and Blasting in Surface Mines:

Factors affecting blasting, Blast design - estimation of burden and spacing, estimation of charge requirement; Initiation patterns; secondary blasting – pop and plaster shooting; Problems associated with blasting, Ground vibration and air over pressure

**Unit – IV**

Drilling and Blasting in Underground Coal Mines:

Blast hole patterns and their applicability, blasting-off-solid, ring hole blasting, calculation of specific charge, specific drilling and detonator factor, initiation patterns.

**Unit – V**

Drilling and Blasting in Underground Metal mines:

Blast hole patterns and their applicability, blast design for horizontal drivage, long hole blasting, vertical crater retreat blasting.

**Text Books:**

1. B. Misra, U.M. Rao Karanam, Principle of rock drilling Taylor & Francis, CRC Press, 1998, ISBN-905410788X.
2. "Drilling & Blasting" Minetech by Pradhan G.K., Ghose A.K., Bhubaneswar, India : MINTECH Publications, c1996 200 pages :

**Reference Books:**

1. Elements of Mining Technology by DJ Deshmukh, Vol. 1, Denett, 2016, First Edition
2. Surface mining, by GB Mishra, Vol.1, Dhanbad Publisher, 1979

**Web Links:**

1. [https://en.wikipedia.org/wiki/Drilling\\_and\\_blastig](https://en.wikipedia.org/wiki/Drilling_and_blastig)
2. <https://www.rpmdrilling.co.za/blast-hole-drilling-process/>
3. [www.railsystem.net/drill-and-blast-method/](http://www.railsystem.net/drill-and-blast-method/)

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## AGRICULTURAL STRUCTURES AND PROTECTED CULTIVATION

### (Open Elective-IV)

|                        |          |          |          |          |
|------------------------|----------|----------|----------|----------|
| VII Semester           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| Course Code: 231AG7O02 | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Classify the poultry houses, dairy barn planning and requirements.

**CO2:** Differentiate the different grain storage structures.

**CO3:** Classify polyhouses based on construction materials.

**CO4:** Apply different irrigation techniques in green house.

**CO5:** Plan fertilizer scheduling, rate of application of fertilizers and methods of application.

#### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | -    | -    | 1    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 1    | 2    | 1    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 1    | -    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| <b>CO4</b> | 2    | -    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | -    | -    | -    | 2    | -    | -    | 1    | -    | -    | -     | -     | -     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | 1     | 2     |
| CO2    | -     | 2     |
| CO3    | 2     | -     |
| CO4    | 3     | -     |
| CO5    | 3     | -     |

#### Unit - I

Planning and layout of farmstead. Scope, importance and need for environmental control, physiological reaction of livestock environmental factors, environmental control systems and their design, control of temperature, humidity and other air constituents by ventilation and other methods.



**Unit – II**

Livestock production facilities, BIS Standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc

**Unit – III**

Storage of grains and Causes of spoilage. Water activity for low and high moisture food grains and its limits for storage, Moisture and temperature changes in grain bins; Traditional storage structures and their improvements, Improved storage structures (CAP, hermetic storage, Pusa bin, RCC ring bins). Design consideration for grain storage godowns, Bag storage structures, Shallow and Deep bin, Calculation of pressure in bins and Storage of seeds

**Unit – IV**

Protected cultivation: Introduction, History, origin, development, national and International Scenario, components of green house, perspective, Types of green houses, polyhouses /shed nets, Cladding materials, Plant environment interactions – principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment. Design and construction of greenhouses – site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment, Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators, evaporative cooling, different shading material fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care etc.

**Unit – V**

Planting techniques in green house cultivation. Irrigation in greenhouse and net house – Water quality, types of irrigation system, components, design, installation and material requirement. Fogging system for greenhouses and net houses – introduction, benefits, design, installation and material requirement. Fertilization – nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application. Greenhouse climate measurement, control and management.

**Text Books:**

1. Pandey, P.H. Principles and practices of Agricultural Structures and Environmental Control, Kalyani Publishers, Ludhiana.
2. Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag, New Delhi.

**Reference Books:**

1. Venugopal Rao, P. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi.
2. Sahay, K.M. and Singh, K.K. Unit Operations of Agricultural Processing, Vikaspublishing pvt. Ltd, Noida.
3. Singh Brahma and Balraj Singh. 2014. Advances in protected cultivation, New India Publishing Company.
4. Sharma P. 2007. Precision Farming. Daya Publishing House New Delhi.

**Web Links:**

1. <https://nptel.ac.in/courses/104103020/3>
2. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=618>
3. <https://agrimoon.com/agricultural-structures-and-environmental-control-pdfbook>

**Software Engineering**  
**(Open Elective-IV)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231AM7O02</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1:** Explain the evolution of software development and analyse life cycle models like Waterfall, RAD, Agile, and Spiral
- CO2:** Apply estimation techniques and risk management for effective project management and develop SRS
- CO3:** Design software using good design principles, structured analysis, and user interface methodologies
- CO4:** Conduct blackbox, whitebox, and integration testing to ensure software reliability and quality
- CO5:** Use CASE tools for software maintenance, reverse engineering, cost estimation, and reuse strategies

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | -    | -    | -    | 1    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | 1    | 3    | 2    | -    | -    | -    | -    | -    | -     | -     | 2     |
| <b>CO3</b> | 2    | 2    | 3    | -    | 3    | -    | -    | 2    | -    | -     | -     | -     |
| <b>CO4</b> | 2    | 2    | -    | 3    | 2    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | 2    | -    | -    | 3    | -    | -    | 1    | 1    | -     | -     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    |      |
| <b>CO2</b> | -    |      |
| <b>CO3</b> | -    |      |
| <b>CO4</b> | -    |      |
| <b>CO5</b> | -    |      |

**UNIT-I**

**Introduction:** Evolution, Software development projects, Exploratory style of software developments, Emergence of software engineering, Notable changes in software development practices, Computer system engineering.

**Software Life Cycle Models:** Basic concepts, Waterfall model and its extensions, Rapid application development, Agile development model, Spiral model.

## UNIT-II

**Software Project Management:** Software project management complexities, Responsibilities of a software project manager, Metrics for project size estimation, Project estimation techniques, Empirical Estimation techniques, COCOMO, Halstead's software science, risk management.

**Requirements Analysis and Specification:** Requirements gathering and analysis, Software Requirements Specification (SRS), Formal system specification, Axiomatic specification, Algebraic specification, Executable specification and 4GL.

## UNIT-III

**Software Design:** Overview of the design process, How to characterize a good software design? Layered arrangement of modules, Cohesion and Coupling. approaches to software design.

**Agility:** Agility and the Cost of Change, Agile Process, Extreme Programming (XP), Other Agile Process Models, Tool Set for the Agile Process (Text Book 2)

**Function-Oriented Software Design:** Overview of SA/SD methodology, Structured analysis, Developing the DFD model of a system, Structured design, Detailed design, and Design Review.

**User Interface Design:** Characteristics of a good user interface, Basic concepts, Types of user interfaces, Fundamentals of component-based GUI development, and user interface design methodology.

## UNIT-IV

**Coding And Testing:** Coding, Code review, Software documentation, Testing, Black-box testing, White-Box testing, Debugging, Program analysis tools, Integration testing, testing object-oriented programs, Smoke testing, and some general issues associated with testing. Software Reliability and Quality Management: Software reliability. Statistical testing, Software quality, Software quality management system, ISO9000. SEI Capability maturity model. Few other important quality standards, and Six Sigma.

## UNIT – V

**Computer-Aided Software Engineering (Case):** CASE and its scope, CASE environment, CASE support in the software life cycle, other characteristics of CASE tools, Towards second generation CASE Tool, and Architecture of a CASE Environment.

**Software Maintenance:** Characteristics of software maintenance, Software reverse engineering, Software maintenance process models and Estimation of maintenance cost.

**Software Reuse:** Reuse-definition, Introduction, Reason behind no reuses of ar, Basic issues in any reuse program, A reuse approach, and Reuse at organization level.

### Text Books:

- 1 Fundamentals of Software Engineering, Rajib Mall, 5<sup>th</sup> Edition, PHI.
- 2 Software Engineering A Practitioner's Approach, Roger S. Pressman, 9<sup>th</sup> Edition, McGraw Hill International Edition.

**Reference Books:**

- 1 Software Engineering, Ian Sommerville, 10th Edition, Pearson
- 2 Software Engineering, Principles and Practices, Deepak Jain, Oxford University Press.

**Web Links:**

- 1 <https://nptel.ac.in/courses/106105087>
- 2 <https://nptel.ac.in/courses/106101061>
- 3 <https://www.coursera.org/specializations/software-design-architecture>

**DATA VISUALIZATION****(Open Elective-IV)****VII Semester****L T P C****Course Code: 231DS7O02****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Identify and recognize visual perception and representation of data.**CO2:** Illustrate about projections of different views of objects.**CO3:** Apply various Interaction and visualization techniques.**CO4:** Analyze various groups for visualization.**CO5:** Apply visualizations for volumetric data to present them graphically.**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 1   | 2   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 1   | 2   | -   | 3   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO3   | 1   | 2   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 1   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 1   | 2   | 2   | 3   | -   | -   | -   | -   | -   | -    | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 2    | -    |
| CO2    | 2    | -    |
| CO3    | 1    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

**Unit– I**

Introduction To Data Visualizations And Perception: Introduction of visual perception, visual representation of data, Gestalt principles, Information over load.

**Unit– II**

Visual Representations: Creating visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications.

**Unit–III**

Classification Of Visualization Systems: Classification of visualization systems, Interaction and visualization techniques mis leading, Visualization of one, two and multi-dimensional data, text and text documents.

**Unit– IV**

Visualization Of Groups: Visualization of groups, trees, graphs, clusters, networks, software, Meta phorical visualization. Various visualization techniques, data structures used in data visualization.

**Unit– V**

Visualization Of Volumetric Data And Evaluation Of Visualizations: Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geo graphic information, GIS systems, collaborative visualizations, evaluating visualizations

**Text Books:**

1. Ward, Grinstein, Keim, Interactive Data Visualization: Foundations, Techniques, and Applications. Natick, 2<sup>nd</sup> edition, AK Peters, Ltd 2015.

**Reference Books:**

1. Tamara Munzner, Visualization Analysis & Design, 1<sup>st</sup> edition, AK Peters Visualization Series 2014
2. Scott Murray, Interactive Data Visualization for the Web, 2<sup>nd</sup> Edition, 2017

**Web Links:**

1. [https://onlinecourses.nptel.ac.in/noc22\\_mg67/preview](https://onlinecourses.nptel.ac.in/noc22_mg67/preview)
2. [https://onlinecourses.nptel.ac.in/noc22\\_mg67/preview](https://onlinecourses.nptel.ac.in/noc22_mg67/preview)
3. <https://www.coursera.org/learn/datavisualization>
4. <https://www.udemy.com/course/data-visualization-foundations/>
5. <https://www.udemy.com/course/masteringd3js/>

## DEEPWATER TECHNOLOGY (OPEN ELECTIVE-IV)

**VII Semester****L T P C****Course Code: 231PT7O04****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Analysis of waves and fluid-induced forces on offshore structures, Current and wind forces.
- CO 2:** Understand the Deepwater exploration and Deepwater drilling techniques.
- CO 3:** Apply the concepts of fixed platforms, compliant towers, subsea systems, extended reach wells and floating production systems.
- CO 4:** Extend innovative subsea completion, installation and associated problem.
- CO 5:** Demonstrate deep-water pipelines, flow assurance strategies and subsea innovations.

**Mapping of Course Outcomes with Program Outcomes**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | 3     | -     |
| CO2      | 3     | -     |
| CO3      | 3     | -     |
| CO4      | 3     | -     |
| CO5      | 3     | -     |

**UNIT-I:**

**Introduction:** Definition, Global Deep-water reserves & development activity. Technological advances. Dynamics of Offshore structure: Analysis of waves and fluid induced forces on offshore structures, Current and wind forces, Soil mechanics of seabed & structures.



**UNIT-II:**

**Deep-water Exploration & Drilling:** Seismic /Seabed survey, constraints in deepwater survey like geo-hazards, gas hydrate etc., Deep water drilling with emphasis on the additional inputs to normal offshore Drilling operation.

**UNIT –III:**

**Deep-water Production System:** Fixed Platforms, Compliant Towers, Subsea systems, Extended Reach Wells, Floating production systems like FPSO, FPSS, TLPS, Spar platform and FSO.

**UNIT-IV:**

**Deep-water applications of Subsea Technology:** Subsea completion, X-mas tree, Control systems, Manifolds, Templates, ROV, Deepwater installation vessels with DP system and associated problems – Offshore mobile units, station- keeping methods like mooring and dynamic positioning system.

**UNIT-V:****Deep-water pipelines, Umbilical's & emerging Deep-water Technologies:**

Issues in Deep-water pipeline design, Rigid and Flexible flow lines, pipe-in-pipe, Deep-water Risers and their configurations, Pipeline installation methods, Umbilical's-functions, configurations and installation, Flow assurance strategies, Innovative floating production concepts, subsea processing, subsea separation and any new innovations.

**Text Books:**

1. Subsea Engineering Handbook, Yong bai and Qiangbai, Gulf Professional Publishing, 2010.
2. Offshore Petroleum Drilling and Production, By Sukumar Laik, 1st Edition, Published June 30, 2020 by CRC Press.
3. Deepwater Petroleum Exploration & Production by [William L. Leffler](#), [Richard Pattarozzi](#), [Gordon Sterling](#) Penn Well Books, 2003.

**Reference Books:**

1. Floating Drilling: Equipment and Its Use, by Riley Sheffield Volume 2 of Floating Drilling and Volume 2 of Practical drilling technology-1980
2. Handbook On Nondestructive Testing of Concrete By V.M. Malhotra And N.J. Carino, Second Edition Crc Press-2004
3. Offshore Handbook Vol.1 to 5: Gulf Pub. Co.
4. Offshore Pipeline Design, Analysis, and Methods by A. H. Mousselli, Publisher, Penn Well Books, 1981.
5. Drilling and Producing Offshore, by R. Stewart Hall, Publisher, Pennwell Corp- 1984.



## INTRODUCTION TO ACIDIZING AND HYDRO-FRACTURING (OPEN ELECTIVE-IV)

**VII Semester**  
**P C**

**L T**

**Course Code: 231PT7O05**

**3 0**

**0 3**

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO 1:** Apply the modelling of hydraulic fractures for different reservoirs.

**CO 2:** Assess fracturing fluid properties and their usage.

**CO 3:** Analyze the fracturing fluid proppant characteristics.

**CO 4:** Apply the methods of matrix acidization and fracture acidization.

**CO5:** Apply the concepts of hydraulic fracturing and its design

### Mapping of Course Outcomes with Program Outcomes

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | 3     | -     |
| CO2      | 3     | -     |
| CO3      | 3     | -     |
| CO4      | 3     | -     |
| CO5      | 3     | -     |

#### UNIT-I:

**Modelling of hydraulic fractures:** Conservation laws and constitutive equations, fracture propagation models, fluid flow modelling, acid fracturing.

#### UNIT-II:

**Fracturing fluid chemistry:** Water base fluids, oil base fluids, multiphase fluids, additives execution.

**UNIT-III:**

**Fracturing fluid proppant and characterization:** Rheology, shear and temperature effects on fluid properties, foam fracturing fluids, slurry rheology, proppant transport, fluid loss, formation and fracture damage, and proppants.

**UNIT-IV:**

**Matrix acidization and fracture acidization:** Well Stimulation acids, matrix acidizing carbonate formations, fracture acidizing carbonate formations, Acid–rock interaction, sandstone acidizing design, carbonate acidizing design.

**UNIT-V:**

**Hydraulic Fracturing:** Introduction, formation fracturing pressure, fracture geometry, productivity of fractured wells, stimulated reservoir volume (SRV) - hydraulic fracturing design.

**Text Book:**

1. Reservoir Stimulation, Michael. J. Economides, Kenneth G. Nolte, 2nd Edition, Prentice Hall, 1989.

**Reference Books:**

1. Oil Well Stimulation, Robert S. Schechter, Prentice Hall, 1992.
2. Modern Fracturing Enhancing Natural Gas Production, Michael J. Economides, Tony Martin, ET Publishing, 2007.



## INTRODUCTION TO RESERVOIR ENGINEERING (OPEN ELECTIVE-IV)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231PT7O06</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Apply the basic concepts in reservoir engineering.
- CO 2:** Perform basic PVT analysis of various types of fluids for wells.
- CO 3:** Carry out the calculations in material balance and estimate the reserves of various sands of the reservoir from well data.
- CO 4:** Apply the Darcy's Law and derive deliverability equations for various types of reservoirs.
- CO 5:** Learn about water Influx methods

### Mapping of Course Outcomes with Program Outcomes

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | -     | -     |
| CO2      | -     | -     |
| CO3      | -     | -     |
| CO4      | -     | -     |
| CO5      | -     | -     |

### UNIT-I

**Basic concepts in reservoir engineering:** Calculation of hydrocarbon volumes- Fluid pressure regimes- Oil recovery and recovery factor -Volumetric gas reservoir engineering – Application of the real gas equation of state - Gas material balance and recovery factor and its conceptual coherence with drive mechanisms - Hydrocarbon phase behavior.

### UNIT-II

**PVT analysis for oil:** Definition of the basic PVT parameters – Collection of fluid samples - Determination of the basic parameters in the laboratory and

conversion for field operating conditions - Alternative manner of expressing PVT lab analysis results - Complete PVT analysis.

### UNIT-III

**Material balance applied to oil reservoirs:** General form -The material balance expressed as a linear equation - Reservoir drive mechanisms - Solution gas drive- Gas cap drive- Natural water drive- compaction drive and related pore compressibility phenomena.

### UNIT-IV

**Darcy's law and applications:** Darcy's law and field potential- Sign convention- Units and unit conversion- Real gas potential – Datum pressures- Different flow regimes- Linear & Radial steady state flow - Pseudo-steady flow- Unsteady state flow- Derivation of deliverability equations – estimation of reservoir permeability - Two phase flow- Effective and relative permeabilities.

### UNIT-V

**Natural water influx:** Steady state water influx methods- Unsteady state water influx theory of Hurst and Van Everdingen and its application in history matching – The approximate water influx theory of Fetkovich for finite aquifers and predicting the amount of water influx – Application of influx calculation techniques to steam soaking.

#### Text Books:

1. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science, 1978 (17th Impression 1998).
2. Reservoir Engineering Handbook, Tarek Ahmed, 3<sup>rd</sup> Edition, Gulf Professional Publishing, 2006.
3. B. C. Craft – M. Hawkins, Ronald E. Terry & J. Brandon Rogers, 3<sup>rd</sup> revised Edition, Prentice Hall, New York, 2014.

#### Reference Books:

1. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman Inc. 1986.
2. Reservoir Engineering Handbook, Tarek Ahmed, 3<sup>rd</sup> Edition, Gulf Professional Publishing, 2006.

**MATLAB**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE7S01</b> | <b>0</b> | <b>0</b> | <b>1</b> | <b>1</b> |

**Module 1: Introduction to MATLAB and Basic Operations**

Overview of MATLAB interface and workspace

Basic arithmetic and logical operations

Data types, variables, and assignment

MATLAB help and documentation

**Module 2: Working with Vectors and Matrices**

Creating and manipulating vectors and matrices

Matrix operations (addition, subtraction, multiplication, division)

Transpose, inverse, and determinant of matrices

Element-wise operations

**Module 3: Plotting and Data Visualization**

Creating 2D plots (line plots, scatter plots, bar graphs)

Formatting plots (labels, legends, grid, title)

Multiple plots in one figure

Exporting and saving plots

**Module 4: File Handling and Data Management**

Reading and writing text and Excel files

Storing and retrieving data in MAT-files

Managing workspace and clearing variables

Handling missing and erroneous data

**Module 5: Mini Project and Applications**

Hands-on project integrating learned concepts

Real-world applications of MATLAB

Debugging and performance optimization

Q&amp;A and discussion on advanced topics



## SUMMER INTERNSHIP-II

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE7P01</b> | <b>0</b> | <b>0</b> | <b>0</b> | <b>2</b> |

### Guidelines:

1. The internship is a team activity comprises of 3-4 students.
2. The internship mainly focuses on the field-oriented experience and also software related any civil engineering projects.
3. The internship relates to Surveying, Engineering materials, Structural, Transportation, Environmental and Water Resources Engineering.
4. Internship should cater to a small system required in laboratory or real life.
5. Artwork and Layout should be made using Auto-CAD software. Based on the project the advanced softwares like STAAD.pro, Sap 2000, Primevera, Sketchup, ETABS, REVIT, Arc.GIS etc., can be used for effective completion of the project.
6. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of mini project.
7. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.
8. The student is expected to exert on design, development and testing of the proposed work as per the schedule.

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Conduct a technical survey to identify a real world engineering problem.
- CO2:** Analyze the industrial plant layout using technical expertise.
- CO3:** Compare theoretical and real work environments in technical perspective.
- CO4:** Identify the challenges in the execution of operations.
- CO5:** Execute the operations and report the results of assigned tasks using modern tools adhering to professional ethics.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | 2    | 2    | -    | -    | -    | 2    | 3    | 2    | 2     | 1     | 1     |
| <b>CO2</b> | 2    | 2    | 2    | -    | -    | -    | 2    | 3    | 2    | 2     | 1     | 1     |
| <b>CO3</b> | 2    | 2    | 2    | -    | -    | -    | 2    | 3    | 2    | 2     | 1     | 1     |
| <b>CO4</b> | 2    | 2    | 2    | -    | -    | -    | 2    | 3    | 2    | 2     | 1     | 1     |
| <b>CO5</b> | 2    | 2    | 2    | -    | 2    | -    | 2    | 3    | 2    | 2     | 1     | 1     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| <b>CO/PSO</b> | <b>PSO1</b> | <b>PSO2</b> |
|---------------|-------------|-------------|
| <b>CO1</b>    | 2           | -           |
| <b>CO2</b>    | 2           | -           |
| <b>CO3</b>    | 2           | -           |
| <b>CO4</b>    | 2           | -           |
| <b>CO5</b>    | 2           | -           |

## RESEARCH METHODOLOGY

**Semester: VII**

**L      T      P      C**

**Course Code: 231MC7T01**

**2      0      0      0**

**Course Outcomes: At the end of the course, student will be able to:**

- CO1** Explain the characteristics and process of research.
- CO2** Select the research problem by applying problem identification techniques.
- CO3** Formulate and execute research design process.
- CO4** Report the results of research process adhering to professional ethics.
- CO5** Analyze the results of research using statistical measures of central tendency, coefficient of variation, correlation and regression

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | 2     | -     | 1     |
| <b>CO2</b> | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | 2     | -     | 1     |
| <b>CO3</b> | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | 2     | -     | 1     |
| <b>CO4</b> | 1    | -    | -    | 2    | -    | -    | -    | 3    | -    | 2     | -     | 1     |
| <b>CO5</b> | 1    | -    | -    | 2    | 2    | -    | -    | -    | -    | 2     | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 2    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 2    | -    |
| <b>CO5</b> | 2    | -    |

### UNIT – I

**Meaning of Research** - Function of Research - Characteristics of Research – Steps involved in Research – Research in Pure and Applied Sciences - Inter Disciplinary Research. Factors which hinder Research – Significance of Research - Research and scientific methods – Research Process– Criteria of good Research – Problems encountered

by Researchers – Literature Review.

## **UNIT – II**

**Identification of Research Problem :** Selecting the Research problem – Necessity of defining the problem – Goals and Criteria for identifying problems for research. Perception of Research problem – Techniques involved in defining the problem.

## **UNIT – III**

**Research Design:** Formulation of Research design – Need for Research design – Features of a good design – Important concepts related to Research design

## **UNIT – IV**

**Interpretation and Report Writing:** Meaning and Technique of interpretation – Precautions in interpretation – Significance of report writing – Different steps in writing a report – Layout of a Research report.

## **UNIT – V**

**Statistical Techniques and Tools: Introduction** of statistics – Functions – Limitations – Measures of central tendency - Arithmetic mean – Median – Mode – Standard deviation – Co-efficient of variation (Discrete series and continuous series) – Correlation - Regression

### **Text Books:**

- 1 Research Methodology Methods & Techniques, C.R. Kothari – New Age international Publishers, Reprint 2008
- 2 A Hand Book of Methodology of Research, Rajammall, P. Devadoss and K. Kulandaivel, RMM Vidyalaya press, 1976

### **Reference Books:**

- 1 Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd., 1997.
- 2 Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi, 2011
- 3 Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi, 1999.

### **Web Links:**

- 1 <https://nptel.ac.in/courses/127106227>
- 2 [https://www.youtube.com/watch?v=IZLn9\\_PA\\_4s](https://www.youtube.com/watch?v=IZLn9_PA_4s)

## Project (Full Semester Internship)

|                               |          |          |           |           |
|-------------------------------|----------|----------|-----------|-----------|
| <b>Semester: VIII</b>         | <b>L</b> | <b>T</b> | <b>P</b>  | <b>C</b>  |
| <b>Course Code: 231CE8P01</b> | <b>0</b> | <b>0</b> | <b>24</b> | <b>12</b> |

### Guidelines for Project:

The objective of this project work is to enable the student to take up investigative study in the field of Agricultural

Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the department for four to six students in a group, under the guidance of a supervisor. This is expected to provide a good initiation for the students in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic.
2. Working out a preliminary Approach to the Problem relating to the assigned topic.
3. Conducting preliminary Analysis/Modeling/Simulation/Experiment/Design/Feasibility.
4. Preparing a Written Report on the Study conducted for presentation to the Department
5. Review and finalization of the Approach to the Problem relating to the assigned topic.
6. Preparing an Action Plan for conducting the investigation, including team work.
7. Detailed Analysis/Modeling/Simulation/Design/Problem Solving/Experiment as needed.
8. Final development of product/process, testing, results, conclusions and future directions.
9. Preparing a paper for Conference presentation/Publication in Journals, if possible.
10. Preparing a Dissertation in the standard format for being evaluated by the Department.
11. Final Project Presentation before a Departmental Committee.

### Course Outcomes: At the end of the Course, Student will be able to:

**CO1:** Find a problem statement by carrying out technical survey.

**CO2:** Demonstrate technical data by collecting and analyse the skills.

**CO3:** Develop potential solutions to the significant issues that have been highlighted by the data analysis.

**CO4:** Identify, analyse, and solve problems creatively through sustained critical investigation.

**CO5:** Provide concrete methods for implementing social, and professional ethical standards

**CO6:** Apply cutting-edge methods for data analysis to get fastidious results from the project.

**CO7:** Evaluate the solution that was achieved with in the context of engineering framework that supports the environmental considerations.

**CO8:** Practice the skills, diligence, and commitment to excellence needed to engage in lifelong learning.

**CO9:** Preparation of technical report and presentation.

**CO10:** Demonstrate communication skills effectively to work as a team.

## Principles of Database Management Systems

Semester: V

L T P C

Course Code: 231CS5M01

3 0 0 3

Course Outcomes: At the end of the course, student will be able to:

CO1

CO2

CO3

CO4

CO5

Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

**UNIT I:**

**Introduction:** Database system, Characteristics (Database Vs File System), Database Users, Advantages of Database systems, Database applications. Brief introduction of different Data Models; Concepts of Schema, Instance and data independence; Three tier schema architecture for data independence; Database system structure, environment, Centralized and Client Server architecture for the database.

**UNIT II:**

**Entity Relationship Model:** Introduction, Representation of entities, attributes, entity set, relationship, relationship set, constraints, sub classes, super class, inheritance, specialization, generalization using ER Diagrams.

**Relational Model:** Introduction to relational model, concepts of domain, attribute, tuple, relation, importance of null values, constraints (Domain, Key constraints, integrity constraints) and their importance.

**UNIT III:**

**BASIC SQL:** Simple Database schema, data types, table definitions (create, alter), different DML operations (insert, delete, update).

**SQL:** Basic SQL querying (select and project) using where clause, arithmetic & logical operations, SQL functions(Date and Time, Numeric, String conversion).Creating tables with relationship, implementation of key and integrity constraints, nested queries, sub queries, grouping, aggregation, ordering, implementation of different types of joins, view(updatable and non- updatable), relational set operations.

**UNIT IV:**

**Schema Refinement (Normalization):** Purpose of Normalization or schema refinement, concept of functional dependency, normal forms based on functional dependency Lossless join and dependency preserving decomposition, (1NF, 2NF and 3 NF), concept of surrogate key, Boyce-Codd normal form (BCNF).

**UNIT V:**

**Transaction Concept:** Transaction State, ACID properties, Concurrent Executions, Serializability, Recoverability, Implementation of Isolation, Testing for Serializability, lock based, time stamp based, optimistic, concurrency protocols, Deadlocks, Failure Classification, Storage, Recovery and Atomicity, Recovery algorithm.

**Text Books:**

- 1) Database Management Systems, 3rd edition, Raghurama Krishnan, Johannes Gehrke, TMH (For Chapters 2, 3, 4)
- 2) Database System Concepts, 5th edition, Silberschatz, Korth, Sudarsan, TMH (For Chapter 1 and Chapter 5)

**Reference Books:**

- 1) Introduction to Database Systems, 8th edition, C J Date, Pearson.
- 2) Database Management System, 6th edition, Ramez Elmasri, Shamkant B. Navathe, Pearson
- 3) Database Principles Fundamentals of Design Implementation and Management, 10th edition, Carlos Coronel, Steven Morris, Peter Robb, Cengage Learning, 2022

**Web-Resources:**

- 1) <https://nptel.ac.in/courses/106/105/106105175/>
- 2) [https://infyspringboard.onwingspan.com/web/en/app/toc/lex\\_auth\\_01275806667282022456\\_shared/overview](https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01275806667282022456_shared/overview)

## Principles of Database Management Systems Lab

Semester: V

L T P C

Course Code: 231CS5M02

0 0 1.5 1.5

**Course Outcomes: At the end of the course, student will be able to:**

CO1

CO2

CO3

CO4

CO5

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

**Experiments covering the topics:**

- DDL, DML, DCL commands
- Queries, nested queries, built-in functions,
- PL/SQL programming- control structures
- Procedures, Functions, Cursors, Triggers,

**Sample Experiments:**

1. Creation, altering and dropping of tables and inserting rows into a table (use constraints while creating tables), examples using SELECT command.
2. Queries (along with sub Queries) using ANY, ALL, IN, EXISTS, NOTEXISTS, UNION, INTERSET, Constraints.  
Example:- Select the roll number and name of the student who secured fourth rank in the class.
3. Queries using Aggregate functions (COUNT, SUM, AVG, MAX and MIN), GROUP BY, HAVING and Creation and dropping of Views.
4. Queries using Conversion functions (to\_char, to\_number and to\_date), string functions (Concatenation, lpad, rpad, ltrim, rtrim, lower, upper, initcap, length, substr and instr), date functions (Sysdate, next\_day, add\_months, last\_day, months\_between, least, greatest, trunc, round, to\_char, to\_date)
5.
  - i. Create a simple PL/SQL program which includes declaration section, executable section and exception –Handling section (Ex. Student marks can be selected from the table and printed for those who secured first class and an exception can be raised if no records were found)
  - ii. Insert data into student table and use COMMIT, ROLLBACK and SAVEPOINT in PL/SQL block.



6. Develop a program that includes the features NESTED IF, CASE and CASE expression. The program can be extended using the NULLIF and COALESCE functions.
7. Program development using WHILE LOOPS, numeric FOR LOOPS, nested loops using ERROR Handling, BUILT –IN Exceptions, USE defined Exceptions, RAISE-APPLICATION ERROR.
8. Program development using creation of procedures, passing parameters IN and OUT of PROCEDURES.
9. Program development using creation of stored functions, invoke functions in SQL Statements and write complex functions.
10. Develop programs using features parameters in a CURSOR, FOR UPDATE CURSOR, WHERE CURRENT of clause and CURSOR variables.
11. Develop Programs using BEFORE and AFTER Triggers, Row and Statement Triggers and INSTEAD OF Triggers.

**Text Books/Suggested Reading:**

1. Oracle: The Complete Reference by Oracle Press
2. Nilesh Shah, "Database Systems Using Oracle", PHI, 2007
3. Rick F Vander Lans, "Introduction to SQL", Fourth Edition, Pearson Education, 2007

## Advanced Data Structures & Algorithm Analysis

Semester: VI

Course Code: 231CS6M01

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

CO1

CO2

CO3

CO4

CO5

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

### UNIT – I:

Introduction to Algorithm Analysis, Space and Time Complexity analysis, Asymptotic Notations.

AVL Trees – Creation, Insertion, Deletion operations and Applications

B-Trees – Creation, Insertion, Deletion operations and Applications

### UNIT – II:

Heap Trees (Priority Queues) – Min and Max Heaps, Operations and Applications Graphs – Terminology, Representations, Basic Search and Traversals, Connected Components and Biconnected Components, applications

**Divide and Conquer:** The General Method, Quick Sort, Merge Sort, Strassen's matrix multiplication, Convex Hull

### UNIT – III:

**Greedy Method:** General Method, Job Sequencing with deadlines, Knapsack Problem, Minimum cost spanning trees, Single Source Shortest Paths Dynamic Programming: General Method, All pairs shortest paths, Single Source Shortest Paths– General Weights (Bellman Ford Algorithm), Optimal Binary Search Trees, 0/1 Knapsack, String Editing, Travelling Salesperson problem

### UNIT – IV:

**Backtracking:** General Method, 8-Queens Problem, Sum of Subsets problem, Graph Coloring, 0/1 Knapsack Problem

**Branch and Bound:** The General Method, 0/1 Knapsack Problem, Travelling Salesperson Problem

**UNIT – V:**

**NP Hard and NP Complete Problems:** Basic Concepts, Cook's theorem

**NP Hard Graph Problems:** Clique Decision Problem (CDP), Chromatic Number Decision Problem (CNDP), Traveling Salesperson Decision Problem (TSP)

**NP Hard Scheduling Problems:** Scheduling Identical Processors, Job Shop Scheduling

**Textbooks:**

1. Fundamentals of Data Structures in C++, Horowitz, Ellis; Sahni, Sartaj; Mehta, Dinesh, 2nd Edition Universities Press
2. Computer Algorithms in C++, Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, 2nd Edition University Press

**Reference Books:**

1. Data Structures and program design in C, Robert Kruse, Pearson Education Asia
2. An introduction to Data Structures with applications, Trembley & Sorenson, McGraw Hill
3. The Art of Computer Programming, Vol.1: Fundamental Algorithms, Donald E Knuth, Addison-Wesley, 1997.
4. Data Structures using C & C++: Langsam, Augenstein & Tanenbaum, Pearson, 1995
5. Algorithms + Data Structures & Programs:, N. Wirth, PHI
6. Fundamentals of Data Structures in C++: Horowitz Sahni & Mehta, Galgottia Pub.
7. Data structures in Java:, Thomas Standish, Pearson Education Asia

**Online Learning Resources:**

1. [https://www.tutorialspoint.com/advanced\\_data\\_structures/index.asp](https://www.tutorialspoint.com/advanced_data_structures/index.asp)
2. <http://peterindia.net/Algorithms.html>
3. Abdul Bari, Introduction to Algorithms (youtube.com)

## Advanced Data Structures & Algorithm Analysis Lab

Semester: VI

Course Code: 231CS6M02

|          |          |            |            |
|----------|----------|------------|------------|
| <b>L</b> | <b>T</b> | <b>P</b>   | <b>C</b>   |
| <b>0</b> | <b>0</b> | <b>1.5</b> | <b>1.5</b> |

**Course Outcomes: At the end of the course, student will be able to:**

CO1

CO2

CO3

CO4

CO5

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

**Experiments covering the Topics:**

- Operations on AVL trees, B-Trees, Heap Trees
- Graph Traversals
- Sorting techniques
- Minimum cost spanning trees
- Shortest path algorithms
- 0/1 Knapsack Problem
- Travelling Salesperson problem
- Optimal Binary Search Trees
- N-Queens Problem
- Job Sequencing

**Sample Programs:**

1. Construct an AVL tree for a given set of elements which are stored in a file. And implement insert and delete operation on the constructed tree. Write contents of tree into a new file using in-order.
2. Construct B-Tree an order of 5 with a set of 100 random elements stored in array. Implement searching, insertion and deletion operations.
3. Construct Min and Max Heap using arrays, delete any element and display the content of the Heap.
4. Implement BFT and DFT for given graph, when graph is represented by
5. a) Adjacency Matrix b) Adjacency Lists
6. Write a program for finding the biconnected components in a given graph.

7. Implement Quick sort and Merge sort and observe the execution time for various input sizes (Average, Worst and Best cases).
8. Compare the performance of Single Source Shortest Paths using Greedy method when the graph is represented by adjacency matrix and adjacency lists.
9. Implement Job Sequencing with deadlines using Greedy strategy.
10. Write a program to solve 0/1 Knapsack problem Using Dynamic Programming.
11. Implement N-Queens Problem Using Backtracking.
12. Use Backtracking strategy to solve 0/1 Knapsack problem.
13. Implement Travelling Sales Person problem using Branch and Bound approach.

**Reference Books:**

1. Fundamentals of Data Structures in C++, Horowitz Ellis, Sahni Sartaj, Mehta, Dinesh, 2nd Edition, Universities Press.
2. Computer Algorithms/C++ Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran, 2<sup>nd</sup> Edition, University Press
3. Data Structures and program design in C, Robert Kruse, Pearson Education Asia
4. An introduction to Data Structures with applications, Trembley & Sorenson, McGraw Hill

**Online Learning Resources:**

1. <http://cse01-iiith.vlabs.ac.in/>
2. <http://peterindia.net/Algorithms.html>

## Computer Networks

Semester: VI

Course Code: 231CS6M03

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

CO1  
CO2  
CO3  
CO4  
CO5

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

**UNIT I: Introduction:** Network Types, LAN, MAN, WAN, Network Topologies Reference models- The OSI Reference Model- the TCP/IP Reference Model - A Comparison of the OSI and TCP/IP Reference Models, OSI Vs TCP/IP.

Physical Layer –Introduction to Guided Media- Twisted-pair cable, Coaxial cable and Fiber optic cable and introduction about unguided media.

**UNIT II: Data link layer:** Design issues, Framing: fixed size framing, variable size framing, flow control, error control, error detection and correction codes, CRC, Checksum: idea, one's complement internet checksum, services provided to Network Layer, Elementary Data Link Layer protocols: simplex protocol, Simplex stop and wait, Simplex protocol for Noisy Channel.

Sliding window protocol: One bit, Go back N, Selective repeat-Stop and wait protocol, Data link layer in HDLC, Point to point protocol (PPP)

**UNIT – III: Media Access Control: Random Access:** ALOHA, Carrier sense multiple access (CSMA), CSMA with Collision Detection, CSMA with Collision Avoidance, Controlled Access: Reservation, Polling, Token Passing, Channelization: frequency division multiple Access(FDMA), time division multiple access(TDMA), code division multiple access(CDMA).

Wired LANs: Ethernet, Ethernet Protocol, Standard Ethernet, Fast Ethernet(100 Mbps), Gigabit Ethernet, 10 Gigabit Ethernet.

**UNIT – IV:** The Network Layer Design Issues – Store and Forward Packet Switching-Services Provided to the Transport layer- Implementation of Connectionless Service-Implementation of Connection Oriented Service- Comparison of Virtual Circuit and Datagram Networks, Routing Algorithms-The Optimality principle-Shortest path, Flooding, Distance vector, Link state,

Hierarchical, Congestion Control algorithms-General principles of congestion control, Congestion prevention policies, Approaches to Congestion Control-Traffic Aware Routing- Admission Control-Traffic Throttling-Load Shedding. Traffic Control Algorithm-Leaky bucket & Token bucket.

**Internet Working:** How networks differ- How networks can be connected- Tunnelling, internetwork routing-, Fragmentation, network layer in the internet – IP protocols-IP Version 4 protocol-IPV4 Header Format, IP addresses, Class full Addressing, CIDR, Subnets-IP Version 6-The main IPV6 header, Transition from IPV4 to IPV6, Comparison of IPV4 & IPV6.

**UNIT –V: The Transport Layer:** Transport layer protocols: Introduction-services- port number- User data gram protocol-User datagram-UDP services-UDP applications-Transmission control protocol: TCP services- TCP features- Segment- A TCP connection- windows in TCP- flow control- Error control, Congestion control in TCP.

**Application Layer — World Wide Web:** HTTP, Electronic mail-Architecture- web based mail-email security- TELENET-local versus remote Logging-Domain Name System.

### **Text Books:**

1. Computer Networksm, Andrew S Tanenbaum, Fifth Edition. Pearson Education/PHI
2. Data Communications and Networks, Behrouz A. Forouzan, Fifth Edition TMH.

### **References Books:**

1. Data Communications and Networks- Achut S Godbole, AtulKahate
2. Computer Networks, Mayank Dave, CENGAGE

## Principles of Operating Systems

Semester: VII

**L T P C**

Course Code: 231CS7M01

**3 0 0 3**

**Course Outcomes: At the end of the course, student will be able to:**

CO1

CO2

CO3

CO4

CO5

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

### UNIT - I

Operating Systems Overview: Introduction, Operating system functions, Operating systems operations, Computing environments, Free and Open- Source Operating Systems

System Structures: Operating System Services, User and Operating-System Interface, system calls, Types of System Calls, system programs, Operating system Design and Implementation, Operating system structure, Building and Booting an Operating System, Operating system debugging

### UNIT - II

Processes: Process Concept, Process scheduling, Operations on processes, Inter-process communication. Threads and Concurrency: Multithreading models, Thread libraries, Threading issues. CPU Scheduling: Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling.

### UNIT – III

Synchronization Tools: The Critical Section Problem, Peterson's Solution, Mutex Locks, Semaphores, Monitors, Classic problems of Synchronization. Deadlocks: system Model, Deadlock characterization, Methods for handling Deadlocks.

### UNIT - IV

Memory-Management Strategies: Introduction, Contiguous memory allocation, Paging, Structure of the Page Table, Swapping.

Virtual Memory Management: Introduction, Demand paging, Copy-on-write, Page replacement, Allocation of frames, Thrashing Storage Management: Overview of Mass Storage Structure, HDD Scheduling.



**UNIT - V**

File System: File System Interface: File concept, Access methods, Directory Structure; File system Implementation: File-system structure, File-system Operations, Directory implementation, Allocation method, Free space management; File-System Internals: File-System Mounting, Partitions and Mounting, File Sharing.

**Text Books:**

1. Operating System Concepts, Silberschatz A, Galvin P B, Gagne G, 10th Edition, Wiley, 2018.
2. Modern Operating Systems, Tanenbaum A S, 4th Edition, Pearson , 2016

**Reference Books:**

1. Operating Systems: A Concept Based Approach, D.M Dhamdhere, 3rd Edition, McGraw-Hill, 2013

**Online Learning Resources:**

1. <https://nptel.ac.in/courses/106/106/106106144/>
2. <http://peterindia.net/OperatingSystems.html>

## Computer Organization and Architecture

Semester: VII

L T P C

Course Code: 231CS7M02

3 0 0 3

**Course Outcomes: At the end of the course, student will be able to:**

CO1

CO2

CO3

CO4

CO5

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

### UNIT I:

Basic Structure Of Computers: Computer Types, Functional unit, Basic Operational concepts, Bus structures, Software, Performance, multiprocessors and multi computers.

Logic gates: Digital Logic gates, Two-level realizations using gates - AND-OR, OR-AND, NAND-NAND and NOR-NOR

### UNIT II:

Sequential circuits I: Classification of sequential circuits (synchronous and asynchronous): basic flip-flops, truth tables and excitation tables (NAND RS latch, NOR RS latch, RS flip-flop, JK flip-flop, T flip-flop, D flip-flop with reset and clear terminals). Conversion of flip-flop to flip-flop, Race around condition, Master J-K flipflop

Register Transfer Language And Micro-operations: Register Transfer language. Register Transfer Bus and memory transfers, Arithmetic Micro- operations, Logic micro operations, shift micro operations, Arithmetic logic shift unit. Instruction codes. Computer Registers, Computer instructions, Instruction cycle.

### UNIT III:

Micro Programmed Control: Control memory, Address sequencing, micro program example, design of control unit. Central Processing Unit: General Register Organization, Instruction Formats, Addressing modes, Data Transfer and Manipulation, Program Control.

### UNIT IV:

Microprocessors: Evaluation of Microprocessors, CISC and RISC, Characteristics of Microprocessors Memory Organization: Memory Hierarchy, Main Memory, Auxiliary memory, Associate Memory, Cache Memory, Cache memories performance considerations, Virtual memories Introduction to Shift registers and RAID

**UNIT V:**

Input – Output Organization: Peripheral Devices, Input-Output Interface, Asynchronous data transfer, Modes of Transfer, Priority Interrupts, DMA, Input Output Processor, Serial Communication.

**Text Books:**

1. Digital Logic and Computer Design, Moriss Mano, 11th Edition, Pearson Education.
2. Computer Organization, 5th ed., Hamacher, Vranesic and Zaky, TMH, 2002
3. Computer System Architecture, 3/e, Moris Mano, Pearson/PHI.

**Reference Books:**

1. Computer System Organization & Architecture, John D. Carpinelli, Pearson, 2008
2. Computer System Organization, Naresh Jotwani, TMH, 2009
3. Computer Organization & Architecture: Designing for Performance, 7<sup>th</sup> ed., William Stallings, PHI, 2006
4. Structured Computer Organization, Andrew S. Tanenbaum, 4<sup>th</sup> Edition, PHI/Pearson.

## Principles of Software Engineering

Semester: VIII

Course Code: 231CS8M01

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

CO1

CO2

CO3

CO4

CO5

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

### UNIT I:

Introduction: Evolution, Software development projects, Exploratory style of software developments, Emergence of software engineering, Notable changes in software development practices, Computer system engineering. Software Life Cycle Models: Basic concepts, Waterfall model and its extensions, Rapid application development, Agile development model, Spiral model.

### UNIT II:

Software Project Management: Software project management complexities, Responsibilities of a software project manager, Metrics for project size estimation, Project estimation techniques, Empirical Estimation techniques, COCOMO, risk management. Requirements Analysis and Specification: Requirements gathering and analysis, Software Requirements Specification (SRS), Formal system specification, Axiomatic specification, Algebraic specification, Executable specification and 4GL.

### UNIT III:

Software Design: Overview of the design process, How to characterize a good software design? Layered arrangement of modules, Cohesion and Coupling. approaches to software design. Agility: Agility and the Cost of Change, Agile Process, Extreme Programming (XP), Other Agile Process Models, Tool Set for the Agile Process (Text Book 2) Function-Oriented Software Design: Overview of SA/SD methodology, Structured analysis, Developing the DFD model of a system, Structured design, Detailed design, and Design Review. User Interface Design: Characteristics of a good user interface, Basic concepts, Types of user interfaces, Fundamentals of component-based GUI development, and user interface design methodology.

**UNIT IV:**

Coding and Testing: Coding, Code review, Software documentation, Testing, Black-box testing, White-Box testing, Debugging, Program analysis tools, Integration testing, Testing object-oriented programs, Smoke testing, and Some general issues associated with testing. Software Reliability and Quality Management: Software reliability. Statistical testing, Software quality, Software quality management system, ISO 9000. SEI Capability maturity model. Few other important quality standards, and Six Sigma.

**UNIT V:**

Software Maintenance: Characteristics of software maintenance, Software reverse engineering, Software maintenance process models and Estimation of maintenance cost.

Software Reuse: reuse- definition, introduction, reason behind no reuse so far, Basic issues in any reuse program, A reuse approach, and Reuse at organization level.

**Text Books:**

1. Fundamentals of Software Engineering, Rajib Mall, 5th Edition, PHI.
2. Software Engineering: A Practitioner's Approach, Roger S. Pressman, 9th Edition, Mc-Graw Hill International Edition.

**Reference Books:**

1. Software Engineering, Ian Sommerville, 10th Edition, Pearson.
2. Software Engineering, Principles and Practices, Deepak Jain, Oxford University Press.

**e- Resources:**

- 1) <https://nptel.ac.in/courses/106/105/106105182/>
- 2) [https://infyspringboard.onwingspan.com/web/en/app/toc/lex\\_auth\\_01260589506387148827\\_shared/overview](https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01260589506387148827_shared/overview)
- 3) [https://infyspringboard.onwingspan.com/web/en/app/toc/lex\\_auth\\_013382690411003904735\\_shared/overview](https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_013382690411003904735_shared/overview)

## Object Oriented Programming Through Java

Semester: VIII

Course Code: 231CS8M02

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

### Course Objectives:

The learning objectives of this course are to:

- identify Java language components and how they work together in applications
- Learn the fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries.
- learn how to extend Java classes with inheritance and dynamic binding and how to use exception handling in Java applications
- understand how to design applications with threads in Java
- understand how to use Java APIs for program development

### UNIT I:

Object Oriented Programming: Basic concepts, Principles,

Program Structure in Java: Introduction, Writing Simple Java Programs, Elements or Tokens in Java Programs, Java Statements, Command Line Arguments, User Input to Programs, Escape Sequences Comments, Programming Style.

Data Types, Variables, and Operators :Introduction, Data Types in Java, Declaration of Variables, Data Types, Type Casting, Scope of Variable Identifier, Literal Constants, Symbolic Constants, Formatted Output with printf() Method, Static Variables and Methods, Attribute Final, Introduction to Operators, Precedence and Associativity of Operators, Assignment Operator (=), Basic Arithmetic Operators, Increment (++) and Decrement (--) Operators, Ternary Operator, Relational Operators, Boolean Logical Operators, Bitwise Logical Operators.

Control Statements: Introduction, if Expression, Nested if Expressions, if– else Expressions, Ternary Operator?, Switch Statement, Iteration Statements, while Expression, do–while Loop, for Loop, Nested for Loop, For–Each for Loop, Break Statement, Continue Statement.

### UNIT II:

Classes and Objects: Introduction, Class Declaration and Modifiers, Class Members, Declaration of Class Objects, Assigning One Object to Another, Access Control for Class Members, Accessing Private Members of Class, Constructor Methods for Class, Overloaded Constructor Methods, Nested Classes, Final Class and Methods, Passing Arguments by Value and by Reference, Keyword this.

Methods: Introduction, Defining Methods, Overloaded Methods, Overloaded Constructor Methods, Class Objects as Parameters in Methods, Access Control, Recursive Methods, Nesting of Methods, Overriding Methods, Attributes Final and Static

### UNIT III:

Arrays: Introduction, Declaration and Initialization of Arrays, Storage of Array in Computer Memory, Accessing Elements of Arrays, Operations on Array Elements, Assigning Array to Another Array, Dynamic Change of Array

Size, Sorting of Arrays, Search for Values in Arrays, Class Arrays, Two- dimensional Arrays, Arrays of Varying Lengths, Three dimensional Arrays, Arrays as Vectors.

Inheritance: Introduction, Process of Inheritance, Types of Inheritances, Universal Super Class-Object Class, Inhibiting Inheritance of Class Using Final, Access Control and Inheritance, Multilevel Inheritance, Application of Keyword Super, Constructor Method and Inheritance, Method Overriding, Dynamic Method Dispatch, Abstract Classes, Interfaces and Inheritance.

Interfaces: Introduction, Declaration of Interface, Implementation of Interface, Multiple Interfaces, Nested Interfaces, Inheritance of Interfaces, Default Methods in Interfaces, Static Methods in Interface, Functional Interfaces, Annotations.

#### **UNIT IV:**

Packages and Java Library: Introduction, Defining Package, Importing Packages and Classes into Programs, Path and Class Path, Access Control, Packages in Java SE, java.lang Package and its Classes, Class Object, Enumeration, class Math, Wrapper Classes, Autoboxing and Auto-unboxing, Java util Classes and Interfaces, Formatter Class, Random Class, Time Package, Class Instant (java.time.Instant), Formatting for Date/Time in Java, Temporal Adjusters Class, Temporal Adjusters Class.

Exception Handling: Introduction, Hierarchy of Standard Exception Classes, Keywords throws and throw, try, catch, and finally Blocks, Multiple Catch Clauses, Class Throwable, Unchecked Exceptions, Checked Exceptions.

Java I/O and File: Java I/O API, standard I/O streams, types, Byte streams, Character streams, Scanner class, Files in Java(Text Book 2)

#### **UNIT V:**

String Handling in Java: Introduction, Interface Char Sequence, Class String, Methods for Extracting Characters from Strings, Comparison, Modifying, Searching; Class String Buffer.

Multithreaded Programming: Introduction, Need for Multiple Threads Multithreaded Programming for Multi-core Processor, Thread Class, Main Thread-Creation of New Threads, Thread States, Thread Priority- Synchronization, Deadlock and Race Situations, Inter-thread Communication - Suspending, Resuming, and Stopping of Threads.

Java Database Connectivity: Introduction, JDBC Architecture, Installing MySQL and MySQL Connector/J, JDBC Environment Setup, Establishing JDBC Database Connections, Result Set Interface

Java FX GUI: Java FX Scene Builder, Java FX App Window Structure, displaying text and image, event handling, laying out nodes in scene graph, mouse events (Text Book 3)

#### **Text Books:**

- 1) JAVA one step ahead, Anitha Seth, B.L.Juneja, Oxford.
- 2) Joy with JAVA, Fundamentals of Object Oriented Programming, Debasis Samanta, Monalisa Sarma, Cambridge, 2023.
- 3) JAVA 9 for Programmers, Paul Deitel, Harvey Deitel, 4th Edition, Pearson.

**References Books:**

- 1) The complete Reference Java, 11th edition, Herbert Schildt, TMH
- 2) Introduction to Java programming, 7th Edition, Y Daniel Liang, Pearson

**Online Resources:**

- 1) <https://nptel.ac.in/courses/106/105/106105191/>
- 2) [https://infyspringboard.onwingspan.com/web/en/app/toc/lex\\_auth\\_012880464547618816347\\_shared/overview](https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012880464547618816347_shared/overview)



## Survey of Quantum Technologies and Applications

Semester: V

L T P C

Course Code: 231EC5M01

3 0 0 3

**Course Outcomes: At the end of the course, student will be able to:**

- CO1** The general physical principles of realising qubits for computation
- CO2** The various hardware implementations of qubits for computation
- CO3** The basic ideas of quantum sensing
- CO4** The applications of quantum sensing
- CO5** The implementations of quantum communications protocols in fibre-based and free-space

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

**UNIT – 1: Quantum Technologies – four verticals:** Motivation for Quantum Technologies A qualitative overview of salient aspects of quantum physics: Quantum States, Wavefunctions, Probabilistic interpretation, Physical observables, Hermitian operators, expectation values, Heisenberg uncertainty principle, Schrodinger equation, Time evolution; distinction from classical physics; Heuristic description of Superposition, Tunnelling and entanglement; No cloning theorem; Simulating classical systems – Feynman’s idea of a quantum simulator and the birth of the field.

**UNIT-II: Quantum Computation:** Basics of qubits -- what is a qubit?, How is it different from a classical bit? – Review of classical logic gates; Di Vincenzo criteria for realising qubits; Basics of qubit gates and quantum circuits; Physical implementation of qubits (very qualitative description); Solid State Qubits: Semiconducting Qubits – quantum dots, spins, Superconducting Qubits – charge, flux and phase, Topological Qubits – proposals and advantages; Atoms and Ions: Trapped ions, Rydberg atoms, Neutral atoms; Photonic Qubits: Conventional linear optical setups, Integrated Photonics; NMR qubits: Conventional NMR qubits, NV centres Overview of applications and recent achievements: RSA and Shor’s algorithm, Quantum Advantage; Long term goals and strategies being followed : Error correction

**UNIT-III: Quantum Sensing:** Basics of quantum sensing, Basics of Photon (single and entangled) generation and detection, Gravimetry, Atomic clock, Magnetometry, State of the art in Quantum Sensing

**UNIT-IV: Quantum Communications:** Basics of digital communication, Quantifying classical information – Shannon entropy, Basic ideas of quantum communication, security, eavesdropping,

Overview of quantum communication achievements : Terrestrial – fibre-based, Free space, Satellite-based

**UNIT-V: Introduction to Quantum Materials:** What are quantum materials, Why are they important, Applications (quantum computing, spintronics, etc.)

**Overview of Key Classes of Quantum Materials:** Topological Insulators, Superconductors, Mott Insulators, 2D Materials and Quantum Spin Liquids.

**Course References:**

1. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
2. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10th Anniversary edition, Cambridge University Press (2010)
3. Elements of Quantum Computation and Quantum Communication, A. Pathak, Boca Raton, CRC Press (2015)
4. An Introduction to Quantum Computing, Phillip Kaye, Raymond Laflamme, and Michele Mosca, Oxford University Press (2006)
5. Quantum computing explained, David McMahon, Wiley (2008)

## Foundations of Quantum Technologies

Semester: V

Course Code: 231EC5M02

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1** The most relevant mathematical techniques
- CO2** Basic postulates of quantum mechanics and applications
- CO3** Basics of Statistical Physics
- CO4** Basics of Information Science
- CO5** Basics of computational complexity

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

**UNIT-I:** Brief overview of classical physics (This segment is meant for the student to understand what a Hamiltonian is, which will feature later in quantum mechanics) : Hamiltonian function and Hamilton's equations, Phase-space description of a system, Connection and Equivalence with Newton's laws for simple systems – free particle, particle moving in a conservative potential, examples of Harmonic oscillator, hydrogen atom. Historical evolution of quantum mechanics: Planck's quantum hypothesis, Photo electric effect, Atomic spectra, Bohr's quantisation principle, De Broglie's Wave particle duality

**UNIT-II** Postulates of Quantum Mechanics: State vectors and Hilbert Space, Dirac Bra-Ket notation, Measurables and Hermitian Operators, Unitary Transformations, Schrodinger. Equation and Time evolution of quantum states, Measurement Postulate, Schrodinger, Heisenberg and Interaction pictures, Eigen values, Expectation values and Matrix elements, Heisenberg's Uncertainty principle

### **UNIT-III:**

Density operator formalism of quantum mechanics – pure and mixed states; Superposition and Entanglement in quantum mechanics; No cloning theorem; Applications of postulates – Particle in a box, Hydrogen atom, Harmonic Oscillator. Number states, ladder operators and Coherent states of a harmonic oscillator; Spin and Angular momentum – spin half particles; Rabi problem of a spin-half particle in a rotating magnetic field; Bosons and Fermions

### **UNIT-IV:**

Statistical Physics: Quick review of first and second laws of thermodynamics, Thermal

Equilibrium and Gibbs principle, Applying Gibbs principle to Classical and Quantum harmonic oscillators, Bosons and Fermions and Quantum statistics – Fermi-Dirac and Bose- Einstein distributions

**UNIT - V:** Information Science: Digital communication and information: Quantifying information in terms of Shannon entropy; Basic ideas of quantum information; Decoherence and noise; Introductory ideas of Kraus operators Brief overview of Computational Complexity: Qualitative ideas of a Turing machine: Types of Turing machines; Time and Space complexity – P vs NP, PSPACE; Quantum complexity classes – Q, EQP, BQP, BPP, QMA; Post Quantum Cryptography (PQC)

### Course References:

1. Introduction to Quantum Mechanics, Griffiths D. J., 3rd Edition, Cambridge University Press (2024)
  2. Introduction to Electrodynamics, Griffiths D. J., 4th edition, Cambridge University Press (2020)
  3. Principles of Quantum Mechanics, Shankar, R., 2nd edition, Springer (2014)
  4. Quantum Information Science – Manenti R., Motta M., 1st Edition, Oxford University Press (2023)
  5. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10<sup>th</sup> Anniversary edition, Cambridge University Press (2010)
  6. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)
  7. Information Theory, Robert B. Ash, Dover Publications (2003)
  8. Introduction to the Theory of Computation, Michael Sipser, 3rd edition, Cengage India Pvt. Ltd. (2014)
- Statistical Mechanics, Pathria R. K., Paul D. Beale, 4th edition, Academic Press, (2021)

## Basic Programming Lab

Semester: VI

Course Code:231EC6M01

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>0</b> | <b>2</b> | <b>2</b> |

**Course Outcomes: At the end of the course, student will be able to:**

CO1

CO2

CO3

CO4

CO5

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

### Course Content and syllabus:

- Basics of programming
  - Data structures, classes, Object-oriented programming
  - Data storage and retrieval, Memory allocation
  - Scientific plotting, documentation of codes
- Simple algorithms and benchmarking run time
  - Sorting
  - Searching
  - Arithmetic algorithms like GCD, Prime factorisation
- Numerical Integration and differential equations
  - Linear 2nd Order ODEs with constant coefficients
  - Linear 2nd order ODEs with variable coefficients
  - Boundary value problems
    - Poisson equation
    - Laplace equation
    - Wave equation
    - Diffusion Equation
- Numerical techniques in linear algebra
  - Matrix inverse
  - Eigenvalue problem
  - Diagonalisation of matrices
  - Singular value decomposition
- Numerical techniques in Probability and Statistics
  - (Pseudo) Random number generation
  - Computing statistical moments for data samples
  - Least Squares fitting

- Error Analysis
  - Hypothesis Testing
  - Monte Carlo sampling
- Applications to Quantum Mechanics (can be done using openly available modules in languages like Python, Julia etc.)
  - Eigen energies of coupled two level systems
  - Eigen energies of two-level system coupled to oscillator (Jaynes-Cummings Model)
  - Driven two-level system – Rabi Problem
  - Driven damped oscillator — coherent states
- Applications to EM theory (e.g. magnetic field simulation)
  - Electrostatic charge distributions
  - Magnetostatic current distributions
  - Finite Element techniques for electromagnetic simulations

**Course outcomes:**

In this course the students will learn

1. Basics of programming
2. To write programs to solve scientific problems
3. Techniques for scientific computing
4. Applications to quantum mechanics and electromagnetism

**Course References:**

Computational Physics, Nicholas Giordano, Hisao Nakanishi, 2<sup>nd</sup> edition, Pearson-Addison Wesley (2005)

## Basic Laboratory Course for Quantum Technologies

Semester: VI

Course Code: 231EC6M02

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>0</b> | <b>0</b> | <b>2</b> | <b>2</b> |

**Course Outcomes: At the end of the course, student will be able to:**

CO1

CO2

CO3

CO4

CO5

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

### Course Content and syllabus:

- Optics
  - Interferometry – wavelength measurements, intensity measurements
  - Diffraction – single slit, grating
  - Microscopy – magnification, aberration
  - Polarization optics – PBS, HWP, QWP
- RLC circuits
  - Series and parallel RLC circuits – Verifying the quality factor formulae
  - Extracting intrinsic losses
- Digital circuits
  - Adder, Multiplier
  - Encoder, Decoder
  - D flipflop, shift registers
  - How to use common Integrated Circuit chips
- Radio Frequency Technology:
  - Using Oscilloscope
    - Ring-up and ring-down time measurements of RLC circuits
    - Measurements of different pulse-shapes generated by a function generator
  - Using Vector Network Analyser
    - Transmission and reflection measurements of coaxial cable in open, short and matched termination
    - Voltage standing wave ratio measurement
    - Amplitude and Phase quadrature, In-phase and Out-of-phase quadrature plots and Quality factor measurement of RLC circuits
    - Characterising S-parameters, ABCD and Z matrices of common 2 port

- networks – coaxial cable, attenuator, low pass high pass bandpass filters etc.
    - Characterising 3 port networks – directional couplers, circulators, isolators
  - Using a spectrum analyser
    - Noise from a resistor at different temperatures
- Interfacing instruments with a computer
- Data acquisition
  - Signal demodulation – heterodyne vs Homodyne, Mixing of signals
  - Sampling, digitisation using ADCs – under-sampling and aliasing, oversampling and noise
  - Averaging and interpolation techniques
- Quantum Simulators
  - Running quantum protocols in a quantum simulator
  - Implementing simple quantum algorithms on cloud-based quantum computers (depending on availability of time on such machines)
- Running simple algorithms on cloud-based quantum processors (optional)

### Course outcomes:

This course teaches the student to

1. Learn basic experimental techniques in optics
2. Learn Basic experimental techniques in characterising resonators and RLC circuits
3. Learn basic digital circuits
4. Learn fundamental techniques in RF engineering
5. Learn interfacing instruments with computers and carry out data acquisition

### Course References:

1. Optics, Eugene Hecht, A. R. Ganesan, 5<sup>th</sup> edition, Pearson (2019)
2. Art of Electronics, Paul Horowitz and Winfield Hill, 3<sup>rd</sup> edition, Cambridge University Press (2015)
3. Digital Design, Morris Mano, Michael D. Ciletti, 6<sup>th</sup> edition, Pearson Education (2018)
4. Microwave Engineering, David Pozar, 4<sup>th</sup> edition, Wiley (2013)
5. Discrete-time signal processing, Alan V. Oppenheim and Ronald W. Shaffer, 4<sup>th</sup> edition, Pearson (2009)
6. Optical quantum information and quantum communication, A. Pathak and A. Banerjee, SPIE Spotlight Series, SPIE Press (2016)



## Introduction to Quantum Computation

Semester: VI

Course Code:231EC6M03

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

CO1

CO2

CO3

CO4

CO5

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

### Course Content and syllabus:

- Qubits versus classical bits
  - Spin-half systems and photon polarizations
  - Trapped atoms and ions
  - Artificial atoms using circuits
  - Semiconducting quantum dots
  - Single and Two qubit gates – Solovay - Kitaev Theorem
- Quantum correlations
  - Entanglement and Bell's theorems
- Review of Turing machines and classical computational complexity
  - Time and space complexity (P, NP, PSPACE)
- Reversible computation
- Universal quantum logic gates and circuits
- Quantum algorithms
  - Deutsch algorithm
  - Deutsch Josza algorithm
  - Bernstein - Vazirani algorithm
  - Simon's algorithm
- Database search
  - Grover's algorithm
- Quantum Fourier Transform and prime factorization
  - Shor's Algorithm.
- Quantum complexity classes – Q, EQP, BQP, BPP, QMA
- Additional Topics in Quantum Algorithms
  - Variational Quantum Eigensolver (VQE)

- HHL
- QAOA
- Introduction to Error correction
  - Fault-tolerance
  - Simple error correcting codes
- Survey of current status
  - NISQ era processors
  - Quantum advantage claims
  - Roadmap for future

### **Course outcomes:**

Students of this course will learn

1. To review the basic postulates of quantum mechanics
2. The theoretical basics of qubits and their physical realisations
3. To work with density operators and time evolution for mixed states
4. The basic ideas of quantum gates
5. The working of important quantum algorithms
6. The basics of quantum error correction

### **Course References:**

1. Quantum Information Science – Manenti R., Motta M., 1<sup>st</sup> Edition, Oxford University Press (2023)
2. Quantum computation and quantum information – Nielsen M. A., and Chuang I. L., 10<sup>th</sup> Anniversary edition, Cambridge University Press (2010)
3. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)
4. Quantum error correction and Fault tolerant computing, Frank Gaitan, 1<sup>st</sup> edition, CRC Press (2008)
5. Quantum computing explained, David McMahon, Wiley (2008)
6. Introduction to Quantum Computing: From a lay person to a programmer in 30 steps, Hui Yung Wong, 1<sup>st</sup> edition, Springer-Nature Switzerland AG (2022)

## Introduction to Quantum Communication

Semester: VI

**L T P C**

Course Code:231EC6M04

**3 0 0 3**

**Course Outcomes: At the end of the course, student will be able to:**

**CO1****CO2****CO3****CO4****CO5**

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

### Course Content and syllabus:

- Basics of Polarization optics
  - Quarter and half-wave plates
  - Polarizing beam splitters
- Basics of linear and square-law detectors
  - Quadrature amplitude modulation
  - Heterodyne and Homodyne demodulation and linear detectors
  - Intensity measurements and square law detectors
  - Photomultipliers, Avalanche Photo diodes
- Digital communication – information theory (basics)
  - Information entropy
  - Noiseless channel encoding
  - Noisy channel encoding
- No cloning theorem
- Quantum Memories
- Quantum repeaters
- Entanglement and Bell Theorems
- Bell Measurements and Tests
- Quantum Teleportation protocol
- Quantum Dense coding
- Quantum Key Distribution protocols
  - BB84
  - E91
  - BBM92.
  - B92

- COW
- DPS
- Quantum Networks and Quantum Internet
- Survey of Hardware implementations
  - Free space communications
  - Satellite based communications
  - Fibre optics-based communications

**Course Outcomes:**

Students of this course will learn

1. The basics of EM theory
2. The basics of photodetection
3. The basics of information theory
4. The central ideas in quantum communications

**Course References:**

1. Quantum computation and quantum information – Nielsen and Chuang Cambridge University Press, Cambridge (2010)
2. A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press (2015)

## Introduction to Quantum Sensing

Semester: VII

Course Code:231EC7M01

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

CO1

CO2

CO3

CO4

CO5

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

### Course Content and syllabus:

- Classical sensing
  - photo detection
- Classical Noise
  - Johnson Noise, Telegraph noise, flicker or 1/f noise
- Sensitivity of classical measurements
  - Classical Fisher information
  - Cramer - Rao bounds (information theory basics may be required here).
- Quantum measurements
  - projective/orthogonal measurements
  - Approximate/non-orthogonal measurements
  - Weak continuous measurements
  - Error-disturbance relations
  - Standard quantum limits
  - Quantum non-demolition measurements
- States of light
  - fock states
  - Coherent states
  - Squeezed states
  - Tomography
  - Wigner quasi-probability distribution
  - P-distribution
  - Husimi Q function
- Quantum photo detection
  - Square-law detectors, Intensity measurements and Photo-detection

- Linear Detectors and Quadrature Measurements
- Quantum Cramer-Rao bounds
- Single photon-based sensing applications
- Entanglement based sensing applications
- Atomic state-based sensing, solid-state spin-based sensing applications (gravimetry, magnetometry)

**Course Outcomes:**

In this course, students will learn

1. The basics of classical sensing
2. Aspects of quantum measurement
3. Ways to quantify quantum sensing
4. About measurements of quantum states of light
5. About the applications of quantum sensing

**Course References:**

1. Quantum Measurement and Control , Howard Wiseman and David Milburn, Cambridge University Press (2014)
2. Quantum Measurement , Vladimir Braginsky and Farid Ya Khalili, Cambridge University Press (1995)
3. Quantum Information Science – Manenti R., Motta M., 1<sup>st</sup> Edition, Oxford University Press (2023)

## Introduction to Quantum Materials

Semester: VII

Course Code:231EC7M02

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

CO1

CO2

CO3

CO4

CO5

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

**Course Content and syllabus:**

- Band theory basics
  - Metals, Semiconductors and Insulators
  - Band structure of solids
  - Survey of semiconducting devices for quantum technologies (electronic, quantum optical devices and principle of operation)
- Correlated systems
- Magnetism
  - Para, ferro magnetism basics
  - Magnetic measurements, hall effect, magnetoresistance
  - Faraday and Kerr effects
- Superconductivity
  - BCS theory
  - Ginzburg Landau
  - Josephson Effect – AC and DC Josephson effects
  - Survey of superconducting devices for quantum technologies
- 2D materials
  - Graphene and its properties – single and few layers
  - Transition Metal Dichalcogenides – Electronic and Optical Properties
- Topological Phases of matter
  - Basics of Topology
  - Geometric phases - Berry Phase
  - Aharonov Bohm effect
  - Topological phases of matter

- Survey of material growth techniques
  - Molecular beam epitaxy
  - Chemical vapor deposition, MOVPE
  - Pulsed laser deposition, etc.
  - Crystal growth techniques

**Course Outcomes:**

In this course, students will learn

1. The basic idea of quantum materials
2. The basics of band theory of solids
3. The basics of magnetism
4. The basics of superconductivity
5. About new 2D materials like graphene, TMDCs
6. About topology and topological phases of matter

**Course References:**

1. Condensed Matter Physics , M P Marder, 2<sup>nd</sup> Edition, John Wiley and Sons, 2010
2. Introduction to Superconductivity, Michael Tinkham, standard ed., Medtech (2017)



## Engineering Foundations of Quantum Technologies

Semester: V

L T P C

Course Code:231EC5M03

3 0 0 3

**Course Outcomes: At the end of the course, student will be able to:**

CO1

CO2

CO3

CO4

CO5

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

### Course Content and syllabus:

- Electrical Networks (4 hours)
  - Analog RLC circuits – resonances, impedances, quality factors
  - Transmission line basics (2 hours)
    - Telegrapher equations, wave impedance, impedance matching, transmission line resonators
- Computer Science (15 hours)
  - Basics of computer architecture (1 hour)
- Arithmetic Logic Unit
- Memory
  - Abstract models of computation (12 hours)
    - Finite State Machine
    - Turing Machines
    - Overview of Hierarchy of languages – Regular, Context-Free, Turing Decidable and Turing Recognisable
  - Complexity Theory (2 hours)
    - Time and Space complexity
    - P vs NP, NP-completeness
- Electrical Communications (1 hour)
  - Analog Communications (1 hour)
    - Quadrature amplitude modulation
    - Heterodyne and Homodyne demodulation
- Noise and Signals (6 hours)
  - Characterising Noise
  - Types of Noise

- Shot Noise
  - Johnson-Nyquist Noise
  - Telegraphic noise or flicker or 1/f noise
- Signal conditioning and noise mitigation
- Amplification and Added Noise
  - Linear Amplifier theory
  - Signal-Noise Ratio, Added Noise, Noise Figure of amplification
  - Dynamic Range
  - Noise temperature
  - Quantum limits on noise in linear amplifiers
- Digital Communications (4 hours)
  - Information entropy
  - Noiseless channel encoding
  - Noisy channel encoding
- Basics of cryptography (6 hours)
  - Basics of Number Theory
  - Random Number Generation
  - One time pad, Private key, public key, symmetric and asymmetric cryptography protocols
  - RSA and DH
  - Post Quantum Cryptography (PQC)

### Course Outcomes:

Students of this course learn

1. Relevant topics from Electrical Networks to design and analyse analog circuits
2. Relevant topics from RF and Microwave Engineering to design systems
3. Relevant topics in Theory of computation to benchmark algorithms
4. Relevant topics in analog and digital communications
5. Basics of cryptography

### Course References:

1. Art of Electronics, Paul Horowitz and Winfield Hill, 3<sup>rd</sup> edition, Cambridge University Press (2015)
2. Digital Design, Morris Mano, Michael D. Ciletti, 6<sup>th</sup> edition, Pearson Education (2018)
3. Microwave Engineering, David Pozar, 4<sup>th</sup> edition, Wiley (2013)
4. Information Theory, Robert B. Ash, Dover Publications (2003)
5. Introduction to the Theory of Computation, Michael Sipser, 3<sup>rd</sup> edition, Cengage India Pvt. Ltd. (2014)
6. Protecting Information – From Classical error correction to quantum cryptography, Susan Loepp and William K. Wootters, Cambridge University Press (2006)

## Solid State Physics for Quantum Technologies

Semester: V

Course Code: 231EC5M04

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

CO1

CO2

CO3

CO4

CO5

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

### Course Content and syllabus:

- Structure of solids –
  - Symmetry, Bravais lattices
  - Laue equations and Bragg's law,
  - Brillouin Zones
  - Atomic scattering and structure factors.
- Characterisation of crystal structures – XRD etc.
- Bonding in solids –
  - van der Waals and Repulsive interactions,
  - Lennard Jones potential,
  - Madelung constant
- The Drude theory of metals –
  - DC & AC electrical conductivity of a metal;
  - Hall effect & magnetoresistance,
  - Density of states, Fermi-Dirac distribution, Specific heat of degenerate electron gases
  - Free electron model
- Beyond the Free electron model
  - Kronig-Penney Model
  - Periodic potential – Bloch Theorem
  - Band theory
  - Tight binding model
- Phonons in Solids
  - One dimensional monoatomic and diatomic chains
  - Normal modes and Phonons

- Phonon spectrum
  - Long wavelength acoustic phonons and elastic constants
  - Vibrational Properties- normal modes, acoustic and optical phonons.
- Magnetism
  - Dia-, Para-, and Ferromagnetism
  - Langevin's theory of paramagnetism
  - Weiss Molecular theory
- Superconductivity:
  - Phenomenological description – Zero resistance, Meissner effect
  - London Theory
  - BCS theory
  - Ginzburg-Landau Theory
  - Type-I and type-II superconductors
  - Flux quantization
  - Josephson effect.
  - High T<sub>c</sub> superconductivity

**Course Outcomes:**

The students of this course will learn the

1. Basics of solid states physics
2. Various approximations for electronic states in matter
3. The theory of phonons in solids
4. The theory of magnetism
5. The theory of superconductivity

**Course References:**

1. Introduction to Solid State Physics, Charles Kittel, Wiley India Edition (2019)
2. Condensed Matter Physics, M P Marder, 2<sup>nd</sup> Edition, John Wiley and Sons (2010)
3. Introduction to Superconductivity, Michael Tinkham, standard edition, Medtech (2017)

## Quantum Optics

Semester: VI

Course Code:231EC6M05

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

CO1

CO2

CO3

CO4

CO5

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO2   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO3   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO4   |      |      |      |      |      |      |      |      |      |       |       |       |
| CO5   |      |      |      |      |      |      |      |      |      |       |       |       |

**Course Content and syllabus:**

- Quantization of the electromagnetic field
  - Number states, coherent states, squeezed states
  - Hanbury-Brown and Twiss experiments – Photon bunching, Photon anti bunching
  - Hong-Ou-Mandel interference
- Theory of Optical coherence
  - Young's double slit experiment and first order coherence
  - Coherence functions of arbitrary order
  - Normal ordering, symmetric ordering and anti-normal ordering of operators
  - Interferometry
- Phase-space representations of states of light
  - Wigner distribution
  - P-function and the notion of non-classicality with some examples of nonclassical states like squeezed states and their applications
  - Husimi Q function
- Light-matter interaction
  - Classical model of light-matter interaction
  - Semi-classical model of light-matter interaction-
  - Quantum light-matter interaction
  - Rabi Model
  - Jayne's-cummings model
- Open quantum systems
  - Fermi golden rule
  - Born-Markov Lindblad Master Equation

**Course Outcomes:**

In this course, students will learn

1. To quantise the electromagnetic field
2. The various experimental techniques in photonics
3. The various representations of states of light
4. Classical, semi-classical and fully quantum models of light-matter interaction
5. Modelling decoherence through Master equation

**Course References:**

1. Introductory Quantum Optics, Christopher Gerry and Peter Knight, Cambridge University Press (2004)
2. Quantum Optics, D. F. Walls, Gerard J. Milburn, 2<sup>nd</sup> Edition, Springer (2008)
3. Quantum Optics: An introduction, Mark Fox, Oxford University Publishers (2006)
4. Quantum Optics for Beginners, Z. Ficek and M. R. Wahiddin, 1<sup>st</sup> edition, Jenny Stanford Publishing (2014)

## PRE-STRESSED CONCRETE

VII Semester

**L      T      P      C**

**Course Code:** 231CE7T01

**3      0      0      3**

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Explain concepts of prestressing.

**CO2:** Estimate losses in prestressed concrete.

**CO3:** Calculate the flexural strength and deflection of prestressed concrete beam.

**CO4:** Design prestressed concrete member for bending, shear, and torsion.

**CO5:** Design of end zone reinforcement for pre tensioned and post tensioned members

### Mapping of Course Outcomes with Program Outcomes:

|     | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-----|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1 | 2    | 2    | -    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |
| CO2 | 2    | 2    | -    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |
| CO3 | 2    | 2    | -    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |
| CO4 | 2    | 2    | 3    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |
| CO5 | 2    | 2    | 3    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|     | PSO1 | PSO2 |
|-----|------|------|
| CO1 | 2    | 3    |
| CO2 | 2    | -    |
| CO3 | 2    | -    |
| CO4 | 3    | -    |
| CO5 | 3    | -    |

### Unit - I

Basic concepts of Prestressing:

Basic concepts of Prestressing – Advantages and Applications of Prestressed Concretes – High Strength Concrete

– Permissible Stresses – Shrinkage – Creep – Deformation Characteristics – High strength Steel – Types – Strength

– Permissible Stresses – Relaxation of Stress – Stress Corrosion – Durability – Fire Resistance – Cover

Requirements.

Prestressing

Systems:

Introduction – Tensioning devices – Pre-tensioning Systems – Post tensioning Systems – Basic Assumptions in Analysis of prestress and design – Analysis of prestress – Resultant Stresses at a section – pressure line – Concepts of load balancing – Stresses in Tendons – Cracking moment

**Unit – II**

Losses of Pre-stressing:

Losses of Pre-stressing – Loss of Pre-stress in pre-tensioned and post tensioned members – Elastic shortening of

concrete – shrinkage of concrete – creep of concrete – Relaxation of steel – slip in anchorage – differential shrinkage – bending of members and frictional losses – Total losses allowed for design.

**Unit-III**

Deflections and Flexure Strength:

Importance of control of deflections – Factors influencing – Prediction of short term and long term deflections – Types of flexural failure – Code procedures – Design of sections for flexure.

**Unit – IV**

Design for Shear and Torsion

Shear and Principal Stresses – Design of Shear reinforcements – Codal Provisions – Design for Torsion – Design for Combined bending, shear, and torsion.

**Unit – V**

Transfer of Stresses: Transfer of Prestress in pre tensioned members – Transmission length – Bond stresses – end zone reinforcement – Codal provisions – Anchorage zone Stresses in Post tensioned members – stress distribution in end block – Anchorage Zone reinforcement.

**Text Books:**

1. Prestressed Concrete, Rajagopalan. N, Narosa publications, 2nd Edition, 2006.
2. Prestressed concrete, Srikanth, B. Vanakudu, Khanna Publications, 2018

**Reference Books:**

1. Prestressed Concrete, Ramamrutham S, Publications, 5th Edition, 2013
2. Design of Prestressed Concrete Structures, Lin T.Y. & Ned H. Burns, John Wiley & Sons, 3rd Edition, 2004

**Web Links:**

1. <https://nptel.ac.in/courses/105106118/>
2. <https://lecturenotes.in/subject/245/prestressed-concrete-structures-pcs>
3. <https://nptel.ac.in/courses/105106117/>



## ADVANCED CONSTRUCTION MANAGEMENT

### VII Semester

**L   T   P   C**

**Course Code:** 231CE7T02

**2   0   0   2**

**Course Outcomes: At the end of the course the student will be able to**

CO1: Apply quality assurance principles, maintain proper project documentation, and ensure compliance with standard construction management practices.

CO2: Implement safety protocols and perform risk assessment to ensure safe working conditions in construction projects.

CO3: Develop accurate cost estimates, analyze project costs, and apply cost control techniques using predictive models for effective financial management.

CO4: Utilize Building Information Modeling (BIM) for data integration, improve collaboration among stakeholders, perform clash detection, and support sustainability analysis.

CO5: Incorporate green building principles and sustainable construction strategies to reduce environmental impacts and address sustainability challenges in the built environment.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO1</b> | 3    | 2    | 2    | -    | 2    | -    | -    | -    | -    | -     | -    |      |
| <b>CO2</b> | 3    | 1    | 2    | -    | 2    | -    | -    | -    | -    | -     | -    |      |
| <b>CO3</b> | 3    | 2    | 2    | 3    | 2    | -    | -    | -    | -    | -     | -    | 1    |
| <b>CO4</b> | 3    | 3    | 2    | -    | 2    | -    | -    | -    | -    | -     | -    | 1    |
| <b>CO5</b> | 3    | 2    | 2    | -    | 2    | 2    | -    | -    | -    | -     | -    |      |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO/PSO      | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | -     | -     |
| <b>CO 2</b> | -     | -     |
| <b>CO 3</b> | -     | -     |
| <b>CO 4</b> | -     | -     |
| <b>CO 5</b> | -     | -     |

### UNIT-I

Quality and Safety Management, Quality assurance and Control Principles and managing On- Site safety procedure to minimize risks

### UNIT-II

Cost Estimation and Control methods for calculating project cost, managing budgets, and performing economic analysis such as benefit cost analysis

**UNIT-III**

Material and machinery management optimizing the procurement, use and maintenance of construction materials and heavy equipment.

**UNIT-IV**

Building Information Modeling (BIM)- The use of 3D Modeling and other technologies to improve Project Management, Collaboration and efficiency

**UNIT-V**

Sustainable Construction and Green Buildings techniques and Practices for reducing project's Environmental impacts, including Green Building certification and waste management strateg a

Text Books:-

1. Construction Safety Management, 1st Edition by Neeraj and Amarjit
2. Construction Quality management: Principles and practice by Tim Howrath
3. Construction Management and Construction Equipments , Dr.S.Meenakshi Sudarvizhi, Dr.S.Govindarajan and Mr.SB.Ankesh, RG International Publications.

References:

1. Safety management in Construction (Principles and Practices) by Sk. Bhattacharjee
2. Construction Quality Management Principles and Practice by Tim Howrath
3. Cost management of Construction Projects by Donald Towey

**Web Links:**

1. <https://archive.nptel.ac.in/courses/105/108/105108075/>
2. <https://archive.nptel.ac.in/courses/105/105/105105210/>

## ADVANCED STRUCTURAL ENGINEERING (Professional Elective-IV)

**VII Semester****L T P C****Course Code: 231CE7E01****3 0 0 3****Course Outcomes:** At the end of the course, student will be able to:**CO 1:** Design raft foundations and different types of RCC retaining walls**CO 2:** Carryout analysis and design of different types of RCC water tanks**CO 3:** Analyze flat slab systems using the Direct Design Method and Equivalent Frame Method**CO 4:** Solve the problems regarding design of RCC Bunkers, Silos and Chimneys**CO 5:** Understand the concepts of pressed steel tank.**Mapping of course outcomes with program outcomes:**

| CO / PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1     | 2   | 3   | -   | 2   | 2   | -   | -   | -   | -   | -    | -    | -    |
| CO2     | 2   | 1   | -   | 2   | -   | -   | 3   | -   | -   | -    | -    | -    |
| CO3     | 2   | 2   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO4     | 2   | 2   | 1   | 1   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO5     | 3   | 2   | -   | 1   | -   | -   | -   | -   | -   | -    | -    | -    |

**Mapping of course outcomes with program Specific Outcomes:**

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | -     | 2     |
| CO2      | -     | 1     |
| CO3      | 3     | 1     |
| CO4      | -     | 1     |
| CO5      | -     | 1     |

**UNIT – I**

Analysis and Design of Raft Foundations – Design of RCC Retaining walls: Cantilever and Counter fort

**UNIT – II**

Analysis and Design of RCC Water Tanks, Circular and Rectangular types- Intze tank including staging.

**UNIT – III**

Analysis and Design of Flat Slabs- Direct Design and Equivalent Frame Methods- Check for Punching shear

**UNIT – IV**

Analysis and Design of RCC Chimney, Concepts of loading

**UNIT- V**

Analysis and design of Pressed Steel Tanks

**Text books:**

1. 'Reinforced Concrete Structures' Vol-2 by B. C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, Laxmi, publications Pvt. Ltd., New Delhi
2. 'Reinforced Concrete Structures' by N. Subramanian, Oxford Publishers

**Reference Books**

1. Design Drawing of Concrete and Steel Structures' by N. Krishna Raju University Press 2005.
2. Pillai, S. U., & Menon, D., *Reinforced Concrete Design*, Tata McGraw-Hill Publishing Company Ltd., New Delhi

**Web Links:**

1. <https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce38/>
2. <https://nptel.ac.in/content/storage2/courses/105101083/download/lec35.pdf>

## DOCK AND HARBOUR ENGINEERING (Professional Elective – IV)

VII Semester

L T P C

Course Code: 231CE7E02

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Introduce history and classifications of harbours  
**CO2:** Explain the natural forces affecting ports and general design aspects of marine structures  
**CO3:** Describe various navigational aids and dock & repair facilities  
**CO4:** Explain and plan port facilities  
**CO5:** Describe maintenance and protection of port facilities

**Mapping of Course Outcomes with Program Outcomes:**

|     | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-----|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1 | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2 | 2    | -    | 3    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3 | 2    | -    | -    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4 | 2    | -    | 2    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5 | 2    | -    | 2    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|     | PSO1 | PSO2 |
|-----|------|------|
| CO1 | 2    | -    |
| CO2 | 2    | -    |
| CO3 | 2    | -    |
| CO4 | 2    | -    |
| CO5 | 2    | -    |

**Unit - I**

General: History, Advantages and disadvantages of water transportation, Modern trends in water transportation, Elements of water transportation, Historical development in India, Classification of harbours, Ports development in India, Port authorities, Bodies and association Harbour Planning: Selection of site and planning of harbours, Ship characteristics, Characteristics of good harbour, Size of harbour, Classification of harbours

**Unit – II**

Natural Phenomena: Tides – Tidal data analysis, Wind, Water waves, Currents phenomena, Characteristics and effects on marine structures, Littoral drift. Marine Structure: General design aspects, Breakwaters - function, types general design principles, Wharves, Quays – construction of Quay walls, Jetties, Piers, Pier heads, Dolphin, Fenders, Mooring Accessories

**Unit – III**

Navigation Aids: Necessity, Types of navigation aids, Requirement of signals, Fixed and floating navigation aid Docks and Repair Facilities: Harbour docks, Wet docks, Repair docks, Lift docks, Floating docks, Slipways

**Unit – IV**

Port Facilities Classification of ports – Requirements of a good port - Port building facilities, Transit sheds, Warehouses, Cargo handling facility, Services for shipping terminals, Inland port facilities planning

**Unit – V**

Dredging: General, Classification of dredging works, Types of dredgers, Uses of dredged material, Execution of dredging work  
Coastal Protection: Sea wall, Revetment, Bulkhead, Cathodic Protection

**Text Books:**

1. R. Srinivasan and S. C. Rangwala, Harbour, Dock and Tunnel Engineering, 1995, Charotar Pub House, Anand, 2015
2. Docks and Harbour Engineering by Bindra S.P. - Dhanpat Rai & Sons, New Delhi, 2012.

**Reference Books:**

1. Transportation Engineering, Railways, Airports, Docks & Harbours, Srinivasa Kumar R, University Press, Hyderabad, 2020
2. Port Design - Guidelines and recommendations by C. A. Thoresen, Tapir Publications, 2018.
3. Highway, Railway, Airport and Harbor Engineering, Subramanian K. P, Scitech Publications (India) Pvt Limited, Chennai, 2016.

**Web Links:**

1. <https://nptel.ac.in/courses/114/106/114106025/>
2. <https://sites.google.com/a/venusict.org/dha/material>

## RAILWAY ENGINEERING (Professional Elective - IV)

**VII Semester**

**L T P C**

**Course Code: 231CE7E03**

**3 0 0 3**

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Explain different components of railway track
- CO2:** Design railway track gradients as per given requirements
- CO3:** Discuss various types of tracks turnouts and crossings
- CO4:** Explain interlocking and signaling systems
- CO5:** Describe purposes and facilities at Railway Stations

### Mapping of Course Outcomes with Program Outcomes:

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | 1    | -    | -    | -    |      | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | -    | 2    | 3    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | -    | 1    | 3    | -    | -    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 1    | -    | -    | -    | -    | 2    | 2    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    | -    |
| <b>CO2</b> | 3    | -    |
| <b>CO3</b> | 1    | -    |
| <b>CO4</b> | 1    | -    |
| <b>CO5</b> | 1    | -    |

### Unit - I

Components of Railway Engineering: Permanent way components – Railway Track Gauge - Cross Section of Permanent Way - Functions of various Components like Rails, Sleepers and Ballast –Rail Fastenings – Creep of Rails- Theories related to Creep – Adzing of Sleepers- Sleeper density – Rail joints.

### Unit – II

Geometric Design of Railway Track: Alignment – Engineering Surveys - Gradients- Grade Compensation- Cant and Negative Super elevation- Cant Deficiency – Degree of Curve – safe speed on curves – Transition curve – Compound curves – Reverse curves – Extra clearance on curves – widening of gauge on curves – vertical curves – cheek rails on curves.

**Unit – III**

Turnouts & Controllers: Track layouts – Switches – Design of Tongue Rails – Crossings – Turnouts – Layout of Turnout – Double Turnout – Diamond crossing – Scissors crossing – Inspection and maintenance of Points and Crossings

**Unit – IV**

Signalling and Interlocking: Objectives of Signalling - Classification of Signals – Fixed Signals - Stop Signals - Signalling Systems – Mechanical Signalling System - Electrical Signalling System - Systems for Controlling Train Movement – Interlocking - Modern Signalling Installations

**Unit – V**

Railway Stations and Yards: Purpose of a Railway Station - Selection of Site for a Railway Station - Facilities Required at Railway Stations – Requirements of a Passenger Station Yard - Classification of Railway Stations - Station Platforms - Types of Yards  
Track Maintenance: Necessity and Advantages of Track Maintenance - Essentials of Track Maintenance - Measuring Equipment and Maintenance Tools for Tracks - Maintenance of Rail Surface

**Text Books:**

1. Railway Engineering, Satish Chandra and M.M. Agrawal, Oxford University Press, New Delhi, 2020.
2. Rangwala, "Railway Engineering", Charotar Publishing House, 2017.

**Reference Books:**

1. Roads, Railways, Bridges & Tunnel Engineering, T.D.Ahuja & G.S.Birdie, 2017
2. Transportation Engineering, Railways, Airports, Docks & Harbours, Srinivasa Kumar R, University Press, Hyderabad, 2020

**Web Links:**

1. <https://nptel.ac.in/courses/105/107/105107123/>
2. <http://www.nptelvideos.in/2012/11/transportation-engineering-ii.html>



**Industrial Waste Water Engineering**  
**(Professional Elective – IV)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE7E04</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Distinguish between the quality of domestic and industrial water requirements and wastewater quantity generation.
- CO2:** Illustrate various treatment methods based on characteristics of wastewater
- CO3:** Suggest treatment methods for any industrial wastewater.
- CO4:** Decide the need of common effluent treatment plant for the industrial area in their vicinity
- CO5:** Discuss the treatment process of specific industries

**Mapping of Course Outcomes with Program Outcomes:**

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | -    | 1    | -    | -    |      | 3    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | -    | 1    | -    | -    | 3    | 2    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 3    | -    | 1    | -    | -    | 1    | 1    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 1    | -    | 2    | -    | -    | 1    | 2    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 1    | -    | -    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

**Unit - I**

Industrial water Quantity and Quality requirements:

Introduction to importance of Industrial water requirement, Boiler and cooling waters–Process water for Textiles, Food processing, Brewery Industries, power plants, fertilizers, sugar mills.

**Unit – II**

Miscellaneous Treatment:

Use of Municipal wastewater in Industries – Advanced water treatment – Adsorption, Reverse Osmosis, Ion Exchange, Ultra filtration, Freezing, elutriation, Removal of Iron and Manganese, Removal of Colour and Odour.

**Unit – III**

Basic theories of Industrial Wastewater Management:

Industrial waste survey – Measurement of industrial wastewater Flow-generation rates – Industrial wastewater sampling and preservation of samples for analysis – Wastewater Characterization- Toxicity of industrial effluents- Treatment of wastewater-unit operations and processes-Volume and Strength reduction – Neutralization – Equalization and proportioning- recycling, reuse and resources recovery.

**Unit – IV**

Industrial wastewater disposal management:

Discharges into Streams, Lakes and oceans and associated problems, Land treatment – Common Effluent

Treatment Plants: advantages and suitability, Limitations and challenges- Recirculation of Industrial Wastes- Effluent Disposal Method.

**Unit – V**

Process and Treatment of specific Industries:

Manufacturing Process and origin, characteristics, effects, and treatment methods of liquid waste from Steel plants, Fertilizers, Textiles, Paper and Pulp industries, Oil Refineries, Coal and Gas based Power Plants.

**Textbooks:**

1. Wastewater Treatment by M.N. Rao and A.K. Dutta, Oxford & IBH, New Delhi, 2016
2. Industrial Wastewater Treatment by KVSG Murali Krishna, Reems publications, 2018.

**Reference Books:**

1. Industrial Water Pollution Control by W. Wesley Eckenfelder, Mc- GrawHill, Third Edition, 2015.
2. Wastewater Treatment- Concepts and Design Approach by G.L. Karia & R.A. Christian, Prentice Hall of India, 2018
3. EnviroUnit Operations and Processes in Environmental Engineering by Reynolds. Richard, Cengage Learning, 2019

**Web Links:**

1. <https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce32/>
2. <https://archive.nptel.ac.in>

**Air Pollution Engineering**  
**(Professional Elective – IV)**

**VII Semester****L T P C****Course Code: 231CE7E05****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to: CO****1:** Interpret the various ambient air quality parameters.**CO 2:** Examine the plume behavior in prevailing atmospheric conditions.**CO 3:** Explain the various methods related to sampling and analysis.**CO 4:** Choose the appropriate air pollution control devices.**CO 5:** Apply suitable particulate and gaseous control measures for an industry.**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO       | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|------|------|
| <b>CO 1</b> | 2    | 1    | -    | -    | -    | -    | 3    | -    | -    | -     | -    | 2    |
| <b>CO 2</b> | 3    | 2    | -    | -    | -    | -    | 2    | -    | -    | -     | -    | 3    |
| <b>CO 3</b> | 1    | 1    | -    | -    | -    | -    | 2    | -    | -    | -     | -    | 2    |
| <b>CO 4</b> | 1    | 2    | -    | -    | -    | -    | 1    | -    | -    | -     | -    | 3    |
| <b>CO 5</b> | -    | 2    | -    | -    | -    | -    | 1    | -    | -    | -     | -    | 3    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO / PSO    | PSO 1 | PSO 2 |
|-------------|-------|-------|
| <b>CO 1</b> | -     | 1     |
| <b>CO 2</b> | -     | 2     |
| <b>CO 3</b> | -     | 1     |
| <b>CO 4</b> | -     | 2     |
| <b>CO 5</b> | -     | 2     |

**UNIT I****Air Pollution:**

Definition – Sources and classification of Air Pollutants –indoor air quality – Effects of air pollution on health of Human & Animals, vegetation & materials, Global effects of air pollution

- Carbon Credits and Carbon Trade.

**UNIT II****Meteorology and Air Pollution:**

Factors influencing air pollution – Temperature lapse rate and atmospheric stability – wind rose –Plume behaviour – Mixing depths – Plume rise and dispersion – prediction of air quality – box model – Gaussian model – Dispersion coefficient – Application of tall chimney for pollutant dispersion.

**UNIT III****Control of Particulate Pollutants:**

Sampling and analysis of air pollutants– Properties of particulate pollution – particle size distribution – control mechanism –Dust removal equipment – Design and operation of settling chambers, cyclones, wet dust scrubbers, fabric filters and ESP.

**UNIT IV****Control of Gaseous Pollutants:**

Process and equipment for the removal of gaseous pollutants by chemical methods – Design and operation of absorption and adsorption equipment- combustion and condensation equipment.

**UNIT V****Control of Air and Noise Pollution:**

Noise pollution and control – Definition – significance in general – sources, measurement - effects and control measures. Air pollution control: Environmental friendly fuels – In plant control measures, process changes, methods of removal and recycling – Air Pollution legislation – Automobile pollution, odour pollution, flares and control – Emission standards.

**Text books:**

1. Air Pollution, M.N.Rao and H.V.N.Rao, Tata McGraw Hill Comapany.
2. Air pollution and Control, Prof.K.V.S.G. Muralikrishna, Kaushal Publications- Kakinada.
3. Fundamentals of air pollution engineering, Richard C Flagan and John H Seinfeld, Prentice hall Inc,

**Reference books:**

1. An introduction to Air pollution, R.K.Trivedy and P.K. Goel, B.S. Publications, 2003.
2. Air Pollution control–A design approach, C David Cooper and F.C. Alley, 4<sup>th</sup> Edition

**Web Links:**

1. <https://nptel.ac.in/courses/103107084>
2. <http://www.moef.nic.in/report/0203>
3. <http://home.iitk.ac.in/~anubha/APC>

## WATERSHED MANAGEMENT (Professional Elective – IV)

VII Semester

|   |   |   |   |
|---|---|---|---|
| L | T | P | C |
|---|---|---|---|

Course Code: 231CE7E06

|   |   |   |   |
|---|---|---|---|
| 3 | 0 | 0 | 3 |
|---|---|---|---|

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Explain the objectives and characteristics of water shed management.
- CO2** Classify the types of soil erosion and control methods
- CO3** Explain different rain water harvesting techniques
- CO4** Organize the land and drought management techniques
- CO5** Explain the concept of watershed modelling

**Mapping of Course Outcomes with Program Outcomes:**

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 1    | -    | -    | -    | -    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 1    | -    | -    | -    | -    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 1    | -    | -    | -    | -    | 1    | 2    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 2    | -    | -    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | -    | 2    | -    | -    | 2    | 2    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | -    |
| <b>CO2</b> | -    | 1    |
| <b>CO3</b> | -    | -    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 1    |

**Unit - I**

Introduction:

Concept of watershed development – objectives of watershed development – need for watershed development – integrated and multidisciplinary approach for watershed management.

Characteristics of Watershed:

Size – shape – physiography – slope – climate – drainage – land use – vegetation – geology and soils – hydrology and hydrogeology – socio-economic characteristics – basic data on watersheds.

**Unit – II**

Principles of Erosion:

Types and causes of erosion – factors affecting erosion– estimation of soil loss due to erosion- Universal soil loss equation.

Measures to Control Erosion:

Contour techniques – ploughing – furrowing – trenching – bunding – terracing – gully control – check dams – rock-fill dams – brushwood dam – Gabion.

**Unit – III**

Water Harvesting:

Techniques of rain water harvesting – rain water harvesting from roof top – surface flow harvesting – subsurface flow harvesting – stop dams – farm ponds and dugout ponds – percolation tanks.

**Unit – IV**

Land Management:

Land use and Land capability classification – management of forest – agricultural – grassland and wild land – land grading operation –reclamation of saline and alkaline soils.

Drought Management: Drought assessment and classification – drought analysis techniques – drought mitigation planning.

**Unit – V**

Watershed Modelling:

Data of watershed for modelling – application and comparison of watershed models – model calibration and validation – advances of watershed models.

**Text Books:**

1. Watershed Management, Das MM and M.D Saikia, PHI Learning Pvt. Ltd., 2013.
2. Land and Water Management, Murthy.VVN, Kalyani Publications, 2007
3. Watershed Management, Murthy J V S, New Age International Publishers, 2006.

**Reference Books:**

1. Water Resource Engineering, Wurbs R A and James R A, Prentice Hall Publishers, 2002
2. Watershed Hydrology, Black P E, Prentice Hall, 1996

**Web Links:**

1. [https://www.ct.gov/deep/cwp/view.asp?a=2719&q=325622&depNav\\_GID=1654](https://www.ct.gov/deep/cwp/view.asp?a=2719&q=325622&depNav_GID=1654)
2. [http://agritech.tnau.ac.in/agriculture/agri\\_majorareas\\_watershed\\_watershedmgt.html](http://agritech.tnau.ac.in/agriculture/agri_majorareas_watershed_watershedmgt.html)

### Design of Tall Buildings (Professional Elective-V)

VII Semester

|   |   |   |   |
|---|---|---|---|
| L | T | P | C |
|---|---|---|---|

Course Code: 231CE7E07

|   |   |   |   |
|---|---|---|---|
| 3 | 0 | 0 | 3 |
|---|---|---|---|

**Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Explain different types of concrete used in construction of tall buildings.**CO2:** Calculate different types of loads acting on buildings**CO3:** Summarize the behaviour of various structural systems**CO4:** Analyze various structural systems for tall buildings.**CO5:** Design various structural systems for tall buildings.**CO6:** Analyze stability of structural members in tall buildings**Mapping of Course Outcomes with Program Outcomes:**

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | 1    | -    | -    | -    |      | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | 3    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO6</b> | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 3    | -    |
| <b>CO5</b> | 3    | -    |
| <b>CO6</b> | 3    | -    |

**Unit - I**

Design Philosophies and Materials: Introduction-Modern concepts High performance concrete  
Fibre reinforced concrete – Lightweight concrete – Self compacting concrete.

**Unit – II**

Gravity and Lateral Loading: Dead load, live load, impact load, construction load, and sequential loading – Wind loading – Static and dynamic approach analytical method – Wind tunnel experimental methods – Earthquake loading – Equivalent lateral load analysis – Response spectrum method –Combination of loads.

**Unit – III**

Behaviour of Structural Systems: Factors affecting the growth – Height and structural form – behavior of braced frames – Rigid frames – in-filled frames – Shear walls – Coupled shear walls – Wall – Frames

**Unit – IV**

Analysis and Design: Modelling for approximate analysis – Accurate analysis and reduction techniques – Analysis of structures as an integral unit – Analysis for member forces – Drift and twist – Computerized 3D analysis – Design for differential movement – Creep and Shrinkage effects – Temperature effects and fire Resistance.

**Unit – V**

Stability Analysis: Overall buckling analysis of frames, wall – Frames – Approximate methods – Second order effect of gravity loading P-Delta Effects – Simultaneous first order and P-Delta analysis Translational instability  
- Torsional instability – Effect of stiffness of members and foundation rotation in stability of structures.

**Textbooks:**

1. Building Structures-Analysis and Design, Bryan Stafford Smith and Alex Coull, Tall, John Wiley and Sons, Inc, 2019.
2. Structural Analysis and Design of Tall Buildings, Taranath B.S, McGraw-Hill, 2021.
3. Structural Concepts and Systems for Architects and Engineers, Lin T.Y. and Burry D. Stotes, John Wiley, Van Nostrand Reinhold Co Publishers, 2017

**Reference Books:**

1. Analysis of Tall & complex structures, FENG FU, BH Publications, 2018
2. Design of Tall Buildings, Mark Skisian, Routledge Publishers, 2019.

**Web Links:**

1. <http://www.madehow.com/Volume-6/Skyscraper.html>
2. <https://www.bdcnetwork.com/5-innovations-high-rise-building-design>
3. <https://theconstructor.org/structural-engg/high-rise-structures/5/>



## ADVANCED FOUNDATION ENGINEERING (Professional Elective – V)

VII Semester

|   |   |   |   |
|---|---|---|---|
| L | T | P | C |
|---|---|---|---|

Course Code: 231CE7E08

|   |   |   |   |
|---|---|---|---|
| 3 | 0 | 0 | 3 |
|---|---|---|---|

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Compute the safe bearing capacity of footings subjected to vertical and inclined loads
- CO2:** Understand the advanced methods of settlement computations and proportion foundation footings
- CO3:** Explain the ultimate bearing capacity of mat foundations
- CO4:** Explain earth retaining structures and its components
- CO5:** Analyse load carrying capacity of pile foundations
- CO6:** Discuss foundations in expansive soils

### Mapping of Course Outcomes with Program Outcomes:

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | 1    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 3    | 2    | -    | 2    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 3    | 2    | -    | 2    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 3    | 2    | -    | 2    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | 1    | -    | 2    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO6</b> | 2    | 1    | -    | 2    | -    | 1    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |
| <b>CO6</b> | -    | 2    |

### Unit - I

Bearing capacity & settlement analysis of foundations:

Bearing capacity of Foundations using general bearing capacity equation - Meyerhorns, Brinch Hansen's and Vesic's methods — Bearing capacity of Layered soils - Strong layer over weak layer, weak layer on strong layer

— Bearing capacity of foundations on a top of slope — Bearing capacity of foundations at the edge of the slope. Settlement analysis: Immediate settlement of footings resting on granular soils - Schmertmann & Hartman method - De Beer and Martens method - Immediate settlement in clays - Janbu's method correction for consolidation settlement using Skempton and Bjerrum's method - Correction for construction period.

**Unit – II**

Mat foundations:

Mat foundations Purpose and types of isolated and combined footings — Mats/ Rafts — Proportioning of footings

— Ultimate bearing capacity of mat foundations allowable bearing capacity of mats founded in clays and granular soils — compensated rafts.

**Unit – III**

Earth retaining structures:

Earth-retaining structures — cantilever sheet piles — anchored bulkheads — fixed and free earth support

methods design of anchors — braced excavations — function of different components — forces in ties stability against bottom heave.

**Unit – IV**

Pile foundations:

Pile foundations single pile versus group of piles load-carrying capacity of pile groups negative skin friction (NSF) -settlement of pile groups in sands and clays — laterally loaded piles in granular soils — Reese and Matlock method laterally loaded piles in cohesive soils — Davisson and Gill method — Broms' analysis

**Unit – V**

Foundation in expansive soils:

Foundations in expansive soils — definitions of swell potential and swelling pressure determination of free swell index factors affecting swell potential and swelling pressure foundation practices sand cushion method CNS layer filled piers and belled piers — under-reamed piles — moisture control methods.

**Textbooks:**

1. Basic and applied soil mechanics' by GopalRanjan and ASR Rao, New Age, 2018 Publishers, 2016

**Reference Books:**

1. Foundation Analysis and Design' by JE Bowles, John Wiley, 1996
2. Foundation Design' by WC Teng, Prentice Hall Publishers, 1962

**Web Links:**

1. <https://nptel.ac.in/courses/105108069>
2. [https://onlinecourses.nptel.ac.in/noc22\\_ce32/preview](https://onlinecourses.nptel.ac.in/noc22_ce32/preview)

**Traffic Engineering**  
**(Professional Elective – V)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE7E09</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Identify traffic stream characteristics and studies
- CO2:** Explain traffic capacity and level of service.
- CO3:** Illustrate measures for Road safety
- CO4:** Understand traffic sign types and signal coordination methods
- CO5:** Explain traffic environmental impact and sustainable strategies

**Mapping of Course Outcomes with Program Outcomes:**

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 1    | 2    | -    | -    | -    |      | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 1    | 2    | 3    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 1    | 2    | 3    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | 1    | -    |
| <b>CO2</b> | 2    | -    |
| <b>CO3</b> | 2    | -    |
| <b>CO4</b> | 3    | -    |
| <b>CO5</b> | 3    | -    |

**Unit – I**

Traffic Characteristics Measurement and Analysis:

Basic traffic Characteristics - Speed, Volume and Concentration. Relationship between Flow, Speed and Concentration. Traffic Measurement and Analysis - Volume Studies - Objectives, Methods; Speed studies – Objectives, Definition of Spot Speed, time mean speed and space mean speed; Methods of conducting speed studies

**Unit – II**

Highway Capacity and Level Of Service:

Basic definitions related to capacity; Level of service concept; Factors affecting capacity and level of service; Computation of capacity and level of service for two lane highways, Multilane highways and freeways.

**Unit – III**

Traffic Safety:

Traffic Safety -Accident studies and analysis; Causes of accidents - The Road, The vehicle, The road user and the Environment; Engineering, Enforcement and Education measures for the prevention of accidents

**Unit – IV**

Traffic Signals:

Traffic Signals –Types of Signals; Principles of Phasing; Timing Diagram; Design of Isolated Traffic Signal by Webster method, Warrants for signalization. Signal Coordination - Signal Coordination methods, Simultaneous, Alternate, Simple progression and Flexible progression Systems.

**Unit – V**

Traffic and Environment:

Detrimental effects of Traffic on Environment, Air pollution; Noise Pollution; Measures to curtail environmental degradation due to traffic. Sustainable Transportation: Sustainable modes, Transit Oriented Development, ITS based benefits for Environment.

**Text Books:**

1. Traffic Engineering and Transport Planning, Kadiyali, L.R., Khanna Publishers, New Delhi, 2016.
2. Fundamentals of Transportation Engineering, Papacostas, C.S., Prentice-Hall, India, 2015.

**Reference Books:**

1. Transportation Engineering-An Introduction C.JothiKhisty, Prentie Hall Publications, 2015.
2. Highway Capacity Manual, Transportation Research Board, USA

**Web Links:**

1. <https://nptel.ac.in/downloads/105101008/>
2. <https://www.civil.iitb.ac.in/tvm/nptel/ceTseLn.html>.

## SUSTAINABLE WATER RESOURCES DEVELOPMENT (Professional Elective – V)

VII Semester

L T P C

Course Code: 231CE7E10

3 0 0 3

**Course Outcomes:** At the end of the Course, Student will be able to:

**CO1:** Role of different agencies in S.W.R.D

**CO2:** Discuss the details of ground water aquifers and zones

**CO3:** Elaborate the concept of watershed management

**CO4:** Explain the methods of rainwater harvesting

**CO5:** Application of remote sensing and GIS in delineation of surface water bodies and wetlands

**CO6:** Application of GIS in hydrological, land and soil moisture mapping

### Mapping of Course Outcomes with Program Outcomes:

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | 1    | -    | -    | -    |      | 2    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | 1    | -    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 2    | 1    | -    | -    | -    | -    | 2    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 2    | -    | -    | 1    | -    | -    | 2    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | -    | -    | 1    | 3    | -    | 2    | -    | -    | -     | -     | -     |
| <b>CO6</b> | 2    | -    | -    | 1    | 3    | -    | 2    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 1    |
| <b>CO2</b> | -    | 1    |
| <b>CO3</b> | -    | 1    |
| <b>CO4</b> | -    | 1    |
| <b>CO5</b> | 2    | -    |
| <b>CO6</b> | 2    | -    |

### Unit – I

Scope of S.W.R.D, Necessity of S.W.R.D, Role of various agencies in S.W.R.D: -

Agriculturists - Meteorologists

- Geologists - Industrialists - Scientists - Biologists - Water quality Control (Authority) -

Mechanical Engg. - Electrical Engg. - Economists - Social workers- NGO's - Politicians -

General Public

### Unit – II

Hydrologic Cycle and its components, Groundwater: source, importance, type of groundwater aquifers, groundwater zones, types of wells, concept, location, and importance. Artificial recharge of groundwater, direct and indirect methods.

**Unit – III**

Concept of watershed, Characteristic of watershed, size, shape, physiography, slope, climate, drainage, land use, vegetation, geology, hydrology, hydrogeology, socioeconomics. Watershed management & people's participation.

**Unit – IV**

Necessity of Rainwater harvesting, Importance of Rainwater harvesting, Rainwater harvesting methods - Check dams. - Nala / Gully plugging - Percolation tank. - Khet-talawadi - Roof harvesting - Vegetation and plantation.

Groundwater development, water logging, desalination

**Unit – V**

Applications of remote sensing and GIS in –delineation of surface water bodies and wetlands, hydrological modelling, hydrological hazard mapping, land use and land cover mapping, soil moisture mapping

**Text Books:**

1. Sustainable Water Resources Management, Chandra S.P. Ojha , Rao Y. Surampalli , 2017
2. Ground water assessment, Development & management, K.R. Karanth, Tata Mc Graw Hill Pub. Co. Ltd., New Delhi, 2015.
3. Sustainable water management and technologies edition 1 (2017), Daniel H. Chen, CRC press.

**Reference Books:**

1. Ground water H.M.Ragunath New Age international Ltd., New Delhi, 2007
2. Hydrology & Water Resources Engg. S.K.Garg Khanna Pub., Delhi, 2010.
3. Sharma, R.K. and Sharma, T.K. (2000) A Textbook of Hydrology and Water Resources Engineering. 5th Edition, DhanpatRai Publications (P) Ltd., New Delhi

**Web Links:**

1. [https://www.researchgate.net/publication/317595495\\_Groundwater\\_Resource\\_Evaluation\\_Management](https://www.researchgate.net/publication/317595495_Groundwater_Resource_Evaluation_Management)
2. <https://guj-nwrws.gujarat.gov.in/showpage.aspx?contentid=1&lang=english>

## ENVIRONMENTAL IMPACT ASSESSMENT (Professional Elective – V)

VII Semester

**L      T      P      C**

**Course Code: 231CE7E12**

**3      0      0      3**

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Explain the basic concepts of EIA
- CO2:** Classify the various EIA methodologies
- CO3:** Explain the systematic procedure of assessment of impacts of developmental activities on various sectors of environment.
- CO4:** Describe the concept of risk assessment in EIA
- CO5:** Apply the knowledge of EIA to day-to-day activities

### Mapping of Course Outcomes with Program Outcomes:

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | -    | -    | -    | -    | -    | 1    | 3    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | -    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 2    | 2    | -    | -    | -    | 3    | 3    | 1    | -    | -     | -     | -     |
| <b>CO4</b> | -    | -    | -    | -    | -    | 1    | 3    | 2    | -    | -     | -     | 2     |
| <b>CO5</b> | -    | -    | -    | -    | -    | 1    | 3    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | -    |
| <b>CO2</b> | -    | -    |
| <b>CO3</b> | -    | -    |
| <b>CO4</b> | -    | -    |
| <b>CO5</b> | -    | -    |

### Unit - I

Basic concepts of Environmental Impact Assessment:

Elements of EIA, factors affecting EIA, Initial environmental Examination, life cycle analysis, Preparation of Environmental Base map, Classification of environmental parameters, role of stakeholders in the EIA preparation, stages in EIA, EIS and EMP

### Unit – II

Environmental Impact Assessment Methodologies:

Introduction, Criteria for the selection of EIA Methodology, E I A methods, Ad-hoc methods, Check lists, Matrix method, Network analysis method, Environmental Media Quality Index method, Overlay method, Cost/benefit analysis.

### **Unit – III**

Impact of Developmental Activities on soil, water, air and biological environment:

Introduction and Methodology, Delineation of study area, Identification of activities, Procurement of relevant quality of the sample, Impact prediction, Assessment of Impact significance, Identification and Incorporation of mitigation measures, Systematic approach in assessment of Impact of development Activities on Vegetation and wildlife.

### **Unit-IV**

Environmental Risk Assessment and Risk management in EIA:

Treatment of uncertainty, key stages in performing an Environmental Risk Assessment, advantages of Environmental Risk Assessment, Application of remote sensing and GIS for EIA.

### **Unit – V**

Environmental Legislation and Environmental Audit:

EIA notification by Ministry of Environment and Forest (Govt. of India), provisions and procedure for environmental clearance, Environmental legislation objectives, Evaluation of Audit data and preparation of Audit report. Post Audit activities, Concept of ISO and ISO 14000.

Case studies and Preparation of Environmental impact assessment statement for various Industries.

#### **Text Books:**

1. Environmental Impact Assessment Methodologies, Y. Anjaneyulu, B.S. Publication, Sultan Bazar, Hyderabad, 2011
2. Environmental Impact Assessment, Canter Larry W, McGraw-Hill education Edi 1996

#### **Reference Books:**

1. Environmental Science and Engineering, J. Glynn and Gary W. Hein Ke – Prentice Hall Publishers, 1988
2. Environmental Science and Engineering, Suresh K. Dhaneja – S.K. Katania & Sons Publication, New Delhi, 2013
3. Environmental Pollution and Control, Dr H.S. Bhatia – Galgotia Publication (P) Ltd., Delhi, 2018

#### **Web Links:**

1. <https://nptel.ac.in/courses/120108004>
2. <https://archive.nptel.ac.in>



## ADVANCED ENVIRONMENTAL ENGINEERING (Professional Elective V)

### VII Semester

**Course Code: 231CE7E13**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Understand the importance of self-purification in natural water bodies and the effects of various pollutants on receiving streams.
- CO2:** Determine the critical dissolved oxygen (D.O.) deficit and evaluate the degree of treatment required for wastewater to maintain the minimum D.O. level in streams
- CO3:** Acquire knowledge of biological wastewater treatment processes and understand recent advancements in treatment technologies.
- CO4:** Analyze the characteristics of industrial wastewater and recommend suitable treatment and disposal methods.
- CO5:** Develop the ability to assess wastewater management strategies for protecting water quality and maintaining environmental sustainability.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO11 | PO12 |
|-------|------|------|------|------|------|------|------|------|------|-------|------|------|
| CO 1  | 2    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO 2  | 1    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO 3  | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO 4  | -    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |
| CO 5  | -    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -    | -    |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO 1     | -     | 2     |
| CO 2     | -     | -     |
| CO 3     | -     | 3     |
| CO 4     | -     | -     |
| CO 5     | -     | 1     |

### UNIT – I

Stream Sanitation Introduction; Self-purification in streams; factors affecting self-purification; Dissolved Oxygen Balance in streams; Streeter- Phelps's Dissolved Oxygen Model; Zones of Self-purification; Impact of pollutants on stream waters and usage of stream water with special reference to flora and fauna.

### UNIT- II

New Concepts in Biological Waste Treatment (theory only)

Introduction; Nitrogen removal by biological nitrification and de-nitrification; Phosphate removal from the activated sludge process; Rotating Disc Biological Contactor; Anaerobic filters; U-Tube aeration systems.

### UNIT – III

Industrial Wastewater Treatment

Introduction to Industrial Wastewater treatment;

Sugar Plant: Quantity of liquid waste; Characteristics of liquid waste; Methods of its treatment and disposal.

Dairy Industry: Quantity of liquid waste; Characteristics of liquid waste; Methods of its treatment and disposal.

Pulp and Paper Industry: Quantity of liquid waste; Characteristics of liquid waste; Methods of its treatment and disposal.

**UNIT – IV****Urban Solid Waste Management**

Sources; Quantities and characteristics; Classification; Collection and transportation; Recovery and reuse; Treatment methods such as composting, incineration, sanitary landfill and pyrolysis. Sources and Classification of Air Pollution Stationary and mobile sources; Primary and secondary pollutants; Natural contaminants;

Particulate matter; Aerosols; Gaseous pollutants. Meteorology and Air Pollution Atmospheric stability and temperature inversions; Maximum Mixing Depth; Wind direction and speed; Plume behaviour; Gaussian Dispersion Model; Plume rise; Wind rose.

**UNIT – V****Effects of Air Pollution**

Global Effects: Global warming; Ozone depletion; Acid rains; Effects of air pollutants on human health; Effects on plants; Economical effects. Control of Air Pollution

Objectives; Types of collection equipment: Settling chamber; Inertial separators; Cyclones; Filters; Electrostatic Precipitators; Scrubbers. Noise Pollution

Introduction; Levels of noise; Noise rating systems; Measurement of noise; Sources of noise and their noise levels; Acceptable noise levels; Effects of noise; Control of noise.

**TEXT BOOKS**

1. Wastewater Treatment by M.N. Rao and A.K. Datta; Oxford & IBH Publishing Co. Pvt. Ltd., 2008.
2. Environmental Pollution Control Engineering by C.S. Rao, New Age International, 2006.

**Web Links:**

1. [https://www.researchgate.net/publication/26253635\\_Solid\\_and\\_Hazardous\\_Waste\\_Management](https://www.researchgate.net/publication/26253635_Solid_and_Hazardous_Waste_Management)
2. <https://www.cartercenter.org/resources/pdfs/health/ephti/library>
3. [https://www.rand.org/content/dam/rand/pubs/commercial\\_books](https://www.rand.org/content/dam/rand/pubs/commercial_books)

## DESIGN & DRAWING OF IRRIGATION STRUCTURES

(Professional Elective - V)

VII Semester

**L      T      P      C**

**Course Code: 231CE7E11**

**3      0      0      3**

**Course Outcomes:** At the end of the Course, Student will be able to:

**CO1:** Understand the design and draw hydraulic structures of Surplus weir

**CO2:** Understand the design and draw hydraulic structures of Tank sluice with a tower head

**CO3:** Understand the design and draw hydraulic structures of Canal drop- Notch type

**CO4:** Understand the design and draw hydraulic structures of Canal regulator

**CO5:** Understand the design and draw hydraulic structures of Syphon aqueduct type III

### Mapping of Course Outcomes with Program Outcomes:

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 1    | -    | -    | -    |      | 3    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 3    | 1    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 2    | 1    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 3    | 1    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 3    | 1    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | 2    |
| <b>CO2</b> | -    | 2    |
| <b>CO3</b> | -    | 2    |
| <b>CO4</b> | -    | 2    |
| <b>CO5</b> | -    | 2    |

Unit I:

Design and drawing of Surplus weir

Unit II:

Design and drawing of Tank sluice with a tower head

Unit III:

Design and drawing of Canal drop-Notch type

Unit IV:

Design and drawing of Canal regulator

Unit V:

Design and drawing of Syphon aqueduct type III

**TEXT BOOKS:**

1. Water Resources Engineering – Principles and Practice by C. Satyanarayana Murthy, New age International Publishers.

**REFERENCE BOOKS:**

1. Irrigation Engineering and Hydraulic Structures by S.K. Garg, Standard Book House.
2. Irrigation and Water Power Engineering by B.C Punmia & Lal, Lakshmi Publications pvt. Ltd., New Delhi.

## INDUSTRIAL WASTEWATER MANAGEMENT (Open Elective-III)

VII Semester

L T P C

Course Code: 231CE7001

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Distinguish between the quality of domestic and industrial water requirements and wastewater quantity generation.
- CO2:** Illustrate various treatment methods based on characteristics of waste water
- CO3:** Suggest treatment methods for any industrial wastewater.
- CO4:** Decide the need of common effluent treatment plant for the industrial area in their vicinity
- CO5:** Explain the treatment methods of liquid waste from various industries.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | 1    | -    | -    | 2    | 3    | -    | -    | -     | -     | -     |
| CO2   | 2    | -    | 1    | -    | -    | 3    | 2    | -    | -    | -     | -     | -     |
| CO3   | 3    | -    | 1    | -    | -    | 1    | 1    | -    | -    | -     | -     | -     |
| CO4   | 1    | -    | 2    | -    | -    | 1    | 2    | -    | -    | -     | -     | -     |
| CO5   | 3    | -    | 1    | -    | -    | 2    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO2 |
|--------|-------|------|
| CO1    | -     | 1    |
| CO2    | -     | 1    |
| CO3    | -     | 1    |
| CO4    | -     | 1    |
| CO5    | -     | 1    |

**Unit - I**

Industrial water Quantity and Quality requirements:

Boiler and cooling waters–Process water for Textiles, Food processing, Brewery Industries, power plants, fertilizers, sugar mills.

**Unit – II**

Miscellaneous Treatment:

Use of Municipal wastewater in Industries – Advanced water treatment – Adsorption, Reverse Osmosis, Ion Exchange, Ultra filtration, Freezing, elutriation, Removal of Iron and Manganese, Removal of Colour and Odour

**Unit – III**

Basic theories of Industrial Wastewater Management:

Industrial waste survey – Measurement of industrial wastewater Flow-generation rates –

Industrial wastewater sampling and preservation of samples for analysis – Wastewater Characterization-Toxicity of industrial effluents-Treatment of wastewater-unit operations and processes-Volume and Strength reduction – Neutralization – Equalization and proportioning-recycling, reuse, and resources recovery.

**Unit – IV**

Industrial wastewater disposal management:

Discharges into Streams, Lakes and oceans and associated problems, Land treatment – Common Effluent Treatment Plants: advantages and suitability, Limitations, and challenges- Recirculation of Industrial Wastes-Effluent Disposal Method

**Unit – V**

Process and Treatment of specific Industries:

Manufacturing Process and origin, characteristics, effects, and treatment methods of liquid waste from Steel plants, Fertilizers, Textiles, Paper and Pulp industries, Oil Refineries, Coal and Gas based Power Plants.

**Text Books:**

1. Wastewater Treatment by M.N. Rao and A.K. Dutta, Oxford & IBH, New Delhi, 2016
2. Industrial Wastewater Treatment by KVSG Murali Krishna.

**Reference Books:**

1. Industrial Water Pollution Control by W. Wesley Eckenfelder, Mc- GrawHill, Third Edition, 2015
2. Wastewater Treatment- Concepts and Design Approach by G.L. Karia & R.A. Christian, Prentice Hall of India

**Web Links:**

1. <https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce32/>
2. <https://www.un-ihe.org/online-course-industrial-effluent-treatment>

## BASICS OF RS&GIS (Open Elective-III)

VII Semester

L T P C

Course Code: 231CE7O02

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Explain the evolution of Remote Sensing and GIS, the energy interactions in the atmosphere and earth surface features.

**CO2:** Elaborate on photogrammetry and various satellites.

**CO3:** Interpret the images for preparation of thematic maps.

**CO4:** Develop GIS based raster and vector data models.

**CO5:** Explain navigation applications based on GCS and GPS systems.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | 1    | -    | 1    | -    |      | -    | 2    | -    | -     | -     | -     |
| CO2   | 2    | 1    | -    | 1    | -    | -    | -    | 2    | -    | -     | -     | -     |
| CO3   | 2    | 1    | -    | 1    | -    | -    | -    | 2    | -    | -     | -     | -     |
| CO4   | 3    | 2    | -    | 1    | -    | -    | -    | 2    | -    | -     | -     | -     |
| CO5   | 3    | 2    | -    | 1    | -    | -    | -    | 2    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

### Unit - I

History and Basic Concept of Remote Sensing:

Introduction to remote sensing: Evolution of Remote Sensing- use of hot air balloons, pigeons and platforms of remote sensing, low-medium-high altitude imaging.

Basic concepts of remote sensing: Electromagnetic spectrum and its interaction with atmosphere, energy interaction with the earth surfaces characteristics of remote sensing systems.

**Unit – II**

Photogrammetry; Aerial and Terrestrial; photo interpretation. Sensors; Radar imaging; colour scanners; thematic mapper. Introduction to space agencies - IRS, Landsat, SPOT, Cartosat, Ikonos, Envisat etc. sensors, sensor resolutions (spatial, spectral, radiometric and temporal).

**Unit – III**

Geographic Information System:

Introduction to GIS; Components of a GIS, Geospatial Data: Spatial Data and Attribute data, Joining Spatial and Attribute data.

Image interpretation:

Introduction, elements of visual image interpretations, digital image processing- image pre-processing, image enhancement, image classification, supervised classification, unsupervised classification using GIS Environs.

**Unit – IV**

Data Models: Vector data model: Representation of simple features – Topology and its importance; coverage and its data structure, Shape file; Relational Database, Raster Data Model: Elements of the Raster data model, Types of Raster Data, Raster Data Structure, Data conversion

**Unit – V**

Coordinate Systems:

Geographic Coordinate System: Approximation of the Earth, Datum; Map Projections: Types of Map Projections-Map projection parameters, commonly used Map Projections. Global positioning system and various navigation applications.

**Text Books:**

1. Textbook of Remote Sensing and Geographical Information Systems, by Anji M. Reddy · 2018, BS Publications.
2. Remote Sensing and GIS, Basudev Bhatta, Oxford Publishers 2015

**Reference Books:**

1. Basics of Remote sensing & GIS by S. Kumar, Laxmi Publications.
2. Introduction to Geographic Information System, Kang-Tsung Chang, McGraw- Hill 2015.

**Web Links:**

1. [http://geology.wlu.edu/harbor/geol260/lecture\\_notes/notes.html](http://geology.wlu.edu/harbor/geol260/lecture_notes/notes.html)
2. <https://lecturenotes.in/subject/572/remote-sensing-and-gis-rsg>



## SAFETY ENGINEERING (Open Elective-III)

VII Semester

L T P C

Course Code: 231CE7O03

3 0 0 3

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Develop management plans to prevent accidents in construction Industry.  
**CO2:** Prepare plans to safe guard workers in construction of high risk Buildings.  
**CO3:** Ensure safety while operating construction machinery.  
**CO4:** Outline safety plans for demolition of buildings.  
**CO5:** Prepare fire safety plans for a given building.

Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 2    | -    | -    | 1    |      | -    | -    | 1    | -     | -     | -     |
| CO2   | 2    | 3    | -    | -    | 2    | -    | -    | -    | 1    | -     | -     | -     |
| CO3   | 1    | 2    | -    | -    | 1    | -    | -    | 2    | -    | -     | -     | 2     |
| CO4   | 2    | 2    | -    | -    | 1    | -    | -    | 2    | -    | -     | -     | 2     |
| CO5   | 2    | 2    | -    | -    | 1    | -    | -    | -    | 1    | -     | -     | -     |

Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

### Unit - I

Accidents Causes and Management Systems:

Problems impeding safety in construction industry- causes of fatal accidents, types and causes of accidents related to various construction activities, human factors associated with these accident – construction regulations, contractual clauses – Pre contract activates, preconstruction meeting - design aids for safe construction – permits to work – quality assurance in construction - compensation – Recording of accidents and safety measures – Education and training.

### Unit – II

Hazards of Construction and Prevention:

Excavations, basement and wide excavation, trenches, shafts – scaffolding , types, causes of accidents, scaffold inspection checklist – false work – erection of structural frame work, dismantling – tunneling – blasting, pre blast and post blast inspection – confined spaces – working on contaminated sites – work over water – road works – power plant constructions – construction.

**Unit – III****Working At Heights:**

Fall protection in construction OSHA 3146 – OSHA requirement for working at heights, Safe access and egress – safe use of ladders- Scaffoldings , requirement for safe work platforms, stairways, gangways and ramps – fall prevention and fall protection , safety belts, safety nets, fall arrestors, controlled access zones, safety monitoring systems – working on fragile roofs, work permit systems, height pass – accident case studies.

**Unit – IV****Construction Machinery:**

Selection, operation, inspection and testing of hoisting cranes, mobile cranes, tower cranes, crane inspection checklist - builder's hoist, winches, chain pulley blocks – use of conveyors – concrete mixers, concrete vibrators – safety in earth moving equipment, excavators, dozers, loaders, dumpers, motor grader, concrete pumps, welding machines, use of portable electrical tools, drills, grinding tools, manual handling scaffolding, hoisting cranes – use of conveyors and mobile cranes – manual handling.

**Unit – V****Safety in Demolition Work:**

Safety in demolition work, manual, mechanical, using explosive - keys to safe demolition, pre survey inspection, method statement, site supervision, safe clearance zone, health hazards from demolition - Indian standard - trusses, girders and beams – first aid – fire hazards and preventing methods – interesting experiences at the construction site against the fire accidents.

**Fire Safety:**

Fire –fire load-control and institutional fire protection systems, Fire Hydrant and extinguishers, Electrical Hazards, protection and interlock- Discharge rod and earthing device, safety in the use of portable tools. Emergency planning and preparedness. Marking of Route Fire Exist.

**Text Books:**

1. 'Safety in the Build Environment' by Jnathea D.Sime, London, 2010
2. 'Reliability Maintenance and Safety Engineering, by Gupta A K, Laxmi Publications, New Delhi.

**Reference Books:**

1. 'Construction hazard and Safety Hand book' by Hudson, R., Butter Worth's, 1985.
2. 'Construction Safety Hand Book' by V.J.Davies and K.Thomasin, Thomas Telford Ltd., London, 1990.

**Web Links:**

1. [nptel.ac.in/courses/105103093/](https://nptel.ac.in/courses/105103093/)
2. [nptel.ac.in/courses/105103093/22](https://nptel.ac.in/courses/105103093/22)

## BATTERY MANAGEMENT SYSTEMS AND CHARGING STATIONS

### (OPEN ELECTIVE-III)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EE7O01</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1** Describe the construction and operation of different batteries for EV applications
- CO2** Describe charging algorithms of different batteries and balancing methods of battery packs
- CO3** Describe the different kinds of infrastructure needed in the charging stations
- CO4** Describe the requirements of battery management and their maintenance.
- CO5** Explain the modelling of batteries

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | 3    | 2    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | 3    | 2    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 2    | 2    | 3    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 2    | 2    | 3    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | 2    | 3    | -    | -    | 1    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> |      |      |
| <b>CO2</b> |      |      |
| <b>CO3</b> |      |      |
| <b>CO4</b> |      |      |
| <b>CO5</b> |      |      |

## UNIT – I

### EV Batteries

Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel. Lead Acid Batteries: Lead acid battery basics, special characteristics of lead acid batteries, battery life and maintenance, Li-ion batteries. Nickel-based Batteries: Nickel cadmium, Nickel metal hydride batteries. Sodium-Based Batteries:

Introduction, sodium sulphur batteries, sodium metal chloride (Zebra) batteries. Lithium Batteries: Introduction, the lithium polymer battery, lithium ion battery

**UNIT – II****Battery Charging Strategies**

Charging algorithms for a single battery: Basic terms for charging performance evaluation and characterization, CC charging for NiCd/NiMH batteries, CV charging for lead acid batteries, CC/CV charging for lead acid and Li-ion batteries, MSCC charging for lead acid, NiMH and Li-ion batteries, TSCC/CV charging for Li-ion batteries, CVCC/CV charging for Li-ion batteries, Pulse charging for lead acid, NiCd/NiMH and Li-ion batteries, Charging termination techniques, Comparisons of charging algorithms and new development; Balancing methods for battery pack charging: Battery sorting Overcharge for balancing, Passive balancing, Active balancing.

**UNIT – III****Charging Infrastructure**

Domestic Charging Infrastructure, Public charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

**UNIT – IV****Battery-Management-System Requirements**

Battery-pack topology, BMS design requirements, Voltage sense, Temperature sense, Current sense, Contactor control, Isolation sense, Thermal control, Protection, Charger control, Communication via CAN bus, Log book, SOC estimation, Energy estimation, Power estimation, Diagnostics.

**UNIT – V****Battery Modelling**

General approach to modelling batteries, simulation model of rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of NiCd battery model, Simulation examples.

**Text Books:**

- 1 Energy Systems for Electric and Hybrid Vehicles by K.T. Chau, IET Publications, First edition, 2016.
- 2 Battery Management Systems Vol. – II Equivalent Circuits and Methods, by Gregory L.Plett, Artech House publisher, First edition 2016.

**Reference Books:**

- 1 Electric and hybrid vehicles: design fundamentals, 2nd edition, husain iqbal, crc press
- 2 Lithium-Ion Batteries: Fundamentals and Applications (Electrochemical Energy Storage and Conversion) 1st Edition by Yuping Wu

**Web Links:**

- 1 <https://www.hydroquebec.com/data/electrification-transport/pdf/technical-guide.pdf>
- 2 <https://www.youtube.com/watch?v=eQX-iobIYmw>

## CONCEPT OF SMART GRID TECHNOLOGY (OPEN ELECTIVE-III)

VII Semester

Course Code: 231EE7O02

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| 3        | 0        | 0        | 3        |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Explain the concepts of smart grid and its issues in interconnection.
- CO2** Explain various smart grid technologies and its usage in smart applications.
- CO3** Describe the concepts of smart substations.
- CO4** Analyze micro grids and distributed generation systems.
- CO5** Describe the different technologies in smart grid.

**Mapping of Course Outcomes with Program Outcomes:**

|            | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 2    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|            | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | -    |
| <b>CO2</b> | -    | -    |
| <b>CO3</b> | -    | -    |
| <b>CO4</b> | -    | -    |
| <b>CO5</b> | -    | -    |

### Unit – I

**Introduction to Smart Grid:** Evolution of Electric Grid - Concept of Smart Grid - Definitions - Need of Smart Grid - Functions of Smart Grid - Opportunities & Barriers of Smart Grid - Difference between conventional & smart grid - Concept of Resilient & Self-Healing Grid - Present development & International policies on Smart Grid.

**Unit – II**

**Smart Grid Technologies: Part 1:** Introduction to Smart Meters - Real Time Pricing - Smart Appliances - Automatic Meter Reading (AMR) - Outage Management System (OMS) - Plug in Hybrid Electric Vehicles (PHEV) - Vehicle to Grid - Smart Sensors - Home & Building Automation - Phase Shifting Transformers -Net Metering.

**Unit – III**

**Smart Grid Technologies: Part 2:** Smart Substations - Substation Automation - Feeder Automation. Geographic Information System (GIS) - Intelligent Electronic Devices (IED) & their application for monitoring & protection.

Smart storage like Battery Energy Storage Systems (BESS) - Super Conducting Magnetic Energy Storage Systems (SMES) - Pumped Hydro - Compressed Air Energy Storage (CAES)

**Unit – IV**

**Micro grids and Distributed Energy Resources:** Concept of micro grid - need & applications of microgrid - formation of microgrid - Issues of interconnection - protection & control of microgrid - Integration of renewable energy sources - Demand Response.

**Unit – V**

**Information and Communication Technology for Smart Grid:** Advanced Metering Infrastructure (AMI) - Home Area Network (HAN) - Neighborhood Area Network (NAN) - Wide Area Network (WAN).

**Text Books:**

1. Integration of Green and Renewable Energy in Electric Power Systems - by Ali Keyhani - Mohammad N. Marwali - Min Dai Wiley - 2009.
2. The Smart Grid: Enabling Energy Efficiency and Demand Response - by Clark W. Gellings - Fairmont Press - 2009.

**Reference Books:**

1. The Advanced Smart Grid: Edge Power Driving Sustainability:1 by Andres Carvallo - John Cooper - Artech House Publishers July 2011
2. Smart Grid: Technology and Applications - by Janaka B. Ekanayake - Nick Jenkins - Kithsiri Liyanage - Jianzhong Wu - Akihiko Yokoyama - Wiley publishers - 2012.

**Web Links:**

1. <https://nptel.ac.in/courses/108104052/>
2. <https://nptel.ac.in/downloads/108101040/>
3. <https://nptel.ac.in/courses/108101040/>

## FINITE ELEMENT METHODS (Open Elective-III)

**Semester: VII****L      T      P      C****Course Code: 231ME7O01****3      0      0      3****Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Understand the concepts behind variational methods and weighted residual methods in FEM.
- CO2:** Solve bar and truss problems Solve bar and truss problems.
- CO3:** Solve beam problems.
- CO4:** Apply suitable boundary conditions for 2D stress analysis and develop the formulation for axi-symmetric problems and higher order iso-parametric elements.
- CO5:** Evaluate the concepts of steady state heat transfer analysis and dynamic analysis.

**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 2    | 2    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 3    | 2    | 2    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 3    | 2    | 2    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 3    | 2    | 2    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 3    | 2    | 2    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | -    |
| <b>CO2:</b> | -    | -    |
| <b>CO3:</b> | -    | -    |
| <b>CO4:</b> | -    | -    |
| <b>CO5:</b> | -    | -    |

**Unit - I****Introduction:**

Introduction to finite element method, stress and equilibrium, strain–displacement relations, stress–strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy, one-dimensional problems. Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations

**Unit -II**

Bar element formulation, Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.

Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations.

**Unit - III**

Analysis of Beams: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

**Unit - IV**

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axisymmetric problems. Higher order and iso-parametric elements: One dimensional, quadratic and cubic elements in natural coordinates, two dimensional four node iso-parametric elements and numerical integration.

**Unit – V**

Steady state heat transfer analysis: one dimensional analysis of a fin.

Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis

**Text Books:**

- 1 Introduction to Finite Elements in Engineering, T.R. Chandrupatla and A.D. Belegundu, PHI publications, 4th Edition, 2011.
- 2 A First Course in the Finite Element Method, Daryl L. Logan, Cengage Learning India Private Limited, 6th edition, 2017.

**Reference Books:**

- 1 An Introduction to the Finite Element Method, J.N. Reddy, McGraw Hill Education, 4th Edition, 2020.
- 2 Concepts and Applications of Finite Element Analysis, Cook et al, Wiley Publications, 4th edition, 2007.
- 3 Engineering Thermodynamics, P. Chattopadhyay, Oxford University Press, 1<sup>st</sup> edition, 2011.
- 4 Refrigeration and Air-conditioning, CP Arora, , McGraw Hill, 4<sup>th</sup> edition 2021.

**Weblinks:**

- 1 <https://nptel.ac.in/courses/112/104/112104193/>
- 2 <https://nptel.ac.in/courses/112/104/112104205/>



## INTRODUCTION TO MECHATRONICS

### (Open Elective-III)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>Semester: VII</b>          | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231ME7O02</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Describe mechatronics systems and various types of sensors and transducers.
- CO2:** Demonstrate knowledge of solid-state devices, analog circuits, and MEMS applications
- CO3:** Explain the components and operation of hydraulic, pneumatic, electro-pneumatic, electro-hydraulic, mechanical, and electrical actuating system
- CO4:** Discuss digital electronics, microcontrollers, PLCs, and their applications in control systems.
- CO5:** Apply system interfacing, data acquisition, system response, and mechatronics design trends.

#### Mapping of Course Outcomes with Program Outcomes:

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 2    | -    | -    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 2    | -    | -    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 2    | -    | -    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 2    | -    | 1    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 2    | -    | -    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | 2    | -    |
| <b>CO2:</b> | 1    | -    |
| <b>CO3:</b> | 1    | -    |
| <b>CO4:</b> | 2    | -    |
| <b>CO5:</b> | 2    | -    |

#### Unit - I

Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

#### Unit -II

Solid state electronic devices, PN junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications.

**Unit - III**

Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems.

**Unit - IV**

Digital electronics and systems, digital logic control, microprocessors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

**Unit – V**

System and interfacing and data acquisition, DAQS, SCADA, A-D and D-A conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends.

**Text Books:**

- 1 Mechatronics Integrated Mechanical Electronics Systems/KP Ramachandran & G K Vijaya Raghavan/WILEY India Edition/2008
- 2 Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005

**Reference Books:**

- 1 Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
- 2 Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
- 3 Mechatronics System Design / Devdas Shetty/Richard/Thomson.
- 4 Mechatronics/M. D. Singh/J. G. Joshi/PHI.

**Weblinks:**

- 1 <https://www.electronicshub.org/different-types-sensors/>
- 2 [https://en.wikipedia.org/wiki/Solid-state\\_electronics](https://en.wikipedia.org/wiki/Solid-state_electronics)
- 3 <http://www.htl-worldwide.com/the-difference-between-pneumatic-hydraulic-and-electrical-actuators/>
- 4 <https://www.worldscientific.com/worldscibooks/10.1142/10193>

## PRODUCT DESIGN AND DEVELOPMENT (Open Elective-III)

**Semester: VII****L      T      P      C****Course Code: 231ME7003****3      0      0      3****Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Apply creative thinking skills for idea generation**CO2:** Translate conceptual ideas into clear sketches.**CO3:** Able to identify causes of failure through fault free analysis and perform failure analysis**CO4:** Test a product under thermal, vibration, electrical and combined environments.**CO5:** Know how to design for manufacturability**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 3    | -    | 1    | -    | 2    | -    | -    | -    | -    | -     | -     | 2     |
| <b>CO3:</b> | 3    | 3    | -    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 3    | 2    | -    | 2    | -    | -    | 2    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 3    | -    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | 2    | -    |
| <b>CO2:</b> | 2    | -    |
| <b>CO3:</b> | 2    | -    |
| <b>CO4:</b> | 2    | -    |
| <b>CO5:</b> | 2    | -    |

**Unit - I****Product design process:**

Design Process Steps, Morphology of Design. Problem Solving and Decision Making: Problem-Sol Process, Creative Problem Solving, Invention, Brainstorming, Morphological Analysis, Behavior Aspects of Decision Making, Decision Theory, Decision Matrix, Decision Trees.

**MODELING AND SIMULATION:**

Triz, Role of Models in Engineering Design, Mathematical Modeling, Similitude and Scale Models, Computer Simulation, Geometric Modeling on Computer, Finite-Element Analysis.

**Unit -II****Product management:**

The operation of product management: Customer focus of product management, product planning process Levels of strategic planning, Wedge analysis, Opportunity search, Product life cycle Life cycle theory practice.

**Product development:**

Managing new products, generating ideas, Sources of product innovation, Selecting the best ideas, political dimension of product design, Managing the product launch and customer feedback.

**Product managers and manufacturing:**

Need for effective relationships, Impact of manufacturing processes on product decisions, Prototype planning, Productivity potentials, Management of product quality, Customer service levels.

**Unit - III****Risk and reliability:**

Risk and Reliability: Risk and Society, Hazard Analysis, Fault Tree Analysis. Failure Analysis and Quality: Causes of Failures, Failure Modes, Failure Mode and Effect Analysis, FMEA Procedure, Classification of Severity, Computation of Criticality Index, Determination of Corrective Action, Sources of Information, Copyright and Copying. Patent Literature.

**Unit-IV****Product testing:**

Thermal, vibration, electrical, and combined environments, temperature testing, vibration testing, test effectiveness. Accelerated testing and data analysis, accelerated factors. Weibull probability plotting, testing with censored data.

**Unit – V****Design for manufacturability:**

Maintenance Concepts and Procedures, Component Reliability, Maintainability and Availability, Isolation in design and Self-Diagnostics. Product Design for Safety, Product Safety and User S Concepts, Examples of Safe Designs.

**Design standardization and cost reduction:**

Standardization Methodology, Benefits of Product Standardization; International, National, Association and Company Level Standards; Parts Modularization

**Text Books:**

- 1 Engineering Design, George E. Dieter, McGraw-Hill
- 2 Product Integrity and Reliability in Design, John W. Evans and Jillian Y. Evans, Springer Verlag.

**Reference Books:**

- 1 The Product Management Handbook, Richard S. Handscombe, McGraw-Hill
- 2 New Product Design, Ulrich Eppinger
- 3 Product Design, Kevin Otto.

**Weblinks:**

- 1 [https://onlinecourses.nptel.ac.in/noc21\\_me83/preview](https://onlinecourses.nptel.ac.in/noc21_me83/preview)
- 2 <https://www.youtube.com/watch?v=HN9GtL21rb4&t=6s>

**ADVANCED MATERIALS****(Open Elective-III)****Semester: VII****L T P C****Course Code: 231ME7O04****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Explain the materials science and engineering concepts of varied materials to understand the correlations between structure and properties.
- CO2:** Apply the concept of strengthening mechanisms to assess the properties of special metallic materials and alloys.
- CO3:** Apply the concept of strengthening mechanisms to assess the properties of polymers and composite materials.
- CO4:** Analyze the role of functional & smart materials in the contemporary applications covered in diverse fields of engineering and technology.
- CO5:** Explain advances in nanomaterials applications in varied fields with a special focus on safety, sustainability, and environmental considerations.

**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 3    | 2    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 3    | 2    | -    | -    | -    | -    | 3    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | 3    |
| <b>CO2:</b> | -    | 3    |
| <b>CO3:</b> | -    | 3    |
| <b>CO4:</b> | -    | 3    |
| <b>CO5:</b> | -    | 3    |

**Unit - I**

Introduction to Materials Science and Engineering:

Introduction to materials and their classifications (metals, polymers, ceramics, composites), Atomic structure and bonding in materials, Crystal structures and defects, Mechanical properties of materials (stress, strain, hardness), Thermal, electrical, and magnetic properties, Phase diagrams and transformations.

**Unit -II**

Advance metallic materials & alloys:

Types of metallic alloys and their applications, Heat treatment and alloying techniques, Strengthening mechanisms (grain size, work hardening, alloying), Special metallic materials (shape memory alloys, superalloys), Corrosion and wear resistance in stainless steels.

**Unit - III**

Polymer and Composite Materials

Classification of polymers and their properties, Polymer processing techniques, Composite materials: types, fabrication, and properties, Reinforcement materials (fibers, nanoparticles), Applications in aerospace, automotive, biomedical fields, Environmental considerations and recyclability.

**Unit – IV****Functional and Smart materials**

Piezoelectric, ferroelectric, and magneto strictive materials, Shape memory alloys and polymers, Thermochromic and photochromic materials, Self-healing and self-cleaning materials, Applications in sensors, actuators, and smart systems.

**Unit – V****Nanomaterials and Future Trends in Materials Science**

Nanomaterials: synthesis, characterization, and properties, Carbon nanotubes and graphene, Nanocomposites and their applications, Ethical, safety, and environmental considerations, Emerging trends: 2D materials, biomaterials, and sustainable materials.

**Text Books:**

- 1 R. Balasubramaniam, "Callister's Materials Science and Engineering," 2<sup>nd</sup> Edition, Wiley, 2009.
- 2 G. E. Dieter, "Mechanical Behavior of Materials," 3rd Edition, McGraw-Hill, 1986.

**Reference Books:**

- 1 L. M. Nieckele, "Advanced Materials: Properties, Processing, and Applications," CRC Press, 2019.
- 2 R. W. Cahn and P. Haasen (Eds.), "Physical Metallurgy," 4th Edition, Elsevier, 1996.
- 3 S. C. Sharma, "Advanced Materials and Their Applications," Dhanpat Rai Publishing Company, 2018.
- 4 V. Raghavan, "Materials Science and Engineering," PHI Learning, 2014.

**Weblinks:**

- 1 <https://ocw.mit.edu/courses/3-051j-materials-for-biomedical-applications-spring-2006/>
- 2 [https://www.youtube.com/playlist?list=PLbRMhDVUMngdzWQyMgoUgdaGBqi\\_p4nVM](https://www.youtube.com/playlist?list=PLbRMhDVUMngdzWQyMgoUgdaGBqi_p4nVM)
- 3 <https://www.coursera.org/specializations/materials-science-for-advanced-technological-applications>

## Smart Manufacturing

### (Open Elective-III)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>Semester: VII</b>          | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231ME7005</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, students will be able to:**

- CO1:** Learn about smart manufacturing systems' components and handle them more effectively in the context of Industry 4.0
- CO2:** Develop an understanding of smart machines and smart sensors
- CO3:** Apply IoT to Industry 4.0, and they can make a system tailor-made as per the requirements of the industry
- CO4:** Develop an understanding of the concepts of Digital Twin to apply Artificial Intelligence and Machine Learning concepts in Manufacturing
- CO5:** Explain the concepts of AR/VR and Metaverse platform

#### Mapping of Course Outcomes with Program Outcomes:

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 2    | 2    | 1    | -    | 2    | 2    | -    | -    | -    | -     | -     | 2     |
| <b>CO2:</b> | 2    | 2    | 1    | -    | 2    | 2    | -    | -    | -    | -     | -     | 2     |
| <b>CO3:</b> | 2    | 2    | 1    | -    | 2    | 2    | -    | -    | -    | -     | -     | 2     |
| <b>CO4:</b> | 2    | 2    | 1    | -    | 2    | 2    | -    | -    | -    | -     | -     | 2     |
| <b>CO5:</b> | 2    | 2    | 1    | -    | 2    | 2    | -    | -    | -    | -     | -     | 2     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

|      | PSO1 | PSO2 |
|------|------|------|
| CO1: | 2    | 0    |
| CO2: | 2    | 0    |
| CO3: | 2    | 0    |
| CO4: | 2    | 0    |
| CO5: | 2    | 0    |

#### UNIT – 1

**Concepts of Smart Manufacturing:** Definition and key characteristics of smart manufacturing, corporate adaptation processes, manufacturing challenges, challenges vs technologies, Stages in smart manufacturing. Minimizing six big losses in manufacturing with Industry 4.0, and their benefits.

#### UNIT – 2

**Smart Machines and Smart Sensors:** Concept and Functions of a Smart, Machine Salient features and Critical Subsystems of a Smart Machine, Smart sensors; smart sensors ecosystem, need, benefits and applications of sensors in industry, Introduction to IoT, IIoT, and Cyber physical systems, Sensing for Manufacturing Process in IIoT, Block Diagram of an IIoT Sensing Device, Sensors in IIoT

Applications, Smart Machine Interfaces,



**UNIT – 3**

**IoT connectivity for Industry 4.0:** Industrial communication requirement and its infrastructure, an overview of different types of networks, mesh network in industrial IoT, IoT protocols and the internet, TCP/IP (transmission control protocol/internet protocol) model, IoT connectivity standards: common protocols, application layer protocols, internet/network layer protocols, physical layer IoT protocols, choosing the right IoT connectivity protocol.

**UNIT – 4**

**Digital Twin:** Introduction, applications of digital twins, impact zones of digital twins in manufacturing (factories/plants and OEMs), advantages of digital twins, basic steps of digital twin technology

**Machine Learning (ML) and Artificial Intelligence (AI) in Manufacturing:** Introduction, benefits and applications of ML in industries, common approaches of ML; supervised and unsupervised, semi-supervised and reinforced ML.

**UNIT – 5**

Metaverse – Basic concepts, AR/VR, Social Metaverse, Industrial Metaverse, How Web 3.0 is changing the Internet, Asset Classes Inside the Metaverse, Land, Coins, Characters/ Avatars, Skins, Utility, Industries Disrupted by the Metaverse, Smart wearables.

**Text Books:**

- 1 Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008
- 2 Tom M. Mitchell, Machine Learning, McGraw Hill, 2013
- 3 Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.
- 4 Aurélien Géron, Hands on Machine Learning with Scikit-Learn and TensorFlow [Concepts, Tools, and Techniques to Build Intelligent Systems], Published by O'Reilly Media, 2017
- 5 S. Kaushik, Artificial Intelligence, Cengage Learning India,

**Reference Books:**

- 1 Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
- 2 Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012.
- 3 M.C. Trivedi, A Classical Approach to Artificial Intelligence, Khanna Publishing House, New Delhi, 2018.
- 4 Artificial Intelligence and Machine Learning, Principles and applications by Vinod Chandra S.S., Anand Hareendran S., PHI 2011.

**Web links:**

- 1 [https://onlinecourses.nptel.ac.in/noc25\\_cs91/preview](https://onlinecourses.nptel.ac.in/noc25_cs91/preview)
- 2 [https://onlinecourses.nptel.ac.in/noc25\\_cs147/preview](https://onlinecourses.nptel.ac.in/noc25_cs147/preview)
- 3 [https://onlinecourses.nptel.ac.in/noc25\\_cs146/preview](https://onlinecourses.nptel.ac.in/noc25_cs146/preview)

## DISCRETE TIME SIGNAL PROCESSING (Open Elective-III)

|                        |   |   |   |   |
|------------------------|---|---|---|---|
| VII Semester           | L | T | P | C |
| Course Code: 231EC7001 | 3 | 0 | 0 | 3 |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Summarize Discrete Time Signals and Systems.
- CO2** Illustrate the functionality of fourier series and fourier transform
- CO3** Apply DFT properties to evaluate the given sequence.
- CO4** Make use of FFT Algorithms for DFT computation.
- CO5** Interpret the basic structures of FIR and IIR digital filters.
- CO6** Extend the single rate digital signal processing to multirate digital signal processing

**Mapping of Course Outcomes with Program Outcomes:**

| CO / PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1     | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2     | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3     | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4     | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5     | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO6     | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | -     | -     |
| CO2      | -     | -     |
| CO3      | -     | -     |
| CO4      | -     | -     |
| CO5      | -     | -     |
| CO6      | -     | -     |

### Unit - I

#### Introduction to Digital Signal Processing:

Discrete time signals & sequences, linear shift invariant systems, stability, and causality. Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems.

**Unit – II****Discrete Fourier Series & Fourier Transforms:**

Properties of discrete Fourier series, DFS representation of periodic sequences, Discrete Fourier transforms: Properties of DFT, linear convolution of sequences using DFT, Computation of DFT.

**Unit – III****Fast Fourier Transforms:**

Fast Fourier Transforms (FFT) - Radix-2 Decimation-in-Time and Decimation-in-Frequency FFT Algorithms, Inverse FFT.

**Unit – IV****Realization Of Digital Filters:**

Review of Z-transforms, Applications of Z-transforms, solution of difference equations - digital filters, Block diagram representation of linear constant-coefficient difference equations, Basic structures of IIR systems, Transposed forms, Basic structures of FIR systems, System function.

**Unit – V****Multirate Digital Signal Processing:**

Decimation, Interpolation, Sampling rate conversion, Implementation of sampling rate conversion.

**Text Books:**

1. Digital Signal Processing, Principles, Algorithms and Applications: John G. Proakis, Dimitris G. Manolakis, Pearson Education/PHI, 2007.
2. Discrete Time Signal Processing, A. V. Oppenheim and R. W. Schaffer, PHI, 2010

**Reference Books:**

1. Fundamentals of Digital Signal Processing using MATLAB, Robert J. Schilling, Sandra L. Harris, Thomson, 2007.
2. Digital Signal Processing, P. Ramesh Babu, SciTech Publications, 6th Edition, 2014.
3. Digital Signal Processing, Tarun Kumar Rawat, Oxford University Press, 1st Edition, 2015.
4. Multirate Systems and Filter Banks, P. P. Vaidyanathan, Pearson, 1st Edition.

**Web Links:**

1. [https://www.tutorialspoint.com/digital\\_signal\\_processing/index.htm](https://www.tutorialspoint.com/digital_signal_processing/index.htm)
2. <https://nptel.ac.in/courses/117/102/117102060/> (Digital Signal Processing - Video course, Coordinator BY Prof. S.C. Dutta Roy Department of Electrical Engineering IIT Delhi)

## Linear and digital IC Applications (Open Elective-III)

|                        |          |          |          |          |
|------------------------|----------|----------|----------|----------|
| VII Semester           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| Course Code: 231EC7002 | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Construct Op Amps using the differential amplifier and other improvement circuits.
- CO2** Explain parameters related to measurement of Op-Amp characteristics.
- CO3** Construct the circuits for different linear applications using Op-Amp.
- CO4** Develop circuits for non-linear applications using Op-Amp.
- CO5** Construct the circuits for different Data conversion and Filtering applications using Op-Amp.
- CO6** Compare different digital logic families.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | 1    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| CO2   | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| CO3   | 2    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 2     |
| CO4   | 2    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 2     |
| CO5   | 2    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | 2     |
| CO6   | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | -    | -    |
| CO2    | -    | -    |
| CO3    | -    | -    |
| CO4    | -    | -    |
| CO5    | -    | -    |
| CO6    | -    | -    |

### Unit - I

**Introduction to Integrated Circuits:** Integrated Circuits Types, Classification, Package Types, Temperature ranges and Power supplies. Differential Amplifier-DC And AC analysis of differential amplifier configurations, circuits for improving CMRR, Necessity of swamping resistors, Cascaded Differential Amplifier Stages and Level translator.

## Unit – II

**Characteristics of Op-Amps:** Block Diagram of a Op-Amp, Pin diagram, symbolic representation and features of 741IC, Ideal and practical characteristics of an Op-Amp, Equivalent circuit of an Op-Amp, Define the terms input offset voltage and current, input bias current, CMRR, Slew Rate, PSRR, etc, Virtual ground concept, DC characteristics, AC characteristics and Measurement of Op-Amp parameters.

## Unit – III

**Linear and Non-Linear Applications of Op- Amps:** Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier, AC amplifier, V to I, I to V converters, Buffers. Non-Linear Applications-Comparators, Multivibrators, Triangular and Square wave generators, Log and Anti- log Amplifier, Precision rectifiers.

## Unit – IV

**D-A and A-D Converters:** Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, and IC 1408 DAC, Different types of ADCs parallel Comparator type ADC, counter type ADC, Successive Approximation ADC and dual slope ADC. DAC and ADC Specifications.

Active Filters: Introduction, Butter worth filters – 1st order, 2nd order LPF, HPF filters. Band pass, Band reject and All pass filters.

## Unit – V

**Digital Logic Families and Interfacing:** Introduction to logic families, CMOS logic, CMOS steady state and dynamic electrical behavior, CMOS logic families. Bipolar logic, transistor-transistor logic, TTL families, CMOS/TTL interfacing, low voltage CMOS logic and interfacing, Emitter coupled logic.

### Text Books:

1. Op Amps and Linear Integrated Circuits, Ramakant A. Gayakwad, 4<sup>th</sup> Edition, PHI, Pearson Education, 2003.
2. Linear Integrated Circuits–D. Roy Chowdhury, New Age International (p) Ltd, 2nd Edition, 2003.
3. Digital Design Principles & Practices – John F. Wakerly, PHI/ Pearson Education Asia, 4th Ed.,

### Reference Books:

1. Design with Operational Amplifiers & Analog Integrated Circuits–Sergio Franco, McGrawHill, 1988
2. OPAMPS and Linear Integrated Circuits concepts and Applications, James MFiore, Cengage Learning India Ltd.
3. Operational Amplifiers & Linear Integrated Circuits–R.F. Coughlin & Fredrick Driscoll, PHI, 6th Edition.
4. Fundamentals of Digital Logic with VHDL Design– Stephen Brown, Zvonko Vranesic, McGrawHill, 3<sup>rd</sup> Edition.

**Web Links:**

1. <http://nptel.ac.in/courses/117108038/Prof.GunashekaranM.K/IIScBangalore>
2. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-01sc-introduction-to-electrical-engineering-and-computer-science-i-spring-2011/unit-3-circuits/op-amps>

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## PRINCIPLES OF EMBEDDED SYSTEMS

### (Open Elective-III)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EC7003</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Summarize the building blocks of an embedded system.
- CO2** Interpret the hardware modules required to design an embedded system.
- CO3** Infer the firmware design approaches for an embedded system.
- CO4** Illustrate the hardware integration with firmware.
- CO5** Outline the process of embedded system development.
- CO6** Choose the tools for embedded system implementation and testing.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO6</b> | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO 1 | PSO 2 |
|------------|-------|-------|
| <b>CO1</b> | -     | -     |
| <b>CO2</b> | -     | -     |
| <b>CO3</b> | -     | -     |
| <b>CO4</b> | -     | -     |
| <b>CO5</b> | -     | -     |
| <b>CO6</b> | -     | -     |

### Unit - I

Introduction: Embedded system-Definition, History of Embedded systems, classification of embedded systems, major application areas of embedded systems, purpose of embedded systems, the typical embedded system-core of the embedded system, Memory, Sensors and Actuators, Communication Interface, Characteristics of an embedded system, Quality attributes of embedded systems, Application-specific and Domain-Specific examples of an embedded system.



**Unit – II**

Embedded Hardware Design: Analog and digital electronic components, I/O types and examples, Serial communication devices, Parallel device ports, Wireless devices, Timer and counting devices, Watchdog timer, Real time clock, multi processors architectures.

**Unit – III**

Embedded Firmware Design: Embedded Firmware design approaches, Embedded Firmware development

languages, Interrupt sources, ISR concept, Interrupt servicing mechanism, Multiple interrupts, DMA, Device driver programming, Concepts of C versus Embedded C.

**Unit – IV**

Real Time Operating System: Operating system basics, Types of operating systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling, Task communication, Task synchronization.

Hardware Software Co-Design:

Fundamental Issues in Hardware Software Co-Design, Computational models in embedded design, Hardware software Trade-offs, Integration of Hardware and Firmware.

**Unit – V**

Embedded System Development: The integrated development environment, Types of files generated on cross-compilation, Deassembler/ Decompiler, Simulators, Emulators and Debugging, Target hardware debugging, Boundary Scan, Embedded Software development process and tools.

Embedded System Implementation and Testing: The main software utility tool, CAD and the hardware, Translation tools-Pre-processors, Interpreters, Compilers and Linkers, Debugging tools, Quality assurance and testing of the design, Testing on host machine.

**Text Books:**

1. Embedded Systems, Shibu.K. V, Tata McGraw Hill Education Private Limited, 2013.
2. Embedded Systems-Architectures, Programming and Design, Raj Kamal, Tata McGraw Hill Publications.

**Reference Books:**

1. Embedded System Design, Frank Vahid and Tony Givargis, John Wiley Publications, 2013.
2. Hardware Software Co-Design Principles and Practice, J. Staunstrup, Springer Publications
3. Embedded Systems Architecture, Tammy Noergaard, Elsevier Publications, 2013.

**Web Links:**

1. <https://www.iitk.ac.in/tkic/workshop/sensors-and-actuators/ppt/sandeep.pdf>
2. [http://www.artistembedded.org/docs/Events/2006/ChinaSchool/1\\_ESIntroduction.pdf](http://www.artistembedded.org/docs/Events/2006/ChinaSchool/1_ESIntroduction.pdf)

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**CYBER SECURITY**  
**(Open Elective-III)**

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CS7O01</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Explain the cyber security and security management methods to maintain security protection

**CO2:** Illustrate the nature of secure software development and operating systems.

**CO3:** Summarize the Network management and cloud computing security issues.

**CO4:** Analyze the data privacy techniques and data management.

**CO5:** Illustrate the legal and social issues related to cyber security.

**Mapping of Course Outcomes with Program Outcomes:**

| CO / PO    | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 1    | -    | -    | 2    | -    | -    | 2    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | 3    | -    | 2    | 2    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 1    | 2    | -    | 2    | 3    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 1    | 2    | -    | 3    | 2    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | 1    | -    | 2    | -    | -    | -    | 3    | -    | -     | -     | -     |
| <b>CO6</b> | 3    | 1    | -    | -    | 2    | -    | -    | 2    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO / PSO   | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | -    |
| <b>CO2</b> | -    | -    |
| <b>CO3</b> | -    | -    |
| <b>CO4</b> | -    | -    |
| <b>CO5</b> | -    | -    |
| <b>CO6</b> | -    | -    |

### **Unit - I**

Introduction: Introduction to Computer Security, Threats, Harm, Vulnerabilities, Controls, Authentication, Access Control, and Cryptography, Authentication, Access Control, Cryptography. Programs and Programming: Unintentional (Non-malicious) Programming Oversights, Malicious Code—Malware, Countermeasures.

### **Unit – II**

Web Security: User Side, Browser Attacks, Web Attacks Targeting Users, Obtaining User or Website Data, Email Attacks. Operating Systems Security: Security in Operating Systems, Security in the Design of Operating Systems, Rootkit.

### **Unit – III**

Network Security: Network Concepts, Threats to Network Communications, Wireless Network Security, Denial of Service, Distributed Denial-of-Service Strategic Defenses: Security Countermeasures, Cryptography in Network Security, Firewalls, Intrusion Detection and Prevention Systems, Network Management . Cloud Computing and Security: Cloud Computing Concepts, Moving to the Cloud, Cloud Security Tools and Techniques, Cloud Identity Management, Securing IaaS.

### **Unit – IV**

Privacy: Privacy Concepts, Privacy Principles and Policies, Authentication and Privacy, Data Mining, Privacy on the Web, Email Security, Privacy Impacts of Emerging Technologies, Where the Field Is Headed. Management and Incidents: Security Planning, Business Continuity Planning, Handling Incidents, Risk Analysis, Dealing with Disaster.

### **Unit – V**

Legal Issues and Ethics: Protecting Programs and Data, Information and the Law, Rights of Employees and Employers, Redress for Software Failures, Computer Crime, Ethical Issues in Computer Security, Incident Analysis with Ethics Emerging Topics: The Internet of Things, Economics, Computerized Elections, Cyber Warfare.

#### **Text Books:**

1. Pfleeger, C.P., Security in Computing, Prentice Hall, 5th edition.
2. Schneier, Bruce. Applied Cryptography, Second Edition, John Wiley & Sons.

#### **Reference Books:**

1. Rhodes-Ousley, Mark. Information Security: The Complete Reference, Second Edition, Information Security Management: Concepts and Practice, McGrawHill.
2. Whitman, Michael E. and Herbert J. Mattord. Roadmap to Information Security for IT and Infosec Managers. Boston, MA: Course Technology.
3. Information Security, Mark Rhodes, Ousley, 2 nd edition, MGH.

#### **Web Links:**

1. <https://www.edx.org/micromasters/ritx-cybersecurity>.
2. <https://www.coursera.org/specializations/cyber-security>.
3. <https://www.nptel.ac.in/courses/106105031/>.
4. <http://bedford-computing.co.uk/learning/wp-content/uploads/2016/08/>
5. <https://www.wileyindia.com/cyber-security-understanding-cybercrimescomputer-forensics-and-legal-perspectives.html>

### INTERNET OF THINGS (Open Elective-III)

|                        |   |   |   |   |
|------------------------|---|---|---|---|
| VII Semester           | L | T | P | C |
| Course Code: 231IT7O01 | 3 | 0 | 0 | 3 |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1:** Explain the fundamental concepts of internet of things.
- CO2:** Illustrate diversified layered architectures and design principles for IoT/M2M.
- CO3:** Identify appropriate network layer protocols used in IoT
- CO4:** Illustrate the scope of data organizing and business models and process.
- CO5:** Describe the role of bigdata, cloud computing and data analytics in a typical IoT system.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 2   | 2   | 1   | -   | 1   | -   | -   | -   | -   | -    | -    | -    |
| CO3   | 2   | 2   | 1   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 2   | 1   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 3   | 1   | -   | -   | 1   | -   | -   | -   | -   | -    | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 1    | -    |
| CO2    | 1    | -    |
| CO3    | 2    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

#### UNIT-I:

**The Internet of Things:** An Overview of Internet of things, Internet of Things Technology, behind IoTs Sources of the IoTs, M2M Communication, Examples of IoTs, Design Principles for Connected Devices.

#### UNIT-II:

Modified OSI Stack for the IoT/M2M Systems, ETSI M2M domains and High- level capabilities, Communication Technologies, Data Enrichment and Consolidation and Device Management Gateway Ease of designing and affordability.

#### UNIT-III:

Design Principles for the Web Connectivity for connected-Devices, Web Communication protocols for Connected Devices, Message Communication protocols for Connected Devices, Web Connectivity for connected-Devices.

**UNIT-IV:**

Data Acquiring, Organizing and Analytics in IoT/M2M, Applications /Services /Business Processes, IOT/M2M Data Acquiring and Storage, Business Models for Business Processes in the Internet of Things, Organizing Data, Transactions, Business Processes, Integration and Enterprise Systems.

**UNIT-V:**

Data Collection, Storage and Computing Using a Cloud Platform for IoT/M2M Applications/Services, Data Collection, Storage and Computing Using cloud platform Everything as a service and Cloud Service Models, IOT cloud-based services using the Xively (Pachube/COSM), Nimbits and other platforms Sensor, Participatory Sensing, Actuator, Radio Frequency Identification, and Wireless, Sensor Network Technology, Sensors Technology, Sensing the World.

**Text Books:**

1. Internet of Things: Architecture, Design Principles And Applications, Rajkamal, McGraw Hill Higher Education.
2. Vijay Madisetti, Arshdeep Bahga, Internet of Things A Hands-On- Approach, 2014

**Reference Books:**

1. An Introduction to Internet of Things, Connecting devices, Edge Gateway and Cloud with Applications, Rahul Dubey, Cengage, 2019. Adrian McEwen, Designing the Internet of Things, Wiley Publishers, 2013.
2. IoT Fundamentals, Networking Technologies, Protocols and Use Cases for the Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetette, rob Barton, Jerome Henry, CISCO, Pearson, 2018.
3. Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, Wiley.

**Web Links:**

1. [https://onlinecourses.nptel.ac.in/noc21\\_cs17/preview](https://onlinecourses.nptel.ac.in/noc21_cs17/preview)
2. <https://arduinomakerspace.com/iot-projects-using-arduino/>
3. <https://www.coursera.org/specializations/iot>

### Computer Networks (Open Elective-III)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231AM7O01</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1:** Identify different types of network topologies, protocols and the layers of the OSI and TCP/IP models
- CO2:** Recognize the data link layer design issues and various protocols used for data transmission
- CO3:** Describe MAC Sublayer and how a network can detect and correct transmission errors
- CO4:** Classify and compare the major routing and congestion control algorithms
- CO5:** Describe the functionality of TCP and UDP and summarize the various Application layer protocols such as http, DNS, and HTTP

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 1    | 2    | 3    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 3    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 1    | 2    | 2    | 3    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 3    | 1    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | POS1 | POS2 |
|--------|------|------|
| CO1    | -    | -    |
| CO2    | -    | -    |
| CO3    | -    | -    |
| CO4    | -    | -    |
| CO5    | -    | -    |

#### UNIT-I

**Introduction:** Computer network and components, Types of Computer Networks, Network Software, Reference Models: OSI Reference Model, TCP/IP Reference Model, Comparison between OSI and TCP/IP Models; Example Networks: The ARPANET, Internet., Transmission Media, Guided and Un-guided media.

#### UNIT-II

**Data Link Layer:** Data Link Layer Design Issues: Services Provided to Network Layer, Framing, Error Control and Flow Control; Error Detection and Correction: Error Correcting Codes, Error Detecting Codes; Elementary Data Link Protocols, Sliding Window Protocols: One-Bit Sliding Window Protocol, Protocol Using Go Back N and Selective Repeat.

**UNIT-III**

**The Medium Access Control Sublayer (MAC):** Channel Allocation Problem: Static Channel Allocation, Dynamic Channel Allocation; Multiple Access Protocol: ALOHA, Carrier Sense Multiple Access Protocols, Collision-Free Protocols, Limited Contention Protocol.

**UNIT-IV**

**The Network Layer:** Network Layer Design Issues, Routing Algorithms: The Optimality Principle, Shortest Path Routing, Flooding, Distance Vector Routing, Link State Routing, Hierarchical Routing, Congestion Control Algorithms: General Principles of Congestion Control, Congestion Prevention Policies. The Network Layer in Internet-The IP Protocol, IP Address IPV4, IPV6.

**UNIT – V**

**The Transport Layer:** Services Provided to Upper Layer; Elements of Transport Protocols: Connection Establishment, Connection Release; The Internet Transport Protocols: UDP and TCP Protocol, TCP Connection Establishment, TCP Connection Release.

**The Application Layer:** DNS- Domain Name System, Electronic Mail: Architecture and Services, The World Wide Web: Architectural Overview; Web documents: Static Web Document, Dynamic Web Document; Hyper Text Transfer Protocol (HTTP).

**Text Books:**

- 1 Andrew S. Tanenbaum, Computer Networks, 5th Edition, Pearson Education, 2016.
- 2 Behrouz A Forouzan, Data Communications and Networking, 4th Edition, McGraw-Hill- 2006

**Reference Books:**

- 1 S Keshav, An Engineering approach to computer Networking, 2nd Edition, Pearson Education
- 2 J.F.Kurose, K.W.Ross, Computer Networking a Top-Down approach featuring the internet, 2nd Edition, Pearson Education.

**Web Links:**

- 1 <https://nptel.ac.in/courses/106105081>
- 2 <https://www.coursera.org/learn/fundamentals-network-communications>
- 3 [nptel.ac.in/courses/106/106/106106091/](https://nptel.ac.in/courses/106/106/106106091/)

## Mine Waste Management (Open Elective-III)

VII Semester

Course Code: 231MI7001

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Explain about power systems used in mines.  
**CO2:** Analyze various earthing methods used in mines.  
**CO3:** Summarize various electrical equipments used in mines.  
**CO4:** Discuss about the instrumentation and control systems used in mines  
**CO5:** Analyze about intrinsic safety.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 2    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

### Unit - I

Mine power supply

Choice of voltage, surface and underground supply: Tariff Computation, standards of lighting and method of illumination in open cast and underground Mine Cables- types, Construction details, installation of cables through shaft and other locations, fault location, cable jointing, care and maintenance, Gate-end boxes and switch gears. Principles of flame-proof enclosures

### Unit – II

Earthing

Earthing Methods, protective devices, overload, under-voltage earth leakage, D.C. Supply-rectifiers, storagebatteries.



**Unit – III****Electrical Equipment**

Mining transformers used in mines, lighting transformer, no load-on-load operations, losses and efficiency and voltage regulation. A.C. and D.C. Motors speed-torque characteristics, starting, braking, speed control, drives for haulage. ventilation fans, pumps, compressors, electrical locomotives, winders, Introduction to thyristor device, flame proof and intrinsic safety.

**Unit – IV**

Control and instrumentation Open and closed loop system, remote control, sequence control, winder control of open cast mine equipment, sensor for measurement of various operational, environmental and safety parameters in underground and open cast mines.

**Unit – V****Communication and data transmission**

Mine telephone system, signaling system, LAN, WAN

Intrinsically – safe circuit – methods of attaining intrinsic safety, zener safety barriers and their application. Indian electricity Act and rules 1956 as applied to mines.

**Text Books:**

1. Electrical equipment in Mines by H.Cotton
2. Electrtechnology mining by N.Merinovic

**Reference Books:**

1. Amitosh Dey, Heavy Earth Moving Machinery, Lovely Prakashan Publications, Dhanbad, 2000.
2. Walker, S.C., Mine Winding and Transport, Elsevier, 1988. 7.
3. Alemgren G., Kumar U., and Vagenas N., Mine Mechanisation and Automation, A.A., Balkema Publication, 1993.

**Web Links:**

1. [http://mineportal.in/upload-study-material.php?imgaaa=1 &imagename= MINE %20MACHINERY\\_243.pdf](http://mineportal.in/upload-study-material.php?imgaaa=1&imagename=MINE%20MACHINERY_243.pdf)
2. [http://mineportal.in/assets/study\\_material/Locomotive\\_Haulage\\_221\\_mineportal.pdf](http://mineportal.in/assets/study_material/Locomotive_Haulage_221_mineportal.pdf)

**SUSTAINABLE DEVELOPMENT IN MINING INDUSTRY****Open Elective -III**

VII Semester

**L T P C****Course Code:** 231MI7O02**3 0 0 3****Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Explain sustainable development principles and regulatory requirements applicable to the mining sector.
- CO2:** Evaluate mining policies and their influence on sustainable mining practices nationally and globally.
- CO3:** Apply clean technologies and resource recovery methods to enhance mining sustainability.
- CO4:** Implement water and air pollution control measures and monitor environmental quality in mining operations.
- CO5:** Develop and manage mine closure plans, land reclamation projects, and promote biodiversity conservation in mining areas.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | 3    | -    | -    | -    | -    | 1    | 1    | -    | -     | -     | -     |
| CO2   | 1    | 3    | -    | -    | -    | -    | 1    | 1    | -    | -     | -     | -     |
| CO3   | 1    | 3    | -    | -    | -    | -    | 1    | 1    | -    | -     | -     | -     |
| CO4   | 1    | 3    | -    | -    | -    | -    | 1    | 1    | -    | -     | -     | -     |
| CO5   | 1    | 3    | -    | -    | -    | -    | 1    | 1    | -    | -     | -     | -     |

**UNIT – I**

Concept of Sustainable development for mining industry-Sustainable development –a perspective of mineral professional community. International sustainability reporting and tools for measurement of sustainability. Milos statement on Sustainable mineral industry. Legislative measures for sustainable development- MMDR Act- star rating of Indian mines (Non-coal), Environmental responsibility – Corporate social responsibility. District mineral fund, its collection, utilization etc.

**UNIT – II**

Current status of mining practices and their impact on sustainability. Mining and environmental frame work, National mineral policies in mineral based countries. Indian national mineral policy, its historical development with the changing goals and sustainable practices. Issues of leases, auctions for mineral development in India.

**UNIT – III**

Clean coal technologies, Coal bed methane, abandoned coal mine methane, Underground gasification of coal. Leaching of old dumps and recovery of metals. Recycling of metals. Application of new techniques for sustainable development

**UNIT – IV**

Mine water- Water conservation Acts and rules in India. New Initiatives in mines. Underground mine water, Water pollution and control measures, Phyto-remediation, Sewage and effluent treatment plants, their use and benefits. Air quality in open pit mines, dust control measures, noise levels- pollution, monitoring and control.

**UNIT – V**

Bio-diversity- Land reclamation and plantation. Mine closure plan- Collection and disbursement of Mine closure fund for both open pit and underground mines in India. Best mining practices for Sustainable mining. - Case studies. Innovative practices for achievement of sustainability. Benefits of sustainability.

**Text Books:**

1. MMRD Act 2015 and amendments, Ministry of Mines
2. Mineral concession Rules

**Reference Books:**

1. Guidelines of MOEF and Climate change - Annual reports of MOEF&CC, Ministry of Mines, Ministry of Coal in India,
2. Sustainable mining practices –A global perspective by Vasudevan Rajaram, Subijoy Dutta, Krishna Paremeswaran, ISBN-90-5809-689-0

**Web Links:**

1. <https://www.slideshare.net/slideshow/sustainable-mining-practices-240275756/240275756>
2. [https://www.teriin.org/sites/default/files/files/Sustainable\\_Mining\\_Practices\\_India.pdf](https://www.teriin.org/sites/default/files/files/Sustainable_Mining_Practices_India.pdf)
3. <https://www.unep.org/resources/report/green-mining-sustainable-mining-practices>

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**MINE RECLAMATION****Open Elective -III****VII Semester****L T P C****Course Code: 231MI7O03****3 0 0 3****Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Describe environmental problems caused by mining and assess the impact of mining machinery on the environment.
- CO2:** Evaluate land degradation and plan for effective waste disposal and tailings impoundment.
- CO3:** Apply land reclamation techniques, including soil conservation and vegetation restoration for disturbed mining sites.
- CO4:** Implement engineering and biological reclamation methods for mine closure and land restoration.
- CO5:** Develop environmental management plans and ensure compliance with environmental laws, standards, and corporate social responsibility practices in mining.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**UNIT – I**

Recent changes in development paradigms; concepts of carrying capacity and sustainable development; environmental problems caused by mining and influencing factors. Environmental aspects of various Mining Machines.

**UNIT – II**

Land Degradation; land use categories; pre-mining investigations; landscape planning and visual impact; waste disposal, overburden dumps and tailings impoundment.

**UNIT – III**

Land reclamation procedures; Influence of type of deposit, topography and equipment; top soil characteristics; top soil removal and storage; application of mulches, stabilizing agents and fertilizers;  
Land Reclamation: Re-vegetation and restoration methodologies; Plant species selection; Reclamation methods by using different combination of equipment, Case studies of coal and metalliferous mine dumps/spoils.

**UNIT – IV**

Engineering and biological reclamation; afforestation of mine areas, tailing ponds, mine closure and amenity banks; best practices of mined out land reclamation.

**UNIT – V**

Corporate Social Responsibility towards mine closure and reclamation: Concepts and principles. Environmental policies and laws: Environmental management systems, environmental impact assessment and environmental management planning; base line studies, environmental audit, ISO 14001, OHSAS.

**Text Books:**

1. Dr. B.B. Dhar, Environmental Management of Mining Operations. Pub
2. Bulk Handling in Open Pit Mines & Quarries: Reinhard H. Wohlbiel
3. Coal Mines Regulations, 1957 and Metalliferous Mines Regulations, 1961
4. Introductory Mining Engineering: Howard L. Hartman

**Reference Books:**

1. Modern Coal Mining Technology: Samir Kumar Das
2. Opencast Mining – Technology and Integrated Mechanization: V.V. Rzhevsky
3. Opencast Mining – Unit Operations: V.V. Rzhevsky
4. SME Hand Books
5. Surface Mining: G.B. Misra
6. Surface Mining Technology: Samir Kumar Das
7. Proceeding of the National & International Seminars/Symposium organized in concern with mine environment.

**Web Links:**

1. <https://www.slideshare.net/slideshow/environmental-impacts-of-mining-and-land-reclamation/238259964/238259964>
2. <https://www.fao.org/3/i6426e/i6426e.pdf>
3. <https://www.slideshare.net/slideshow/environmental-management-in-mining-industry/250032112/250032112>

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## IMPACTS OF MINING ON ENVIRONMENT

### Open Elective -III

VII Semester

Course Code: 231MI7O04

|   |   |   |   |
|---|---|---|---|
| L | T | P | C |
| 3 | 0 | 0 | 3 |

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Explain environmental management principles and global/local environmental issues affecting mining.
- CO2:** Identify types of pollution, assess their impacts, and recommend control and preventive measures.
- CO3:** Analyze land pollution challenges, tailing management techniques, and implement mine closure plans.
- CO4:** Apply environmental management tools including EIA, audits, and economic analysis for mining operations.
- CO5:** Demonstrate knowledge of key environmental legislation and regulatory compliance for mining projects.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | -    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | -    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | -    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | -    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | -    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

#### UNIT – I

Introduction: Goals, strategies and tools for environmental management – systems approach to environmental management – environmental guideline – National Policies on environment with respects to mining activities – Global and Local environmental issues – resource degradation – desertification – Industrialization, Objectives of Sustainable Development. Structure of the atmosphere – ozone layer depletion – Acid rain – Greenhouse gases and global warming Ambient Air quality and emission standards, Air quality Sampling and monitoring, Dispersion of air pollutants.

#### UNIT – II

Environmental Pollution – I: Environmental Pollutants due to surface – Air, Water, Noise, Sources and Classification of pollutants including dust and their effect on human health, Sources, hazards, sampling and analysis, standards, instrumentation and measurement of pollutants including dust, Air born dust modeling, Control and preventive measures for air pollution including for dust, , Water pollution standards, Noise standards – Measurement – Noise Impact Index assessment, Control and preventive measures for water, noise pollution. Pollution due to blast and equipment vibrations their monitoring, prevention and control.

#### UNIT – III

Environmental Pollution – II: Land pollution, land for alternation dealing with mind out land, re-vegetation, tailing management, tailing dams, method and construction, land use plan, Mine closure planning. Textural classification and properties of soil. Impact of pollution on human health, miner's diseases and their social impact.

**UNIT – IV**

Environmental Management: Environmental quality objectives, Emission and ambient standards – Minimum National standards – International environmental standards – ISO 14000 – EIA Notification – Siting of Industries – Environmental management plans, Environmental impact assessment, Environmental management system audits, Environmental economics – Principles of cost benefit analysis – Valuing the Environment – Environmental Accounting, Environmental administration- training awareness and competence, Mine subsidence, its prediction and control.

**UNIT – V**

Environmental Legislations: Environmental laws, the Environmental (Protective) Act, 2004, The Water Act (1974), The Air act (1981), The Forest Act 1927, The forest conservation act 1980, Power and responsibilities of regulatory agencies and occupation consent to establish and operate wild life protection act and rules, Environmental clearance procedure for a mining Project.

**Text Books:**

1. Manahan S.E. Environmental Science and Technology.
2. Mackenthun, K.M. Basic Concepts in Environmental Management, Lewis Publications, London, 1998.

**Reference Books:**

1. Noel de Nevers, Air Pollution Control Engg., McGraw Hill, New York, 1995
2. Anjaneyulu, Y. Air Pollution & Control Technologies, Allied Publishers (P) Ltd, India, 2002.
3. Nick Hanley, Jaison F. Shogren and Ben White. Environmental Economics – In Theory and Practice, Macmillan India Ltd, New Delhi, 1999.
4. Roger Perman, Yue Ma and James McGilvray. Natural Resources and Environmental Economics, Second edition, Addison Wesley Longman Ltd, Singapore, 1997

**Web Links:**

1. [https://nptel.ac.in/courses/124/105/124105076/downloads/Lecture\\_Notes\\_Environmental\\_Management\\_Mining.pdf](https://nptel.ac.in/courses/124/105/124105076/downloads/Lecture_Notes_Environmental_Management_Mining.pdf)
2. [https://www.academia.edu/38723281/Environmental\\_Management\\_Pollution\\_Control\\_in\\_Mining\\_Industries](https://www.academia.edu/38723281/Environmental_Management_Pollution_Control_in_Mining_Industries)
3. [https://moef.gov.in/wp-content/uploads/2023/04/guidelines\\_for\\_environmental\\_impact\\_assessment\\_emp.pdf](https://moef.gov.in/wp-content/uploads/2023/04/guidelines_for_environmental_impact_assessment_emp.pdf)

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## WATER HARVESTING AND SOIL CONSERVATION STRUCTURES (Open Elective-III)

VII Semester

L T P C

Course Code: 231AG7O01

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Recommend the short term and long-term runoff harvesting at appropriate places in watershed.

**CO2:** Design criteria and cost estimation of farm ponds.

**CO3:** Explain the functions of soil erosion control structures.

**CO4:** Apply the concept hydraulic jump, runoff measuring structures and various permanent gully control structures.

**CO5:** Estimate the load analysis on various components of soil conservation structures.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | 2    | -    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 1    | -    | -    | -    | 1    | 1    | -    | -    | -    | -     | 1     | -     |
| CO3   | 2    | 1    | -    | -    | 1    | 1    | -    | -    | -    | -     | -     | -     |
| CO4   | 2    | 1    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 2    | 1    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | 3     | -     |
| CO2    | 3     | -     |
| CO3    | 3     | -     |
| CO4    | 3     | -     |
| CO5    | 3     | -     |

### Unit - I

Water harvesting -principles, importance and uses. Water harvesting techniques – classification based on source, storage and use. Runoff harvesting – short-term and long-term techniques. Short-term harvesting techniques - contour bunds, semicircular hoop, trapezoidal bunds, graded bunds, rock catchment and ground catchment. Long term harvesting techniques- purpose and design criteria

### Unit – II

Structures - farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes. Farm pond - components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction. Percolation pond - site selection, design and construction details. Design considerations of nala bunds.



**Unit – III**

Soil erosion control structures - introduction, classification and functional requirements. Design of Gabion structures. Permanent structures for soil conservation and gully control – check dams, drop, chute and drop inlet spillways - design requirements, planning for design, design procedures - hydrologic, hydraulic and structural design and stability analysis.

**Unit – IV**

Hydraulic jump and its application. Drop spillway - applicability, types - straight drop, box-type inlet spillways - description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions.

Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway - description, functional use and design criteria.

**Unit – V**

Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension.

**Text Books:**

1. Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
2. Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

**Reference Books:**

1. Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
2. Schwab, G.O., D.D. Fangmeier, W.J. Elliot, R.K. Frevert. 1993. Soil and Water Conservation Engineering. 4th Edition, John Wiley and Sons Inc. New York.

**Web Links:**

1. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=125071>
2. <http://ecoursesonline.iasri.res.in/course/view.php?id=54>
3. <https://nptel.ac.in/courses/126/105/126105012/>
4. <https://www.fao.org/land-water/water/water-management/water-storage/en/>

## BIG DATA ANALYTICS

(Open Elective-III)

VII Semester

Course Code: 231DS7O01

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Illustrate big data challenges in different domains.
- CO2:** Use various techniques for mining data stream.
- CO3:** Demonstrate Building blocks of Hadoop.
- CO4:** Choose map reduce approach to solve big data Problems.
- CO5:** Make use of Pig and Hive to structure and work with big Data.
- CO6:** Make use of Spark tool to work with bigdata.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 3   | 2   | -   | 1   | 2   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 2   | 3   | -   | 1   | 2   | -   | -   | -   | -   | -    | -    | -    |
| CO3   | 2   | 1   | -   | 3   | 2   | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 3   | 2   | -   | 2   | 2   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 2   | 3   | -   | 2   | 2   | -   | -   | -   | -   | -    | -    | -    |
| CO6   | 2   | 2   | -   | 1   | 3   | -   | -   | -   | -   | -    | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | -    | -    |
| CO2    | -    | -    |
| CO3    | -    | -    |
| CO4    | -    | -    |
| CO5    | -    | -    |
| CO6    | -    | 2    |

### Unit– I

Introduction: Introduction to bigdata: Introduction to Big Data Platform, Challenges of Conventional Systems, Intelligent data analysis, Nature of Data, Analytic Processes and Tools, Analysis vs Reporting.

### Unit– II

Stream Processing: Mining data streams: Introduction to Streams Concepts, Stream Data Model and Architecture, Stream Computing, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting One ness in a Window, Decaying Window, Real time Analytics Platform (RTAP) Applications.

### Unit–III

Introduction to Hadoop: Hadoop: History of Hadoop, the Hadoop Distributed File System, Components of Hadoop Analyzing the Data with Hadoop, Scaling Out, Hadoop Streaming, Design of HDFS, Java interfaces to HDFS Basics, Developing a Map Reduce Application, How Map Reduce Works, Anatomy of a Map Reduce Job run, Failures, Job Scheduling, Shuffle and Sort, Task execution, Map Reduce Types and Formats, Map Reduce Features Hadoop environment.

### Unit– IV

Pig: Hadoop Programming Made Easier: Admiring the Pig Architecture, Going with the Pig Latin Application Flow, Working through the ABCs of Pig Latin, Checking out the Pig Script Interfaces, Scripting with Pig Latin.

Working with Hive Data Types, Creating and Managing Data bases and Tables, Seeing How the Hive Data Manipulation Language Works with examples, Querying and Analyzing Data.

### Unit– V

Spark: Installing Spark, Spark applications, Jobs, stages and Tasks, Resilient Distributed datasets, Shared Variables, Anatomy of a Spark job run.

#### Text Books:

1. Hadoop: The Definitive Guide, Tom White, 4<sup>th</sup> Edition, O'reilly, 2012.
2. Hadoop for Dummies, Dirkde Roos, PaulC.Zikopoulos, RomanB.Melnyk, Bruce Brown, Rafael Coss, John Wiley& Sons, 2014.
3. Anand Raja ramanand Jeffrey David Ullman, "Mining of Massive Datasets", CUP, 2012

#### Reference Books:

1. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley& sons, 2012.
2. Paul Zikopoulos, Dirkde Roos, Krishnan Parasuraman, Thomas Deutsch, James Giles, David Corrigan, "Harness the Power of Big Data: The IBM Big Data Platform", Tata Mc Graw Hill Publications, 2012.
3. Arshdeep Bahga and Vijay Madiseti, "Big Data Science& Analytics: A Hands On Approach", VPT, 2016.
4. Learning Spark: Lightning Fast Big Data Analysis Paper back, Holden Karau

#### Web Links:

1. Hadoop: <http://hadoop.apache.org/>
2. Hive: <https://cwiki.apache.org/confluence/display/Hive/Home>
3. <http://nptel.ac.in/courses/106106142/>
4. <https://hortonworks.com/tutorial/how-to-process-data-with-apache-hive/>
5. <https://databricks.com/spark/getting-started-with-apache-spark>

## PIPELINE ENGINEERING (OPEN ELECTIVE-III)

**VII Semester**

**L T P C**

**Course Code: 231PT7O01**

**3 0 0 3**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Illustrate Fluid physical properties and flow in pipes
- CO 2:** Derive the single phase fluid flow equations
- CO 3:** Determine the flow regime and pressure drop calculations.
- CO 4:** Estimation of pressure loss across control valves
- CO 5:** Explain the design aspects of subsea and buried pipelines.

### Mapping of Course Outcomes with Program Outcomes

| CO/PO | PO1 | PO2 | PO 3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|------|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 2   | -   | -    | -   | -   | -   | -   | -   | -   | 2    | -    | 2    |
| CO2   | 2   | -   | -    | -   | -   | -   | -   | -   | -   | 2    | -    | 2    |
| CO3   | 2   | -   | -    | -   | -   | -   | -   | -   | -   | 2    | -    | 2    |
| CO4   | 2   | -   | -    | -   | -   | -   | -   | -   | -   | 2    | -    | 2    |
| CO5   | 2   | -   | -    | -   | -   | -   | -   | -   | -   | 2    | -    | 2    |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | 3     | -     |
| CO2      | 3     | -     |
| CO3      | 3     | -     |
| CO4      | 3     | -     |
| CO5      | 3     | -     |

#### Unit-I:

**Fluid flow and piping:** Bernoulli's theorem, Fluid physical properties, Flow in pipes and Reynolds number, Pressure loss due to friction, Friction factor and effect of pipe roughness, Equivalent length of valves and fittings, Compressibility of gas.

#### Unit-II:

**Single Phase Flow:** Transmission line gas flow - Isothermal flow, flow equation: The AGA equations, The Weymouth equation, Panhandle A equation, Panhandle B equation; Low Pressure gas flow; Plant piping gas flow.

#### Unit-III:

**Two Phase Flow:** Flow regime determination; Pressure drop calculation- Frictional component, Elevation component; Liquid Holdup.  
Liquid Slugging- Purpose of separators, Mechanism of slug generation, Slug catchers, Pigging.

**Unit-IV:**

**Pipe, Fittings and Valves:** Usual industry pipe sizes and classes practice, total line pressure drop. Pressure drop in fittings, valves, connections. Incompressible fluid, use of k factors, validity of k values. Laminar flow, piping systems, resistance and flow coefficients of valves, nozzles and orifices.

Alternate calculation basis for piping system friction head loss: liquids, equivalent feet concept. Friction pressure drop for non-viscous liquids. Estimation of pressure loss across control valves: Usage of various methods. Friction loss for water flow in pipe system

Pipe flow system with liquid of specific gravity other than water; Friction pressure drop for compressible fluid flow; Pressure drop for vapor system, alternate solution to compressible flow problems, friction drop for air, steam flow using Babcock formula.

**Unit-V:**

Sonic conditions, limiting flow of gases and vapors, gas flow through sharp-edged orifice, sonic velocity and friction drop for compressible natural gas in long pipelines. Complex pipe system handling natural gas, factors of safety for design basis. Design aspects of subsea and buried pipelines; Material selection.

**Text Book:**

1. GPSA Engineering Data Book, Volume 2, 12 Edition, 2003.
2. Ludwig's Applied Process Design for Chemical and Petrochemical Plants, Volume 1, 4<sup>th</sup> Edition, A. Kayode Coker, Elsevier, 2007
3. Piping and Pipeline Calculations Manual, Construction, Design, Fabrication and Examination, Philips Ellenberger, Elsevier, 2010.

**Reference Books:**

1. Liquid pipeline hydraulics; E. Sashi Menon; Marcel Dekker Inc.; 2004.
2. Gas-pipe hydraulics; E. Sashi Menon; CRC Press-Taylor & Francis Publications; 2005.
3. Flow of fluids, Crane, 7<sup>th</sup> edition, 1988

## INTRODUCTION TO SEISMIC METHODS (OPEN ELECTIVE-III)

**VII Semester**

**L T P C**

**Course Code: 231PT7O02**

**3 0 0 3**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Illustrate the Geophysical exploration methods
- CO 2:** Differentiate between Seismic Refraction and Seismic Reflection
- CO 3:** Explain the application of seismic refraction method.
- CO 4:** Estimation of Seismic Reflection methods and its applications
- CO 5:** Explain the recent advances in seismic methods.

### Mapping of Course Outcomes with Program Outcomes

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      |       |       |
| CO2      |       |       |
| CO3      |       |       |
| CO4      |       |       |
| CO5      |       |       |

#### UNIT-I:

**Introduction to Geophysical methods:** used in oil Industry with emphasis on seismic methods and their historical back ground , basic concepts and the present status of these methods in the industry.

#### UNIT-II:

**Historical back ground of seismic methods:** Different types of these methods namely Seismic Refraction, Seismic Reflection, and well seismic methods, Different types of seismic waves.

**UNIT-III:**

**Seismic refraction methods:** Geometry of a Refracted wave, single layer and two layer case. Recording instruments & energy sources- Corrections to refraction data Interpretation. Application of seismic refraction method in calculating statics for application in reflection survey.

**UNIT IV**

**Seismic Reflection methods:** Geometry of reflected ray path: Single horizontal reflector- The reflection seismograph and seismogram (Seismic traces)- Importance of seismic reflection survey over seismic refraction survey technique.

Field procedures & principles- Receivers and sources. Field Layouts. Time corrections applied to seismic data- Data processing - Introduction to 2D & 3D data acquisition. - Common depth point (CDP) profiling & stacking- data interpretation of reflection data for identification of drillable structures. Marking of reflectors (different lithologic units in the subsurface, construction of time and depth structures maps and calculation of reserves based on these identified structures. AVO and seismic inversions.

**UNIT V:**

Brief introduction to recent advances in seismic methods namely 4D seismic methods, Virtual Reality Centers for interpretation. Well seismic shooting for velocity determination and Vertical Seismic Profiling (VSP) and their importance

**Text Books:**

1. Introduction to Geophysical Prospecting, Milton B. Dobrin, and Carl H. Savit, 4<sup>th</sup> Edition, McGraw Hill, 1988.
2. Outlines of Geophysical Prospecting: A Manual for Geologists, M.B. Ramachandra Rao, EBD Educational Pvt Ltd., 1993.
3. Field Geophysics, John Milsom and Asger Eriksen, 4<sup>th</sup> Edition, John Wiley, 2011.

**Reference Books:**

1. Elements of Geology: Oil and Gas Exploration Techniques, J. Guillemot, Technip 1991.
2. Fundamentals of Geophysics, Lowri, W., Cambridge University Press. (1997).
3. Applied Geophysics, Telford, W. M, Geldart L.P., Sheriff, R.E., Keys, D.A. (1990).

## INTRODUCTION TO ARTIFICIAL LIFT METHODS (OPEN ELECTIVE-III)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231PT7O03</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Illustrate the Purpose of artificial lift selection
- CO 2:** Explain about Sucker rod lift system and its advantages and disadvantages
- CO 3:** Differentiate between continuous and intermittent gas lift advantages and limitations.
- CO 4:** Explain about design process of Electrical submersible pumps
- CO 5:** Apply the skills for the selection and type of artificial lift method.

### Mapping of Course Outcomes with Program Outcomes

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | 3     | -     |
| CO2      | 3     | -     |
| CO3      | 3     | -     |
| CO4      | 3     | -     |
| CO5      | 3     | -     |

### UNIT-I

**Introduction:** Definition and Purpose of artificial lift selection-Reservoir pressure and well productivity-reservoir fluids-Types of artificial lift.

### UNIT-II

**Sucker Rod lift:** Sucker rod lift system-polished rod motion-load to the pumping unit-pump deliverability and power requirement-sucker rods-steel sucker rods-pony rods-FRP sucker rods-Non- API sucker rods-criteria for rod string design, advantages and limitations-Trouble shooting sucker rod lift installation.



### UNIT-III

**Gas lift:** Gas lift system-gas compression requirements sonic flow-subsonic flow- volumetric efficiency-stage compression-gas lift valve design-selection of gas lift valves-pilot valve continuous and intermittent gas lift advantages and limitations.

### UNIT-IV

**Electrical submersible pumps:** Electrical submersible pumps. (ESP)- Principle - hydraulic piston pumping-ESP design-ESP advantages and limitations.

### UNIT -V

**Hydraulic Jet pumping:** Hydraulic Jet pumping-selection of jet pump-advantages and disadvantages.

**Selection of artificial lift method:** artificial lift method selection-gas lift vs pump assisted lift installation and replacement of artificial lift-maintenance of artificial lift.

#### **Text books:**

1. Petroleum Production engineering: A computer assisted approach, Boyun GUO, William C. Lyons, Ali Ghalambor, Elsevier Science and Technology books 2007.
2. Petroleum Engineering Handbook-Production Operations Engineering, Volume 4, Joe Dunn Clegg and Larry W. Lake, SPE, 2014.

#### **Reference Books:**

1. Petroleum production systems, M.J. Economides, A. Daniel Hill & C. E. Economides, Prentice-Hall, N.J-07488, 1994.
2. The Technology of Artificial Lift Method, Brown, K.E, Volume 1-4, Penn Well Books, Tulsa, Oklahoma, 1977.
3. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University, 2014.

## BASICS OF SOIL MECHANICS (Open Elective-IV)

VII Semester

Course Code: 231CE7O04

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes:** At the end of the Course, Student will be able to:

**CO1:** Explain physical properties of soil and its determination

**CO2:** Determine the various index properties and the classification of soil

**CO3:** Assess the stress developed due to various loads and soil conditions

**CO4:** Explain the various compaction methods and the determination of permeability

**CO5:** Explain the concept of consolidation, compressibility and settlement calculation

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | 2    | -    | -    | -    | 1    | -    | -    | -    | 2     | -     | -     |
| CO2   | 1    | 3    | -    | -    | -    | -    | -    | 2    | -    | 1     | -     | -     |
| CO3   | 1    | 2    | -    | -    | -    | -    | -    | 2    | -    | 1     | -     | -     |
| CO4   | 1    | 2    | -    | -    | -    | -    | -    | 2    | -    | 1     | -     | -     |
| CO5   | 1    | 2    | -    | -    | -    | 1    | -    | -    | -    | 2     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

### Unit - I

#### Physical Properties of Soil:

Three phase system - phase diagram - physical properties Functional Relationships between physical properties-determination of water content, specific gravity, In-situ density-Relative density

### Unit – II

**Plasticity Characteristics of soil:** Consistency, Atterberg's limits and their determination liquid limit, plastic limit, shrinkage limit - Index Properties-Activity-Free swell index. Soil Classification: Soil classification- need and criteria for soil classification-IS Particle size classification-Classification tests-grain size analysis - hydrometer analysis- grain size distribution curve - Unified Soil Classification- Indian Standard Soil classification- Coarse grained soils- Fine grained soils-Plasticity chart.

**Unit – III**

**Effective stress:** Stresses due to self-weight-total, neutral and effective stresses – Pressure diagrams under different soil conditions. Stresses due to applied loads: Boussinesq theory- Concentrated load-Strip footing- circular footing- Rectangular footing-Newmark's influence chart - Pressure bulb-Significant depth Westergaard's theory - 2:1 distribution method

**Unit – IV**

**Compaction:** Principle of compaction, OMC and MDD, Lab tests-IS light weight and heavy weight compaction tests, Factors affecting compaction - zero air void line-Effect of compaction on engineering

properties of soils - Field compaction control – Proctor's Needle.

Permeability and Seepage: types of soil water, Permeability-Darcy's law-Factors effecting permeability- laboratory tests-Average permeability of stratified soils. Seepage pressure critical hydraulic gradient -quick sand condition.

**Unit – V**

**Consolidation:** Definition and significance-mechanism-Terzaghi's soil-spring analogy -lab consolidation test

– e-log p curve-Coefficient of compressibility-coefficient of volume change-compression index- determination of consolidation settlement – Terzaghi's theory of 1D consolidation-Time-settlement calculations. Determination of coefficient of consolidation-time fitting methods – Pre-consolidation pressure- normally consolidated and over consolidated clays-secondary consolidation.

**Text Books:**

1. Arora, K.R. (2019), "Soil Mechanics and Foundation Engineering", Standard Publishers, Delhi
2. Gopal Ranjan and Rao, A.S.R., "Basic and Applied Soil Mechanics", New Age Ltd. International Publisher New Delhi (India) 2016

**Reference Books:**

1. Craig, R.F. (2019), "Soil Mechanics", McGraw hill, New Delhi
2. Narasinga Rao, B.N.D. (2015), Soil Mechanics and Foundation Engineering, Wiley Publishers

**Web Links:**

1. <http://nptel.ac.in/courses/105103097/>

## CONSTRUCTION MATERIALS AND EQUIPMENTS (Open Elective-IV)

VII Semester

Course Code: 231CE7O05

|   |   |   |   |
|---|---|---|---|
| L | T | P | C |
| 3 | 0 | 0 | 3 |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Explain the tests on stones, cement and aggregates.

**CO2:** Explain the concepts of strength and durability testing on mortar and concrete.

**CO3:** Compare the properties of most common and advanced building materials.

**CO4:** Selection of Automation techniques in construction industry.

**CO5:** Analyze benefits of robotics versus conventional construction equipment.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | -    | 3    | -    | -    |      | -    | -    | -    | -     | -     | -     |
| CO2   | 1    | 2    | 1    | 3    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | -    | 1    | -    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 1    | 2    | 1    | 3    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | -    | 1    | -    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | 3     |
| CO2    | -     | 3     |
| CO3    | -     | 3     |
| CO4    | -     | 3     |
| CO5    | -     | 3     |

### Unit - I

**Stones, Bricks and Concrete Blocks:** Stone as building material–Criteria for selection– Tests on stones– Deterioration and Preservation of stone work – Bricks – Classification – Manufacturing of clay bricks – Tests on bricks–Compressive Strength–Water Absorption–Efflorescence–Bricks for special use–Refractory bricks–Cement, Concrete blocks– Light weight concrete blocks. Nano Aggregate – RCA ( Recylced Concrete Aggregate) – RCCA.

### Unit – II

**Lime, Cement, Aggregate and Mortar:** Lime–Preparation of lime mortar–Cement–Ingredients– Manufacturing process–Types and Grades – Properties of cement and Cement mortar – Hydration – Compressive strength –Tensile strength–Fineness– Soundness and consistency–Setting time–Industrial byproducts–Fly ash – Aggregates – Natural stone aggregates – Crushing strength – Impact strength – Flakiness Index– Elongation Index – Abrasion Resistance –Grading–Sand Bulking.

Concrete Ingredients – Manufacturing Process – Batching plants – RMC – Properties of fresh concrete – Slump – Flow and compaction Factor – Properties of hardened concrete – Compressive, Tensile and shear strength – Modulus of rupture – Tests – Mix specification – Mix proportioning – BIS method – High Strength Concrete and HPC – Self compacting Concrete – Other types of Concrete – Durability of Concrete.

### Unit – III

**Modern materials:** Glass–Ceramics–Sealants for joints–Fibre glass reinforced plastic–Clay products– Refractories–Compositematerials–Types–Applicationsoflaminarcomposites–Fibre textiles– Geo membrane sand Geotextiles for earth reinforcement.

### Unit – IV

**Introduction:** Unique features of construction equipment, Need of construction Equipment, past history. Construction equipment: Capacity, Feasibility, owning and operating cost and Productivity of Different Equipment: Excavators, Pavers, Plastering machines; Pre-stressing jacks and grouting equipment; Cranes and Hoists, Concrete Batching Plants, etc.

### Unit – V

**Automation in Construction Industry:** Need and Benefit of automation: Automation in Canal lining, Automation in Construction of Highway, Automation in concrete technology. Robotics in Construction: Use of robots for construction activities like Brick laying, Demolition, Material Handling, Structural steel cutting, Rebar tying/bending, Form work mould making, 3D printing- print complex, layered, parts and objects of homes, buildings, bridges and roads.

#### Text Books:

1. Varghese.P.C, "Building Materials", PHI Learning Pvt. Ltd, New Delhi, 2018.
2. Rajput.R.K., "Engineering Materials", S.Chand and Company Ltd., 2018.

#### Reference Books:

1. Jagadish.K.S, "Alternative Building Materials Technology", New Age International, 2017.
2. Gambhir.M.L., & Neha Jamwal., "Building Materials, products, properties and systems", Tata McGraw Hill Education Pvt. Ltd, New Delhi, 2019.

#### Web Links:

1. <https://nptel.ac.in/courses/105/102/105102012/>
2. <https://nptel.ac.in/courses/105/106/105106176/>

## NATURAL DISASTER MANAGEMENT & MITIGATION (Open Elective-IV)

VII Semester

Course Code: 231CE7O06

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Explain the aspects of disaster management and adopt remedial measures

**CO2:** Explain disaster risk assessment and coping measures.

**CO3:** Explain the vulnerability conditions

**CO4:** Assess the impact of hazards on structures

**CO5:** Adopt the rehabilitation procedures

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | 2    | -    | -     | -     | -     |
| CO2   | -    | 1    | -    | -    | -    | 3    | -    | 2    | -    | -     | -     | -     |
| CO3   | -    | 1    | -    | -    | -    | -    | -    | 2    | -    | -     | -     | -     |
| CO4   | 2    | -    | -    | -    | -    | 3    | -    | 2    | -    | -     | -     | -     |
| CO5   | 2    | -    | -    | -    | -    | 3    | -    | 2    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

### Unit - I

Introduction Concept of Disaster Management. Types of Disasters. Disaster mitigating agencies and their organizational structure at different levels.

### Unit – II

Overview of Disaster Situations in India Vulnerability of profile of India and Vulnerability mapping including disaster – prone areas, communities, places. Disaster preparedness – ways and means; skills and strategies; rescue, relief reconstruction. Case Studies: Lessons and Experiences from Various Important Disasters in India and Biological disasters – SARS-spread and transmissions -pandemic, endemic and epidemic.

**Unit – III**

Flood and Drought Disaster Raising flood damage, assessing flood risk, flood hazard assessment, flood impact assessment, flood risk reduction options. Drought and development, relief management and prevention, drought mitigation and management- integrating technology and people.

**Unit – IV**

Landslide and Earthquake Disaster Land slide hazards zonation mapping and geo environmental problems associated with the occurrence of landslides. The use of electrical resistivity method in the study of landslide. Causes and effects of earthquakes. Secondary effects. Criteria for earthquake resistant design.

**Unit – V**

Cyclone and Fire Disaster Cyclone occurrence and hazards. Cyclone resistant house for coastal areas. Disaster resistant construction role of insurance sector. Types of fire. Fire safety and firefighting method, fire detectors, fire extinguishers. Rehabilitation: Rehabilitation programmes, Management of Relief Camp.

**Text Books:**

1. Disaster Management, RB Singh (Ed), Rawat Publications, 2000.
2. Disaster Management Future Challenges and Opportunities, Jagbir Singh, I.K International publishing house

**Reference Books:**

1. Natural Hazards in the Urban habitat by Iyengar, CBRI, Tata McGraw Hill
2. Natural Disaster management, Jon Ingleton (Ed), Tulor Rose, 1999

**Web Links:**

1. <https://www.youtube.com/watch?v=2v7N5a3tLgE>
2. <https://www.youtube.com/watch?v=5KtVocJfVGw>

### Concepts of Power Quality (Open Elective-IV)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231EE7O03</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1** Differentiate between different types of power quality problems and sources of voltage sag, voltage swell.
- CO2** Explain about the sources of transient over voltages in a power system.
- CO3** Explain about the Long – Duration Voltage Variations and Flickering.
- CO4** Analyse the Harmonic distortion and solutions and their indices.
- CO5** Explain the concepts of distributed generation technologies.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 1    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2</b> | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3</b> | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4</b> | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 1    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | -    |
| <b>CO2</b> | -    | -    |
| <b>CO3</b> | -    | -    |
| <b>CO4</b> | -    | -    |
| <b>CO5</b> | -    | -    |

## UNIT – I

### Introduction - Terms & Definitions

Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations – Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power frequency variations – Voltage Sags – Voltage Swell.



**UNIT – II****Transient Over Voltages:**

Sources of Transient Over voltages - Principles of Over voltage protection- Devices for Over voltage protection – Utility Capacitor Switching Transients - Utility System Lightning Protection – Managing Ferro resonance – Switching Transient Problems with Loads.

**UNIT – III****Long – Duration Voltage Variations:**

Principles of regulating the voltage – Device for voltage regulation – Utility voltage regulator application – Capacitor for voltage regulation – End-user capacitor application – Regulating utility voltage with distributed resources – Flicker.

**UNIT – IV****Harmonic distortion and solutions:**

Voltage distortion vs. Current distortion –Harmonic indices: THD - TDD and True Power Factor– Sources of harmonics – Effect of harmonic distortion – Impact on capacitors, transformers, motors and meters – Concept of Point of common coupling – Passive and active filtering – Numerical problems.

**UNIT – V****Distributed Generation and Monitoring:**

Resurgence of distributed generation – DG technologies – Interface to the utility system – Power quality issues and operating conflicts – DG on low voltage distribution networks.

**Monitoring:**

Power quality monitoring and considerations – Historical perspective of PQ measuring instruments – PQ measurement equipment – Assessment of PQ measuring data.

**Text Books:**

- 1 Electrical Power Systems Quality - Dugan R C - McGranaghan M F – Santoso S - and Beaty H W - Second Edition - McGraw–Hill - 2012 - 3rd edition.
- 2 Electric power quality problems – M.H.J.Bollen IEEE series-Wiley india publications – 2011.
- 3 Power Quality Primer - Kennedy B W - First Edition - McGraw–Hill - 2000.

**Reference Books:**

- 1 Understanding Power Quality Problems: Voltage Sags and Interruptions - Bollen M HJ - First Edition - IEEE Press; 2000.
- 2 G. T, Heydt, "Electric Power Quality", Stars in a Circle Publications, 1991  
Power System Harmonics - Arrillaga J and Watson N R - Second Edition - John Wiley & Sons - 2003.
- 3 Electric Power Quality control Techniques - W. E. Kazibwe and M. H. Sendaula – Van Nostrad Reinhold - New York.
- 4 Harmonics and Power Systems –Franciso C.DE LA Rosa–CRC Press (Taylor & Francis).

**Web Links:**

- 1 <https://nptel.ac.in/courses/108107157>
- 2 [https://onlinecourses.nptel.ac.in/noc21\\_ee103/preview](https://onlinecourses.nptel.ac.in/noc21_ee103/preview)

**QUANTUM SCIENCE AND TECHNOLOGY**  
(Open Elective-IV)

VII Semester

L T P C

Course Code: 231EE7004

3 0 0 3

**Course Outcomes: At the end of the course, student will be able to:**

- CO1** Explain core principles of quantum mechanics and their technological implications.
- CO2** Analyze quantum phenomena like superposition and entanglement.
- CO3** Apply mathematical tools to model and solve quantum systems.
- CO4** Demonstrate understanding of quantum algorithms and quantum circuits. g
- CO5** Evaluate potential applications and challenges in quantum communication and sensing.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 1    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | -    | -    |
| CO2    | -    | -    |
| CO3    | -    | -    |
| CO4    | -    | -    |
| CO5    | -    | -    |

**Unit 1: Fundamentals of Quantum Mechanics:** Historical background: Blackbody radiation, photoelectric effect, and Compton scattering; Dual nature of light and matter; De Broglie hypothesis; Schrödinger equation; Free particle, infinite potential well, step potential; Operators and observables: position, momentum, Hamiltonian; Commutation relations and uncertainty principle; Quantum postulates and measurement theory; Eigenvalues, eigenfunctions.

**Unit 2: Quantum Information Theory:** Classical vs. quantum information; Qubit representation using Bloch sphere; Quantum superposition and quantum entanglement; Dirac notation (bra-ket), tensor products, and composite systems; Bell states and EPR paradox; Quantum gates: Pauli-X, Y, Z; Hadamard; Phase; T; CNOT; Quantum circuit models and notation; Measurement in computational basis; Quantum teleportation and no-cloning theorem; Quantum state tomography (introductory)

**Unit 3: Quantum Computing:** Classical computing review and limitations; Quantum parallelism and interference; Deutsch and Deutsch-Jozsa algorithms; Grover's search algorithm, Oracle and amplitude

amplification; Shor's factoring algorithm (overview and significance); Quantum Fourier Transform (QFT); Quantum error correction: Bit-flip, phase- flip, and Shor's 9-qubit code; Introduction to quantum programming: Qiskit, Cirq, IBM Quantum Experience (overview)

**Unit 4: Quantum Communication:** Introduction to quantum cryptography; Quantum key distribution (QKD): BB84 protocol; Entanglement-based QKD: Ekert protocol (E91); Eavesdropping and security of QKD; Quantum teleportation (circuit and protocol); Quantum dense coding; Quantum networks and entanglement swapping; Role of quantum repeaters; Single-photon sources and detectors; Implementation challenges (loss, decoherence, noise)

**Unit 5: Quantum Technologies and Applications:** Quantum sensors: magnetometry, gravimetry; Quantum metrology: standard time, atomic clocks; Quantum imaging and lithography; Quantum materials: topological insulators, graphene, quantum dots; NV centers in diamonds for sensing; Hardware platforms: Superconducting qubits, Trapped ions, Photonic quantum processors; Quantum supremacy and NISQ era; Global initiatives: IBM, Google, D-Wave, IonQ, India's NQM; Ethical concerns and future prospects

**Text Books:**

1. **"Quantum Computation and Quantum Information"** by Michael A. Nielsen and Isaac L. Chuang
2. **"Quantum Mechanics: Concepts and Applications"** by Nouredine Zettili

**Online Learning Resources:**

1. <https://nptel.ac.in/courses/104104082>
2. <https://nptel.ac.in/courses/115104096>
3. <https://nptel.ac.in/courses/122106034>

## OPTIMIZATION TECHNIQUES

(Open Elective-IV)

**Semester: VII**

**L      T      P      C**

**Course Code: 231ME7O06**

**3      0      0      3**

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Understand the classical optimization techniques

**CO2:** Learn numerical methods for optimization

**CO3:** Get insights into genetic algorithm and its variants

**CO4:** Know the applications of optimization in mechanical engineering

**CO5:** Understand the concept of reliability

**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 2    | 2    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 3    | 3    | 2    | -    | 1    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 3    | 2    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 3    | 2    | 2    | -    | -    | -    | 1    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 2    | 1    | 2    | -    | 1    | -    | 1    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | 1    |
| <b>CO2:</b> | -    | 1    |
| <b>CO3:</b> | -    | 1    |
| <b>CO4:</b> | -    | 1    |
| <b>CO5:</b> | -    | 1    |

### Unit - I

Classical Optimization Techniques: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions, merits and demerits of classical optimization techniques.

### Unit -II

Numerical Methods for Optimization: Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, Pattern search methods, conjugate method, types of penalty methods for handling constraints, advantages of numerical methods

### Unit - III

**Genetic Algorithm (GA) :** Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA,

**Genetic Programming (GP):** Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP. **Multi-Objective GA:** Pareto's analysis, Non-dominated front, multi – objective GA, Non- dominated sorted GA, convergence criterion, applications of multi-objective problems

### Unit – IV

Applications Of Optimization In Design And Manufacturing Systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

### Unit – V

**Reliability:** Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, hazard analysis.

#### Text Books:

- 1 Engineering Optimization by S.S.Rao, 3<sup>rd</sup> edition, New Age Publishers,2013, **ISBN13 978-8122427233**
- 2 Reliability Engineering by L.S.Srinath, East west publishers,2005, **ISBN13 978-8176710480**

#### Reference Books:

- 1 Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
- 2 Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers
- 3 Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers
- 4 An Introduction to Reliability and Maintainability Engineering by CE Ebeling, Waveland Printers Inc., 2009

#### Weblinks:

- 1 [https://onlinecourses.nptel.ac.in/noc21\\_me10/preview](https://onlinecourses.nptel.ac.in/noc21_me10/preview)
- 2 <https://www.coursera.org/learn/operations-research-modeling>

## ADVANCED MANUFACTURING PROCESSES

### (Open Elective-IV)

**Semester: VII**

**L      T      P      C**

**Course Code: 231ME7O07**

**3      0      0      3**

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Explain the working principle of various nonconventional machining processes and their applications.
- CO2:** Explain the working principles of additive manufacturing methods.
- CO3:** Understand various surface treatment techniques and processing of ceramics.
- CO4:** Gain the knowledge on advanced coating processes.
- CO5:** Describe various fabrication methods for microelectronic devices.

**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | -    | -    | -    | 1    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO2:</b> | 3    | -    | -    | -    | 1    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO3:</b> | 3    | -    | -    | -    | 1    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO4:</b> | 3    | -    | -    | -    | -    | 2    | -    | -    | -    | -     | -     | -     |
| <b>CO5:</b> | 3    | -    | -    | -    | 1    | 2    | -    | -    | -    | -     | -     | -     |

**Mapping Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | 2    | -    |
| <b>CO2:</b> | 2    | -    |
| <b>CO3:</b> | 2    | -    |
| <b>CO4:</b> | 2    | -    |
| <b>CO5:</b> | 2    | -    |

### Unit - I

**Advanced Machining Processes:** Introduction, AJM, WJM, EDM, ECM, LBM, EBM, & PAM – principle, working, advantages, limitations, Process Parameters & capabilities and applications.

### Unit -II

**Additive Manufacturing:** Working principles, methods- stereo lithography, LENS, LOM, laser sintering, fused deposition method, applications and limitations, direct and indirect rapid tooling techniques.

### Unit - III

**Surface Treatment:** Scope, cleaners, methods of cleaning, surface coating types, electro forming, chemical vapour deposition, physical vapour deposition, thermal spraying methods, ion implantation, diffusion coating, ceramic and organic methods of coating, and cladding methods.

**Processing of Ceramics:** Applications, characteristics, classification, processing of particulate ceramics, powder preparations, consolidation, hot compaction, drying, sintering, and finishing of ceramics, areas of application.

### Unit - IV

**Processing of Composites:** Composite layers, particulate and fiber reinforced composites, elastomers, reinforced plastics, processing methods for MMC, CMC, polymer matrix composites.

**Processing of Nanomaterials:** Introduction, top-down vs bottom-up techniques, ball milling, lithography, plasma arc discharge, pulsed laser deposition, sputtering, sol-gel, molecular beam epitaxy.

### Unit – V

#### **Fabrication of Microelectronic Devices:**

Crystal growth and wafer preparation, film deposition, oxidation, lithography, bonding and packaging, reliability and yield, printed circuit boards, surface mount technology, integrated circuit economics.

#### **Text Books:**

- 1 Manufacturing Engineering and Technology, Serope Kalpakjian and Steven R. Schmid, Pearson Education, 8<sup>th</sup> Edition, 2023.
- 2 Process and Materials of Manufacturing, R. A. Lindburg, Prentice Hall India Learning Private Limited, 4<sup>th</sup> Edition, 1990.

#### **Reference Books:**

- 1 Advanced Machining Processes, V. K. Jain, Allied Publications, 2002.
- 2 Introduction to Nanoscience and Nano Technology, K. K. Chattopadhyay & A. N. Banerjee, PHI Learning, 2009.
- 3 MEMS & Micro Systems Design and Manufacture, Tai Run Hsu, McGraw Hill Education, 1st edition, 2017.
- 4 Introduction to Manufacturing Processes, John A Schey, McGraw-Hill Education, 3rd edition, 1999.

#### **Weblinks:**

- 1 <https://archive.nptel.ac.in/courses/112/107/112107077/>.
- 2 <https://archive.nptel.ac.in/courses/112/103/112103306/>
- 3 <https://archive.nptel.ac.in/courses/112/105/112105053/>
- 4 <https://home.iitk.ac.in/~mohite/ae681.html>
- 5 <https://archive.nptel.ac.in/courses/113/104/113104102/>
- 6 <https://archive.nptel.ac.in/courses/103/106/103106075/>



## TOTAL QUALITY MANAGEMENT

### (Open Elective-IV)

**Semester: VII**

**L T P C**

**Course Code: 231ME7O08**

**3 0 0 3**

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Explain the quality management philosophies and frameworks.

**CO2:** Explain quality costs and leadership.

**CO3:** Explain the concepts of customer focus, continuous quality improvement and supplier partnership

**CO4:** Apply various TQM tools to improve management processes

**CO5:** Calculate process capability index in TQM process

#### Mapping of Course Outcomes with Program Outcomes:

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 3    | 1    | 3    | 3    | 2    | 2    | 3    | 2    | 3     | 1     | 1     |
| <b>CO2:</b> | 3    | 2    | 3    | 2    | 2    | 1    | 2    | 1    | 3    | 2     | 2     | 2     |
| <b>CO3:</b> | 3    | 3    | 2    | 1    | 3    | 2    | 3    | 1    | 1    | 1     | 2     | 2     |
| <b>CO4:</b> | 3    | 2    | 2    | 2    | 1    | 3    | 2    | 2    | 2    | 1     | 3     | 3     |
| <b>CO5:</b> | 3    | 1    | 2    | 1    | 2    | 2    | 2    | 2    | 2    | 2     | 2     | 2     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | -    |
| <b>CO2:</b> | -    | -    |
| <b>CO3:</b> | -    | -    |
| <b>CO4:</b> | -    | -    |
| <b>CO5:</b> | -    | -    |

#### Unit - I

Introduction: Definition of Quality, Factors effecting quality, Quality management, Quality Dimensions, four phases of quality, Total Quality, Salient features of Total Quality Management (TQM)-definition of TQM, Elements of TQM, Principles of TQM, Pillars of TQM, Traditional Approach and TQM Approach. Characteristics of TQM: TQM Enablers, Approaches, relevance, Barriers to TQM Implementation

#### Unit -II

Quality costs: Cost classification, Basic cost of quality. Applications and Importance of quality cost. Quality leadership: Quality of leadership, Quality of successful leader, leadership for TQM, Deming Philosophy, Contributions of Gurus of TQM

**Unit - III**

Customer Focus: Customer Complaints and suggestions, panels, Customer satisfaction, Customer Perception of Quality, Customer driven quality circles, Customer focus and activities, needs and expectations, Organizations action from the customer point of view.

Continuous Quality Improvement - Juran Trilogy, PDCA Cycle, Kaizen- kaizen suggestion's, program introduction at workplace, principles of kaizen. Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development

**Unit - IV**

TQM Tools: Bench marking - Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) - House of Quality, QFD Process, Benefits. Taguchi Quality Loss Function.

Total Productive Maintenance (TPM) - Concept, Improvement Needs, FMEA -Stages of FMEA, the seven tools of quality, Process Capability- Concept, Methods of calculating process capability, Process capability index, Concept of six sigma.

**Unit – V**

Need for ISO9000-ISO9001-2008 Quality System- Elements, documentation Quality Auditing– QS9000-ISO14000-Concepts, Requirements and Benefits–TQM, Implementation in manufacturing and service sectors.

**Text Books:**

- 1 Total Quality Management, Dale HB ester field, Pearson,4th Edition 2015
- 2 Total Quality Management,K.C.Arora,S.K.Kataria&sons,NewDelhi,2016
- 3 Total Quality Management, Subburaj Ramaswamy, TataMcgraw HillPublishing Company Ltd., 2005

**Reference Books:**

- 1 Management Quality-Concepts and Tasks, Narayana V and Sreenivasan N.S.,New age publishers;1st edition(1January2005).
- 2 Statistical Quality Control, SeventhEdition, RichardS.Leavenworth & Eugene LodewickGrant,7th Edition,TataMcgrawHill,2015
- 3 Total QualityManagement, Subburaj Ramasamy, TataMcGrawHill Publishing CompanyLtd., NewDelhi, 2005.

**Web links:**

- 1 <https://nptel.ac.in/courses/110/105/110105039/>
- 2 <https://nptel.ac.in/courses/110/104/110104085/>
- 3 <https://nptel.ac.in/courses/110/104/110104080/#>

**OPERATIONS MANAGEMENT****(Open Elective-IV)****VII Semester****Course Code: 231ME7009**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to****CO1** Formulate and solve real industrial problems using Graphical and Simplex methods**CO2** Interpret Transportation and sequencing problems**CO3** Solve replacement problems and analyze queuing models**CO4** Solve game theory and deterministic inventory problems**CO5** Interpret Statistics knowledge to design problems**Mapping of Course Outcomes with Program Outcomes:**

| CO/PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|--------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1    | 2    | 1    | 1    | -    | -    | 2    | -    | -    | -    | -     | 1     | 1     |
| CO2    | 1    | 1    | 1    | -    | -    | 1    | -    | -    | -    | -     | 1     | 1     |
| CO3    | 3    | 2    | 1    | -    | -    | 1    | -    | -    | -    | -     | 1     | 1     |
| CO4    | 2    | 1    | 1    | -    | -    | 2    | -    | -    | -    | -     | 1     | 1     |
| CO5    | 2    | 1    | 1    | -    | -    | 2    | -    | -    | -    | -     | 1     | 1     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO 2 |
|--------|------|-------|
| CO1    |      | 2     |
| CO2    |      | 2     |
| CO3    |      | 2     |
| CO4    |      | 2     |
| CO5    |      | 2     |

**UNIT – 1****INTRODUCTION** - definition– characteristics and phases – types of operation research models – applications.

Linear programming: Problem formulation – graphical solution – simplex method – artificial variables techniques -two-phase method, big-M method – duality principle.

**UNIT – 2**

**TRANSPORTATION PROBLEM:** Formulation – optimal solution, unbalanced transportation problem – degeneracy, assignment problem – formulation – optimal solution - variants of assignment problem- travelling salesman problem.

**SEQUENCING** – Introduction – flow –shop sequencing –  $n$  jobs through two machines –  $n$  jobs through three machines – job shop sequencing – two jobs through ‘ $m$ ’ machines.

### UNIT – 3

**REPLACEMENT THEORY:** Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.

**GAME THEORY:** Introduction – mini. max (max. mini) – criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points –  $2 \times 2$  games – dominance principle –  $m \times 2$  &  $2 \times n$  games -graphical method.

### UNIT – 4

**WAITING LINES:** Introduction – single channel – poisson arrivals – exponential service times – with infinite population and finite population models– multichannel – poisson arrivals – exponential service times with infinite population single channel.

**PROJECT MANAGEMENT:** Basics for construction of network diagram, Program Evaluation and Review Technique (PERT), Critical Path Method (CPM) – PERT Vs. CPM, determination of floats- Project crashing and its procedure.

### UNIT – 5

**RELIABILITY:** Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, hazard analysis

#### Text Books:

1. Operations Research-An Introduction/Hamdy A Taha/Pearson publishers
2. Operations Research –Theory & publications / S.D.Sharma Kedarnath/McMillan publishers India Ltd

#### References:

1. Introduction to O.R/Hiller & Libermann/TMH
2. Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.
3. Operations Research: Methods & Problems / Maurice Saseini, ArhurYaspan& Lawrence Friedman/Wiley
4. Operations Research / R.Pannerselvam/ PHI Publications.
5. Operations Research / Wagner/ PHI Publications.

#### Web Links:

1. <https://nptel.ac.in/courses/110/106/110106062/>
2. <https://ocw.mit.edu/courses/sloan-school-of-management/15-760a-operations-management-summer-2002/>

## ENERGY AUDITING (Open Elective-IV)

**Semester: VII****L T P C****Course Code: 231ME7O10****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Understand the classification of Energy and importance of Energy Conservation.  
**CO2:** Illustrate energy auditing methodologies  
**CO3:** Understand Material and Energy balance and carry out Material and energy balance  
**CO4:** Determine Energy Performance assessment of equipment  
**CO5:** Perform financial analysis for determining simple payback period

**Mapping of Course Outcomes with Program Outcomes:**

|             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1:</b> | 3    | 2    | 1    | 1    | 3    | 2    | 3    | 2    | 2    | 3     | 1     | 1     |
| <b>CO2:</b> | 3    | 2    | 2    | 2    | 2    | 2    | 2    | 3    | 3    | 2     | 3     | 3     |
| <b>CO3:</b> | 3    | 3    | 2    | 3    | 2    | 3    | 1    | 2    | 2    | 2     | 2     | 2     |
| <b>CO4:</b> | 3    | 2    | 3    | 2    | 1    | 1    | 2    | 2    | 1    | 1     | 1     | 1     |
| <b>CO5:</b> | 3    | 2    | 1    | 2    | 1    | 2    | 1    | 1    | 2    | 1     | 2     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

|             | PSO1 | PSO2 |
|-------------|------|------|
| <b>CO1:</b> | -    | -    |
| <b>CO2:</b> | -    | -    |
| <b>CO3:</b> | -    | -    |
| <b>CO4:</b> | -    | -    |
| <b>CO5:</b> | -    | -    |

**Unit - I**

INTRODUCTION: Classification of Energy – Primary and Secondary Energy, Commercial Energy and Noncommercial Energy and Renewable & Non-renewable energy; Various forms of Energy – potential (stored energy) and kinetic(working) energy; Basics of Electrical energy and thermal energy; Energy and Environment; Energy Conservation and its importance.

**Unit -II**

ENERGY MANAGEMENT: Definition and objectives of Energy Management, Energy Audit – types and methodology; need for energy audit; energy auditing methodology; Benchmarking energy performance; Maximizing system efficiency; Energy Audit Instruments.

**Unit - III**

MATERIAL AND ENERGY BALANCE: Basic principles of material and energy balance; Sankey diagram and its use; Material balances; Energy balances; Carrying out material and energy balance.

**Unit - IV**

ENERGY PERFORMANCE ASSESSMENT: Purpose and parameters of performance of (a) boilers, (b) furnaces, (c) turbines, (d) fans and blowers, (e) pumps, (f) compressors and (g) lighting. Detailed performance analysis of boilers and pumps.

**Unit – V**

PERFORMING FINANCIAL ANALYSIS: Introduction, fixed and variable costs, Interest charges, simple pay-back period, discounted cash flow methods- Net Present Value method and Internal rate of return method; Factors affecting analysis

**Text Books:**

- 1 General Aspects of Energy Management & Energy Audit,, National Certificate Examination for Energy Managers and Energy Auditors, National Productivity Council of India
- 2 Energy Performance Assessment for Equipment and Utility systems, National Certificate Examination for Energy Managers and Energy Auditors, National Productivity Council of India

**Reference Books:**

- 1 Murphy, W.R. , McKay, G. (1982) 'Energy Management ', London: Butterworth-Heinemann
- 2 K. Smith, C.B. (Ed. 4) (1981). 'Energy Management Principles : applications, benefits, savings', Amsterdam : Pergamon Press
- 3 Witte, L. C. (1988), ' Industrial energy management and utilization ', Washington: Hemisphere Pub. Corp

**Web links:**

- 1 <https://sustainabilityeducationacademy.com/free-online-energy-audit-course/>
- 2 <https://coursevania.com/courses/introduction-to-energy-auditing/>
- 3 <https://www.cdgtraining.com/courses/Certified-Energy-Auditor-CEA-Course-66f78d2e6560e62a1e6ef941>

## FUNDAMENTALS OF IMAGE PROCESSING

### (Open Elective-IV)

VII Semester

L T P C

Course Code: 231EC7004

3 0 0 3

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1** Infer the fundamental components of digital image processing.

**CO2** Illustrate image enhancement techniques.

**CO3** Compare image restoration techniques.

**CO4** Infer the color image processing methods.

**CO5** Make use of morphological operators for image processing.

**CO6** Interpret image segmentation techniques.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO6   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |
| CO6    | -     | -     |

### Unit - I

**Introduction:** Introduction to Image Processing, Fundamental steps in digital image processing, components of an image processing system, image sensing and acquisition, image sampling and quantization, some basic relationships between pixels, an introduction to the mathematical tools used in digital image processing.

## Unit – II

**Image Enhancement and Restoration:** Background, Some basic intensity transformation functions, histogram processing, fundamentals of spatial filtering, smoothing spatial filters, sharpening spatial filters, combining spatial enhancement methods, A model of the image degradation/restoration process, Noise models, Inverse filtering, Minimum mean square error (Wiener) filtering.

## Unit – III

**Color image processing:** color fundamentals, color models, pseudo color image processing, basics of full color image processing, color transformations, smoothing and sharpening, noise in color images.

## Unit – IV

**Morphological Image Processing:** Preliminaries, Erosion and dilation, opening and closing, basic morphological algorithms for boundary extraction, thinning, gray-scale morphology, Segmentation using morphological watersheds

## Unit – V

**Image segmentation:** Fundamentals, point, line, edge detection, thresholding, and region – based segmentation, Image segmentation based on color.

### Text Books:

1. R. C. Gonzalez and R. E. Woods, Digital Image Processing, 3rd edition, Prentice Hall, 2008.
2. Anil K.Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India, 9th Edition, Indian Reprint, 2002.

### Reference Books:

1. Jayaraman, S. Esakkirajan, and T. Veerakumar,” Digital Image Processing”, Tata McGraw-Hill Education, 2011
2. B.Chanda, D.Dutta Majumder, “Digital Image Processing and Analysis”, PHI, 2009.

### Web Links:

1. <http://www.imageprocessingplace.com/>.
2. [http://nptel.ac.in/courses/117105079/\(Prof.P.K.Biswas,IIT, Kharagpur\)](http://nptel.ac.in/courses/117105079/(Prof.P.K.Biswas,IIT,Kharagpur))
3. <https://sisu.ut.ee/imageprocessing/avaleht>
4. <https://www.coursera.org/learn/digital#ratings> (Fundamentals of digital image and video processing, Aggelos K. Katsaggelos, University of North western )
5. <https://www.coursera.org/courses?languages=en&query=image+processing>



### Electronic Measurement Techniques (Open Elective-IV)

|                        |          |          |          |          |
|------------------------|----------|----------|----------|----------|
| VII Semester           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| Course Code: 231EC7005 | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1** Outline the performance characteristics of measuring Instruments.

**CO2** Select signal generators for the given application.

**CO3** Contrast wave analyzers based on their performance.

**CO4** Interpret the working principle of oscilloscopes.

**CO5** Choose a suitable bridge for parameter measurement.

**CO6** Make use of transducers for physical parameter measurement.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 1    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 3    | 2    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO6   | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |
| CO6    | -     | -     |

#### Unit - I

Performance Characteristics of Instruments:

static characteristics, Accuracy, Resolution, Precision, Expected value, Error, Sensitivity, errors in measurement, Dynamic characteristics- speed of response, fidelity, lag, dynamic error, DC voltmeters, multi range, range extension/Solid state and differential voltmeters, AC voltmeters- multi range, range extension, shunt, thermocouple type RF ammeter, Ohmmeters series type, shunt type, multi-meter for voltage, current, and resistance measurements.

**Unit – II**

Signal Generators & Wave Analyzers:

Fixed and variable, AF oscillators, standard and AF sine and square wave signal generators, Function generators, square, pulse, Random noise, sweep, arbitrary wave form, Wave analyzers, Harmonic distortion analyzers, spectrum analyzers, Digital Fourier analyzers.

**Unit – III**

Oscilloscopes:

CRT features, Vertical amplifiers, Horizontal deflection system, sweep, trigger pulse, delay line, sync selector circuits. Simple CRO, triggered sweep CRO, dual beam CRO, dual trace oscilloscope, sampling oscilloscope, storage oscilloscope, digital readout oscilloscope, digital storage oscilloscope, Lissajous method of frequency measurement, standard specifications of CRO, probes for CRO, active and passive, attenuator type.

**Unit – IV**

AC Bridges:

Measurement of Inductance, Maxwell's bridge, Anderson bridge, Measurement of Capacitance, Schering bridge, Wheatstone bridge, Wein bridge, Errors and precautions in using bridges, Q meter.

**Unit – V**

Transducers:

Active and passive transducers, resistance, capacitance, inductance, strain gauges, LVDT, piezo electric transducers, Resistance thermometers, thermocouples, thermistors, sensistors, Measurement of physical parameters-force, pressure, velocity, humidity, moisture, speed, proximity and displacement, data acquisition systems

**Text Books:**

1. Electronic Instrumentation, H.S.Kalsi, 2nd edition, Tata MCgraw Hill, 2004
2. Modern electronic Instrumentation and measurement techniques, A.D.Helfric, W.D.Cooper, 5th edition, PHI, 2002.

**Reference Books:**

1. Electronic Instrumentation and measurements, DavidA. Bell, 2nd edition, PHI, 2003
2. Electronic test Instruments, analog and digital measurements, Robert A. Wittie, 2nd edition, Pearson education, 2004.
3. Electronic measurements and Instrumentations, K. Lal Kishore, Pearson education, 2005

**Web Links:**

1. <https://www.allaboutcircuits.com/textbook/alternating-current/chpt-12/ac-bridge-circuits/>
2. <https://www.science-ebooks.com/bridge-circuit.html>

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## SENSORS AND ACTUATORS

### (Open Elective-IV)

VII Semester

Course Code: 231EC7006

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1** Classify various sensors/transducers based on their applications.
- CO2** Categorize various types of Resistive, Inductive and Capacitive Sensors.
- CO3** Analyze various approaches, procedures and results related to Thermal sensors.
- CO4** Analyze various approaches, procedures and results related to Magnetic sensors.
- CO5** Examine the radiation sensors based on their characteristics.
- CO6** Apply Smart Sensors in the field of Communication, Automation and Manufacturing

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 1    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 2    | 3    | 2    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 2    | 3    | 2    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 2    | 3    | 2    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 2    | 3    | 2    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO6   | 2    | 2    | 3    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |
| CO6    | -     | -     |

### Unit - I

Sensors / Transducers:

Principles – Classification – Parameters – Characteristics – Environmental Parameters (EP) – Characterization.

Mechanical and Electromechanical Sensors: Introduction – Resistive Potentiometer – Strain Gauge – Resistance Strain Gauge – Semiconductor Strain Gauges -Inductive Sensors: Sensitivity and Linearity of the Sensor –Types-Capacitive Sensors:- Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors.

**Unit – II****Thermal Sensors:**

Introduction – Gas thermometric Sensors – Thermal Expansion Type Thermometric Sensors – Acoustic Temperature Sensor – Dielectric Constant and Refractive Index thermo sensors – Helium Low Temperature Thermometer – Nuclear Thermometer – Magnetic Thermometer – Resistance Change Type Thermometric Sensors –Thermo emf Sensors– Junction Semiconductor Types– Thermal Radiation Sensors –Quartz Crystal Thermoelectric Sensors – NQR Thermometry – Spectroscopic Thermometry – Noise Thermometry – Heat Flux Sensors.

Magnetic sensors: Introduction – Sensors and the Principles Behind – Magneto-resistive Sensors – Anisotropic Magneto resistive Sensing – Semiconductor Magneto resistors– Hall Effect and Sensors – Inductance and Eddy Current Sensors– Angular/Rotary Movement Transducers – Synchros – Synchro- resolvers - Eddy Current Sensors – Electromagnetic Flow meter – Switching Magnetic Sensors SQUID Sensor

**Unit-III****Radiation Sensors:**

Introduction – Basic Characteristics – Types of Photo sensistors /Photo detectors– X-ray and Nuclear Radiation Sensors– Fiber Optic Sensors.

Electro analytical Sensors: Introduction – The Electrochemical Cell – The Cell Potential – Standard Hydrogen Electrode (SHE) – Liquid Junction and Other Potentials – Polarization – Concentration Polarization– Reference Electrodes - Sensor Electrodes – Electro ceramics in Gas Media. Radiation Sensors –Quartz Crystal Thermoelectric Sensors – NQR Thermometry – Spectroscopic Thermometry – Noise Thermometry – Heat Flux Sensors.

**Unit – IV****Smart Sensors:**

Introduction – Primary Sensors – Excitation – Amplification – Filters – Converters – Compensation– Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface – The Automation

Sensors-Applications: Introduction – On-board Automobile Sensors (Automotive Sensors)– Home Appliance Sensors – Aerospace Sensors — Sensors for Manufacturing –Sensors for environmental Monitoring.

**Unit – V****Actuators:**

Pneumatic and Hydraulic Actuation Systems- Actuation systems – Pneumatic and hydraulic systems - Directional Control valves – Presure control valves – Cylinders - Servo and proportional control valves – Process control valves – Rotary actuators

Mechanical Actuation Systems- Types of motion – Kinematic chains – Cams – Gears – Ratchet and pawl – Belt and chain drives – Bearings – Mechanical aspects of motor selection

Electrical Actuation Systems- Electrical systems -Mechanical switches – Solid-state switches Solenoids – D.C. Motors – A.C. motors – Stepper motors

**Text Books:**

1. D. Patranabis – “Sensors and Transducers” –PHI Learning Private Limited.
2. W. Bolton – “Mechatronics” –Pearson Education Limited.

**Reference Books:**

1. Sensors and Actuators – D. Patranabis – 2nd Ed., PHI, 2013.
2. Hardware Software Co-Design Principles and Practice, J. Staunstrup, Springer Publications
3. Embedded Systems Architecture, Tammy Noergaard, Elsevier Publications, 2013.

**Web Links:**

1. <https://www.iitk.ac.in/tkic/workshop/sensors-and-actuators/ppt/sandeep.pdf>
2. <https://www.hella.com/techworld/ae/Technical/Sensors-and-actuators-204/>
3. <https://www.leanix.net/en/blog/iot-devices-sensors-and-actuators-explained>

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## INTRODUCTION TO MACHINE LEARNING

### (Open Elective-IV)

VII Semester

**L      T      P      C**

**Course Code:** 231CS7O02

**3      0      0      3**

**Course Outcomes:** At the end of the Course, Student will be able to:

**CO1:** Explain the fundamental usage of the concept Machine Learning system with an emphasis on statistical learning

**CO2:** Demonstrate various regression techniques and linear models for binary classification

**CO3:** Analyze the role of Ensemble Learning Methods and Support Vector Machines in Machine Learning

**CO4:** Illustrate the Clustering Techniques and Dimensionality Reduction Models in Machine Learning

**CO5:** Discuss the Neural Network Models and Fundamentals concepts of Deep Learning

#### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 1    | -    | -    | 2    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 2    | 2    | 1    | -    | 3    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 1    | 2    | 1    | 3    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 1    | 3    | 1    | 2    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 2    | 1    | 1    | -    | 3    | -    | -    | -    | -    | -     | -     | -     |

#### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

#### Unit - I

Introduction- Artificial Intelligence, Machine Learning, Deep learning, Types of Machine Learning Systems, Main Challenges of Machine Learning. Statistical Learning: Introduction, Supervised and Unsupervised Learning, Training and Test Loss, Tradeoffs in Statistical Learning, Estimating Risk Statistics, Sampling distribution of an estimator, Empirical Risk Minimization.

**Unit – II**

Supervised Learning(Regression/Classification):Basic Methods: Distance based Methods, Nearest Neighbours, Decision Trees, Naive Bayes, Linear Models: Linear Regression, Logistic Regression, Generalized Linear Models, Support Vector Machines, Binary Classification: Multiclass/Structured outputs, MNIST, Ranking.

**Unit – III**

Ensemble Learning and Random Forests: Introduction, Voting Classifiers, Bagging and Pasting, Random Forests, Boosting, Stacking.Support Vector Machine: Linear SVM Classification, Nonlinear SVM ClassificationSVM Regression, Naïve Bayes Classifiers.

**Unit – IV**

Unsupervised Learning Techniques: Clustering, K-Means, Limits of K-Means, Using Clustering for Image Segmentation, Using Clustering for Preprocessing, Using Clustering for Semi-Supervised Learning, DBSCAN, Gaussian Mixtures. Dimensionality Reduction: The Curse of Dimensionality, Main Approaches for Dimensionality Reduction, PCA, Using Scikit-Learn, Randomized PCA, Kernel PCA.

**Unit – V**

Neural Networks and Deep Learning: Introduction to Artificial Neural Networks with Keras, Implementing MLPs with Keras, Installing TensorFlow 2, Loading and Preprocessing Data with TensorFlow.

**Text Books:**

1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Publications, 2019
2. Data Science and Machine Learning Mathematical and Statistical Methods,Dirk P. Kroese, Zdravko I. Botev, Thomas Taimre, Radislav Vaisman,25th November 2020

**Reference Books:**

1. Machine Learning Probabilistic Approach, Kevin P. Murphy, MIT Press, 2012.
2. Stephen Marsland, “Machine Learning -An Algorithmic Perspective”, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
3. Andreas C. Müller and Sarah Guido “Introduction to Machine Learning with Python: A Guide for Data Scientists”, Oreilly

**Web Links:**

1. <https://www.deeplearning.ai/machine-learningyearning/>
2. <https://www.cse.huji.ac.il/~shais/UnderstandingMachineLearning/index.html>
3. [https://onlinecourses.nptel.ac.in/noc21\\_cs24/preview](https://onlinecourses.nptel.ac.in/noc21_cs24/preview)
4. <https://www.udemy.com/course/machinelearning/>

**DATA VISUALIZATION****(Open Elective-IV)****VII Semester****L T P C****Course Code: 231DS7002****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Identify and recognize visual perception and representation of data.**CO2:** Illustrate about projections of different views of objects.**CO3:** Apply various Interaction and visualization techniques.**CO4:** Analyze various groups for visualization.**CO5:** Apply visualizations for volumetric data to present them graphically.**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| CO1   | 1   | 2   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO2   | 1   | 2   | -   | 3   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO3   | 1   | 2   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO4   | 1   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| CO5   | 1   | 2   | 2   | 3   | -   | -   | -   | -   | -   | -    | -    | -    |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 2    | -    |
| CO2    | 2    | -    |
| CO3    | 1    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

**Unit– I**

Introduction To Data Visualizations And Perception: Introduction of visual perception, visual representation of data, Gestalt principles, Information over load.

**Unit– II**

Visual Representations: Creating visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications.

**Unit–III**

Classification Of Visualization Systems: Classification of visualization systems, Interaction and visualization techniques mis leading, Visualization of one, two and multi-dimensional data, text and text documents.



**Unit– IV**

Visualization Of Groups: Visualization of groups, trees, graphs, clusters, networks, software, Meta phorical visualization. Various visualization techniques, data structures used in data visualization.

**Unit– V**

Visualization Of Volumetric Data And Evaluation Of Visualizations: Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geo graphic information, GIS systems, collaborative visualizations, evaluating visualizations

**Text Books:**

1. Ward, Grinstein, Keim, Interactive Data Visualization: Foundations, Techniques, and Applications. Natick, 2<sup>nd</sup> edition, AK Peters, Ltd 2015.

**Reference Books:**

1. Tamara Munzner, Visualization Analysis & Design, 1<sup>st</sup> edition, AK Peters Visualization Series 2014
2. Scott Murray, Interactive Data Visualization for the Web, 2<sup>nd</sup> Edition, 2017

**Web Links:**

1. [https://onlinecourses.nptel.ac.in/noc22\\_mg67/preview](https://onlinecourses.nptel.ac.in/noc22_mg67/preview)
2. [https://onlinecourses.nptel.ac.in/noc22\\_mg67/preview](https://onlinecourses.nptel.ac.in/noc22_mg67/preview)
3. <https://www.coursera.org/learn/datavisualization>
4. <https://www.udemy.com/course/data-visualization-foundations/>
5. <https://www.udemy.com/course/masteringd3js/>

## CLOUD COMPUTING

### (Open Elective-IV)

VII Semester

Course Code: 231IT7O02

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Explain cloud computing concepts, service models (IaaS, PaaS, SaaS), and deployment models (public, private, hybrid).
- CO2:** Analyze cloud-enabling technologies including distributed computing, virtualization, and SOA.
- CO3:** Evaluate virtualization technologies and container platforms such as Docker and Kubernetes.
- CO4:** Assess the major challenges in cloud computing, including security, interoperability, and fault tolerance.
- CO5:** Describe advanced cloud topics like serverless computing, IoT integration, and DevOps practices.

#### Mapping of Course Outcomes with Program Outcomes:

| CO \ PO    | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| <b>CO1</b> | 3   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO2</b> | 2   | 3   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO3</b> | 2   | 2   | 3   | 2   | 2   | -   | -   | -   | -   | -    | -    | -    |
| <b>CO4</b> | 2   | 3   | -   | 3   | 2   | 1   | 1   | -   | -   | -    | -    | -    |
| <b>CO5</b> | 3   | 2   | 2   | 2   | 2   | -   | -   | -   | -   | 1    | 1    | 1    |

#### Mapping of Course Outcomes with Program Specific Outcomes:

| CO \ PSO   | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    | -    |
| <b>CO2</b> | -    | -    |
| <b>CO3</b> | -    | -    |
| <b>CO4</b> | -    | -    |
| <b>CO5</b> | -    | -    |

**UNIT – I****Introduction to Cloud Computing Fundamentals**

Cloud computing at a glance, defining a cloud, cloud computing reference model, types of services (IaaS, PaaS, SaaS), cloud deployment models (public, private, hybrid), utility computing, cloud computing characteristics and benefits, cloud service providers (Amazon Web Services, Microsoft Azure, Google App Engine).

**UNIT – II****Cloud Enabling Technologies**

Ubiquitous Internet, parallel and distributed computing, elements of parallel computing, hardware architectures for parallel computing (SISD, SIMD, MISD, MIMD), elements of distributed computing, Inter-process communication, technologies for distributed computing, remote procedure calls (RPC), service-oriented architecture (SOA), Web services, virtualization.

**UNIT – III****Virtualization and Containers**

Characteristics of virtualized environments, taxonomy of virtualization techniques, virtualization and cloud Computing, pros and cons of virtualization, technology examples (XEN, VMware), building blocks of containers, container platforms (LXC, Docker), container orchestration, Docker Swarm and Kubernetes, public cloud VM (e.g. Amazon EC2) and container (e.g. Amazon Elastic Container Service) offerings.

**UNIT-IV****Cloud computing challenges**

Economics of the cloud, cloud interoperability and standards, scalability and fault tolerance, energy efficiency in clouds, federated clouds, cloud computing security, fundamentals of computer security, cloud security architecture, cloud shared responsibility model, security in cloud deployment models.

**UNIT –V****Advanced concepts in cloud computing**

Serverless computing, Function-as-a-Service, serverless computing architecture, public cloud (e.g. AWS Lambda) and open-source (e.g. OpenFaaS) serverless platforms, Internet of Things (IoT), applications, cloud-centric IoT and layers, edge and fog computing, DevOps, infrastructure- as-code, quantum cloud computing.

**Text Books:**

1. Mastering Cloud Computing, 2<sup>nd</sup> edition, Rajkumar Buyya, Christian Vecchiola, Thamarai Selvi, Shivananda Poojara, Satish N. Srirama, Mc Graw Hill, 2024.
2. Distributed and Cloud Computing, Kai Hwang, Geoffery C. Fox, Jack J. Dongarra, Elsevier, 2012.

**Reference Books:**

1. Cloud Computing, Theory and Practice, Dan C Marinescu, 2<sup>nd</sup> edition, MK Elsevier, 2018.
2. Essentials of cloud Computing, K. Chandrasekhran, CRC press, 2014.
3. Online documentation and tutorials from cloud service providers (e.g., AWS, Azure, GCP)

**Weblinks:**

1. <https://docs.aws.amazon.com>
2. <https://learn.microsoft.com/en-us/azure/>
3. <https://cloud.google.com/docs>
4. <https://nptel.ac.in/courses/106106129>
5. <https://nptel.ac.in/courses/106105167>

## Software Engineering (Open Elective-IV)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231AM7O02</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the course, student will be able to:**

- CO1:** Explain the evolution of software development and analyse life cycle models like Waterfall, RAD, Agile, and Spiral
- CO2:** Apply estimation techniques and risk management for effective project management and develop SRS
- CO3:** Design software using good design principles, structured analysis, and user interface methodologies
- CO4:** Conduct blackbox, whitebox, and integration testing to ensure software reliability and quality
- CO5:** Use CASE tools for software maintenance, reverse engineering, cost estimation, and reuse strategies

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 3    | 2    | -    | -    | -    | -    | -    | 1    | -    | -     | -     | -     |
| <b>CO2</b> | 2    | 1    | 3    | 2    | -    | -    | -    | -    | -    | -     | -     | 2     |
| <b>CO3</b> | 2    | 2    | 3    | -    | 3    | -    | -    | 2    | -    | -     | -     | -     |
| <b>CO4</b> | 2    | 2    | -    | 3    | 2    | 1    | -    | -    | -    | -     | -     | -     |
| <b>CO5</b> | 2    | 2    | -    | -    | 3    | -    | -    | 1    | 1    | -     | -     | 2     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO     | PSO1 | PSO2 |
|------------|------|------|
| <b>CO1</b> | -    |      |
| <b>CO2</b> | -    |      |
| <b>CO3</b> | -    |      |
| <b>CO4</b> | -    |      |
| <b>CO5</b> | -    |      |

## UNIT-I

**Introduction:** Evolution, Software development projects, Exploratory style of software developments, Emergence of software engineering, Notable changes in software development practices, Computer system engineering.

**Software Life Cycle Models:** Basic concepts, Waterfall model and its extensions, Rapid application development, Agile development model, Spiral model.

**UNIT-II**

**Software Project Management:** Software project management complexities, Responsibilities of a software project manager, Metrics for project size estimation, Project estimation techniques, Empirical Estimation techniques, COCOMO, Halstead's software science, risk management.

**Requirements Analysis and Specification:** Requirements gathering and analysis, Software Requirements Specification (SRS), Formal system specification, Axiomatic specification, Algebraic specification, Executable specification and 4GL.

**UNIT-III**

**Software Design:** Overview of the design process, How to characterize a good software design? Layered arrangement of modules, Cohesion and Coupling. approaches to software design.

**Agility:** Agility and the Cost of Change, Agile Process, Extreme Programming (XP), Other Agile Process Models, Tool Set for the Agile Process (Text Book 2)

**Function-Oriented Software Design:** Overview of SA/SD methodology, Structured analysis, Developing the DFD model of a system, Structured design, Detailed design, and Design Review.

**User Interface Design:** Characteristics of a good user interface, Basic concepts, Types of user interfaces, Fundamentals of component-based GUI development, and user interface design methodology.

**UNIT-IV**

**Coding And Testing:** Coding, Code review, Software documentation, Testing, Black-box testing, White-Box testing, Debugging, Program analysis tools, Integration testing, testing object-oriented programs, Smoke testing, and some general issues associated with testing. Software Reliability and Quality Management: Software reliability. Statistical testing, Software quality, Software quality management system, ISO9000. SEI Capability maturity model. Few other important quality standards, and Six Sigma.

**UNIT – V**

**Computer-Aided Software Engineering (Case):** CASE and its scope, CASE environment, CASE support in the software life cycle, other characteristics of CASE tools, Towards second generation CASE Tool, and Architecture of a CASE Environment.

**Software Maintenance:** Characteristics of software maintenance, Software reverse engineering, Software maintenance process models and Estimation of maintenance cost.

**Software Reuse:** Reuse-definition, Introduction, Reason behind no reuses of ar, Basic issues in any reuse program, A reuse approach, and Reuse at organization level.

**Text Books:**

- 1 Fundamentals of Software Engineering, Rajib Mall, 5<sup>th</sup> Edition, PHI.
- 2 Software Engineering A Practitioner's Approach, Roger S. Pressman, 9<sup>th</sup> Edition, McGraw Hill International Edition.

**Reference Books:**

- 1 Software Engineering, Ian Sommerville, 10th Edition, Pearson
- 2 Software Engineering, Principles and Practices, Deepak Jain, Oxford University Press.

**Web Links:**

- 1 <https://nptel.ac.in/courses/106105087>
- 2 <https://nptel.ac.in/courses/106101061>
- 3 <https://www.coursera.org/specializations/software-design-architecture>

## DEEPWATER TECHNOLOGY

### (OPEN ELECTIVE-IV)

**VII Semester****L T P C****Course Code: 231PT7O04****3 0 0 3****Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Analysis of waves and fluid-induced forces on offshore structures, Current and wind forces.
- CO 2:** Understand the Deepwater exploration and Deepwater drilling techniques.
- CO 3:** Apply the concepts of fixed platforms, compliant towers, subsea systems, extended reach wells and floating production systems.
- CO 4:** Extend innovative subsea completion, installation and associated problem.
- CO 5:** Demonstrate deep-water pipelines, flow assurance strategies and subsea innovations.

**Mapping of Course Outcomes with Program Outcomes**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     | 2     |

**Mapping of Course Outcomes with Program Specific Outcomes**

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | 3     | -     |
| CO2      | 3     | -     |
| CO3      | 3     | -     |
| CO4      | 3     | -     |
| CO5      | 3     | -     |

**UNIT-I:**

**Introduction:** Definition, Global Deep-water reserves & development activity. Technological advances. Dynamics of Offshore structure: Analysis of waves and fluid induced forces on offshore structures, Current and wind forces, Soil mechanics of seabed & structures.

**UNIT-II:**

**Deep-water Exploration & Drilling:** Seismic /Seabed survey, constraints in deepwater survey like geo-hazards, gas hydrate etc., Deep water drilling with emphasis on the additional inputs to normal offshore Drilling operation.



**UNIT –III:**

**Deep-water Production System:** Fixed Platforms, Compliant Towers, Subsea systems, Extended Reach Wells, Floating production systems like FPSO, FPSS, TLPS, Spar platform and FSO.

**UNIT-IV:**

**Deep-water applications of Subsea Technology:** Subsea completion, X-mas tree, Control systems, Manifolds, Templates, ROV, Deepwater installation vessels with DP system and associated problems – Offshore mobile units, station- keeping methods like mooring and dynamic positioning system.

**UNIT-V:****Deep-water pipelines, Umbilical's & emerging Deep-water Technologies:**

Issues in Deep-water pipeline design, Rigid and Flexible flow lines, pipe-in-pipe, Deep-water Risers and their configurations, Pipeline installation methods, Umbilical's-functions, configurations and installation, Flow assurance strategies, Innovative floating production concepts, subsea processing, subsea separation and any new innovations.

**Text Books:**

1. Subsea Engineering Handbook, Yong bai and Qiangbai, Gulf Professional Publishing, 2010.
2. Offshore Petroleum Drilling and Production, By Sukumar Laik, 1st Edition, Published June 30, 2020 by CRC Press.
3. Deepwater Petroleum Exploration & Production by [William L. Leffler](#), [Richard Pattarozzi](#), [Gordon Sterling](#) Penn Well Books, 2003.

**Reference Books:**

1. Floating Drilling: Equipment and Its Use, by Riley Sheffield Volume 2 of Floating Drilling and Volume 2 of Practical drilling technology-1980
2. Handbook On Nondestructive Testing of Concrete By V.M. Malhotra And N.J. Carino, Second Edition Crc Press-2004
3. Offshore Handbook Vol.1 to 5: Gulf Pub. Co.
4. Offshore Pipeline Design, Analysis, and Methods by A. H. Mousselli, Publisher, Penn Well Books, 1981.
5. Drilling and Producing Offshore, by R. Stewart Hall, Publisher, Pennwell Corp- 1984.

## INTRODUCTION TO ACIDIZING AND HYDRO-FRACTURING (OPEN ELECTIVE-IV)

**VII Semester**

**Course Code: 231PT7O05**

|          |          |          |          |
|----------|----------|----------|----------|
| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO 1:** Apply the modelling of hydraulic fractures for different reservoirs.

**CO 2:** Assess fracturing fluid properties and their usage.

**CO 3:** Analyze the fracturing fluid proppant characteristics.

**CO 4:** Apply the methods of matrix acidization and fracture acidization.

**CO5:** Apply the concepts of hydraulic fracturing and its design

### Mapping of Course Outcomes with Program Outcomes

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | 2     |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO /<br>PSO | PSO 1 | PSO 2 |
|-------------|-------|-------|
| CO1         | 3     | -     |
| CO2         | 3     | -     |
| CO3         | 3     | -     |
| CO4         | 3     | -     |
| CO5         | 3     | -     |

**UNIT-I:**

**Modelling of hydraulic fractures:** Conservation laws and constitutive equations, fracture propagation models, fluid flow modelling, acid fracturing.

**UNIT-II:**

**Fracturing fluid chemistry:** Water base fluids, oil base fluids, multiphase fluids, additives execution.

**UNIT-III:**

**Fracturing fluid proppant and characterization:** Rheology, shear and temperature effects on fluid properties, foam fracturing fluids, slurry rheology, proppant transport, fluid loss, formation and fracture damage, and proppants.

**UNIT-IV:**

**Matrix acidization and fracture acidization:** Well Stimulation acids, matrix acidizing carbonate formations, fracture acidizing carbonate formations, Acid–rock interaction, sandstone acidizing design, carbonate acidizing design.

**UNIT-V:**

**Hydraulic Fracturing:** Introduction, formation fracturing pressure, fracture geometry, productivity of fractured wells, stimulated reservoir volume (SRV) - hydraulic fracturing design.

**Text Book:**

1. Reservoir Stimulation, Michael. J. Economides, Kenneth G. Nolte, 2nd Edition, Prentice Hall, 1989.

**Reference Books:**

1. Oil Well Stimulation, Robert S. Schechter, Prentice Hall, 1992.
2. Modern Fracturing Enhancing Natural Gas Production, Michael J. Economides, Tony Martin, ET Publishing, 2007.

## INTRODUCTION TO RESERVOIR ENGINEERING (OPEN ELECTIVE-IV)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231PT7O06</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO 1:** Apply the basic concepts in reservoir engineering.  
**CO 2:** Perform basic PVT analysis of various types of fluids for wells.  
**CO 3:** Carry out the calculations in material balance and estimate the reserves of various sands of the reservoir from well data.  
**CO 4:** Apply the Darcy's Law and derive deliverability equations for various types of reservoirs.  
**CO 5:** Learn about water Influx methods

### Mapping of Course Outcomes with Program Outcomes

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO2   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO4   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |
| CO5   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes

| CO / PSO | PSO 1 | PSO 2 |
|----------|-------|-------|
| CO1      | -     | -     |
| CO2      | -     | -     |
| CO3      | -     | -     |
| CO4      | -     | -     |
| CO5      | -     | -     |

### UNIT-I

**Basic concepts in reservoir engineering:** Calculation of hydrocarbon volumes- Fluid pressure regimes- Oil recovery and recovery factor -Volumetric gas reservoir engineering – Application of the real gas equation of state - Gas material balance and recovery factor and its conceptual coherence with drive mechanisms - Hydrocarbon phase behavior.

### UNIT-II

**PVT analysis for oil:** Definition of the basic PVT parameters – Collection of fluid samples - Determination of the basic parameters in the laboratory and conversion for field operating conditions - Alternative manner of expressing PVT lab analysis results - Complete PVT analysis.

### UNIT-III

**Material balance applied to oil reservoirs:** General form -The material balance expressed as a linear equation - Reservoir drive mechanisms - Solution gas drive- Gas cap drive- Natural water drive- compaction drive and related pore compressibility phenomena.

### UNIT-IV

**Darcy's law and applications:** Darcy's law and field potential- Sign convention- Units and unit conversion- Real gas potential – Datum pressures- Different flow regimes- Linear & Radial steady state flow - Pseudo-steady flow- Unsteady state flow- Derivation of deliverability equations – estimation of reservoir permeability - Two phase flow- Effective and relative permeabilities.

### UNIT-V

**Natural water influx:** Steady state water influx methods- Unsteady state water influx theory of Hurst and Van Everdingen and its application in history matching – The approximate water influx theory of Fetkovich for finite aquifers and predicting the amount of water influx – Application of influx calculation techniques to steam soaking.

#### Text Books:

1. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science, 1978 (17th Impression 1998).
2. Reservoir Engineering Handbook, Tarek Ahmed, 3<sup>rd</sup> Edition, Gulf Professional Publishing, 2006.
3. B. C. Craft – M. Hawkins, Ronald E. Terry & J. Brandon Rogers, 3rd revised Edition, Prentice Hall, New York, 2014.

#### Reference Books:

1. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman Inc. 1986.
2. Reservoir Engineering Handbook, Tarek Ahmed, 3<sup>rd</sup> Edition, Gulf Professional Publishing, 2006.

## Principles of Mineral Engineering (Open Elective-IV)

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231MI7O05</b> | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Differentiate between explosives.  
**CO2:** Use blasting accessories along with monitoring and assessment.  
**CO3:** Analyse problems associated with open cast blasting and mitigation  
**CO4:** Analyse problems associated with underground blasting and mitigation.  
**CO5:** Assess blasting in metal mines

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | 3    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 1    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 1    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 1    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | -     | -     |
| CO2    | -     | -     |
| CO3    | -     | -     |
| CO4    | -     | -     |
| CO5    | -     | -     |

### Unit - I

Drilling:

Drillability, mechanics of drilling, major types of drilling machines, Principles of drilling, Types of drill, Drillrods and drill bits -Types and applications, Exploratory and Production Drilling.

### Unit – II

Explosives and Blasting Accessories:

Mechanism of blasting, Explosives- types and properties. Selection of explosives, Handling and storage of explosives. Types of initiating systems – Electrical Detonators, Detonating Fuse, Detonating Relays, NONEL, Electronic Detonators, Blasting accessories, exploders. Blast Design in Surface and Underground Mines.

**Unit – III**

Drilling and Blasting in Surface Mines:

Factors affecting blasting, Blast design - estimation of burden and spacing, estimation of charge requirement; Initiation patterns; secondary blasting – pop and plaster shooting; Problems associated with blasting, Ground vibration and air over pressure

**Unit – IV**

Drilling and Blasting in Underground Coal Mines:

Blast hole patterns and their applicability, blasting-off-solid, ring hole blasting, calculation of specific charge, specific drilling and detonator factor, initiation patterns.

**Unit – V**

Drilling and Blasting in Underground Metal mines:

Blast hole patterns and their applicability, blast design for horizontal drivage, long hole blasting, vertical crater retreat blasting.

**Text Books:**

1. B. Misra, U.M. Rao Karanam, Principle of rock drilling Taylor & Francis, CRC Press, 1998, ISBN-905410788X.
2. "Drilling & Blasting" Minetech by Pradhan G.K., Ghose A.K., Bhubaneswar, India : MINTECH Publications, c1996 200 pages :

**Reference Books:**

1. Elements of Mining Technology by DJ Deshmukh, Vol. 1, Denett, 2016, First Edition
2. Surface mining, by GB Mishra, Vol.1, Dhanbad Publisher, 1979

**Web Links:**

1. [https://en.wikipedia.org/wiki/Drilling\\_and\\_blastig](https://en.wikipedia.org/wiki/Drilling_and_blastig)
2. <https://www.rpmdrilling.co.za/blast-hole-drilling-process/>
3. [www.railsystem.net/drill-and-blast-method/](http://www.railsystem.net/drill-and-blast-method/)

**MINING INSTRUMENTATION****Open Elective-IV****VII Semester****L T P C****Course Code: 231MI7006****3 0 0 3****Course Outcomes:** At the end of the Course, Student will be able to:

- CO1: Identify and apply electrical instruments for accurate measurement and monitoring in mining systems.
- CO2: Use appropriate pressure and flow measurement devices for different operational needs.
- CO3: Measure vibration, velocity, humidity, and level parameters using relevant instruments.
- CO4: Operate and interpret readings from analysers for environmental and process control.
- CO5: Implement rock mechanics instrumentation techniques in both underground and surface mining operations.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | -    | -    | -    | -    | -    | -    | -    | -    | 1     | -     | -     |
| CO2   | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | 1     | -     | -     |
| CO3   | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | 1     | -     | -     |
| CO4   | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**UNIT – I**

Electrical Instruments: Basic Concepts: Sensitivity, range, reproducibility and accuracy, drift, absolute and relative measurements, error, environmental factors and planning for instrumentation. Accuracy, precision, resolution, sensitivity, linearity, span and range - Dynamic characteristics. Ammeters (MI & MC), Volt meters, Watt meters (Dynamometer), Energy Meters, Megger, Power Factor meters, Earth resistance measurement. and thermocouples, Inclination meters.

**UNIT – II**

Pressure Measurements and Flow Measurements: Unit of Pressure – Manometers Different types, - Elastic type pressure gauges and sensors– Bourdon tube – Bellows – Diaphragm – Elastic elements with LVDT and strain gauge, deformation gauge – Capacitive type pressure gauge – Measurement of vacuum – McLeod gauge – Thermal conductivity gauge – Ionisation gauge. Piezometer, Flow meters – Variable head type flow meter – Orifice plate – Venturi tube – Positive displacement flow meter: Nutating disc, Reciprocating piston, oval gear and helix type flow meter – Rotameter – Mass flow meters.

**UNIT – III**

Vibration, Humidity, Velocity and Level Measurements: Mechanical type vibration measuring instruments – Seismic instruments as an accelerometer – Vibrometers – Geophones. Humidity – Hot wire electro type hygrometer – Dew cell – Electrolysis type hygrometer. Anemometer, Velometer, Pitot static tube, Sound level meter, microphone, Lux meter; Level measurements: – Float gauges - Displacer type – D/P methods -Bubbler system Load cell – Electrical types – Conductivity sensors – Capacitive sensors – Nucleonic gauge - Ultrasonic gauge – Boiler drum level measurement – Differential pressure method and Hydrastep method -Solid level measurement...



**UNIT – IV**

Analyzers: Dissolved Analyzer: Conductivity meter – pH meter – Dissolved oxygen analyzer – Sodium analyzer – Silica analyzer – Turbidity meter – Gas analyzer – O<sub>2</sub>, NO<sub>x</sub> – H<sub>2</sub>S analyzer – CO and CO<sub>2</sub> monitor, Dust & Smoke measurement. IR analyzers, thermal conductivity analyzers, analysis based on ionization of gases. hydrocarbons, nitrogen oxides, Sulphur dioxide estimation - Calibration methods.

**UNIT – V**

Rock Mechanics Instrumentation: Different types of Load cells, stress capsules, Flat jack, tape extensor meters, convergence indicators and recorders, borehole deformation gauges of different types, depth indicators. Seismic measurements, Applications in Mining: Coal mining – bord and pillar development, depillaring and Longwall, Metal mining and opencast mining applications, rock slope instrumentation.

**Text Books:**

1. De, N.K. and Sen, P.K. 'Electric Drives' Prentice Hall of India Private Ltd, 2002.
2. Subramaniam, V. 'Electric Drives' Tata McGraw Hill , New Delhi, 2007

**Reference Books:**

1. Dubey, G.K. 'Fundamentals of Electrical Drives' Narosa, Second Edition.
2. Morris, A.S. Principles of Measurement and Instrumentation, Prentice-Hall of India Pvt., Ltd. New Delhi, 1999.
3. Doebelin, E.O. Measurement Systems Application & Design, Tata McGraw Hill Publishing Co., New. Delhi, 1999.

**Web Links:**

1. <https://www.nptel.ac.in/courses/108/106/108106165/>
2. <https://engineeringinterviewquestions.com/wp-content/uploads/2019/08/industrial-instrumentation-notes.pdf>
3. [https://miningandblasting.files.wordpress.com/2009/09/rock\\_mechanics\\_instrumentation.pdf](https://miningandblasting.files.wordpress.com/2009/09/rock_mechanics_instrumentation.pdf)

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**MINE SAFETY & ERGONOMICS****Open Elective-IV****VII Semester****L T P C****Course Code: 231MI7007****3 0 0 3****Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Demonstrate knowledge of historical safety practices and major global mining disasters.
- CO2:** Apply risk assessment techniques and HIRA methodology in identifying and controlling mining hazards.
- CO3:** Utilize advanced risk analysis methods such as FMEA, HAZOP, FTA, and Markov Models.
- CO4:** Analyze mine accidents using safety engineering theories, ANN, and SEM tools.
- CO5:** Evaluate and implement ergonomic principles to improve safety and productivity in mining environments.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 2    | -    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**UNIT – I**

Introduction: Historical Developments of Mine Safety in India and Abroad; Need for Improving, Safety Engineering Approach in Mining, Industry; Engineering Safety Goals; Mine Safety Facts and Figures; Worldwide Major Mine Disasters.

**UNIT – II**

Risk Management: Risk Management Related Terms and Definitions; Basic Concept of Risk, Reliability and Hazard Potential; Risk Components and Types; Risk Management Objectives; Risk Management Process; Functions of a Risk Manager; Common Errors in Risk Management; Risk Estimates for Selective, Events; Hazards Identification and Risk Assessment (HIRA) Methodology; Implementation of HIRA and its Controls & Review; Advantages of Risk Management

**UNIT – III**

Statistical Methods of Risk analysis: Basic Risk Analysis Methods based on Frequency Rates and Severity of Accidents Appraisal of advanced techniques - Preliminary Hazards Analysis (PHA); Hazards and Operability Analysis (HAZOP); Failure Mode and Effect Analysis (FMEA); Failure Mode Effect and Critical Analysis (FMECA); Job Safety Analysis (JSA); Fault Tree Analysis (FTA); Markov Model (MM) – An Important Risk analysis Tool.

**UNIT – IV**

Analyzers: Dissolved Analyzer: Conductivity meter – pH meter – Dissolved oxygen analyzer  
 System Safety Engineering Concept in Mine Safety: An Introduction to Systems Safety Engineering; Different School of Thoughts in Accident Causations - Domino Model; Behavioral Accident Model based on the human perception; Epidemiological Accident Models, Normal Accident Theory; The Swiss Cheese Model; Systems-Theoretic Accident Modeling and Process (STAMP); In-depth Study of Accidents Due to Various Causes; Application of Structural Equation Modelling (SEM) and Artificial Neural Network (ANN) in Determining the Accident Causation in Mines. Safety audits and control: Objectives of safety audit in mines; Different steps in safety audit; Risk control procedures.

**UNIT – V**

Mine Ergonomics: Domain, Philosophy and Objective of Mine Ergonomics; Ergonomics/human, Factors fundamentals; Work physiology, and stress; Human body- structure and, function, anthropometrics; Posture and movement; Posture and Job Relation – Work Posture Analysis using OWAS, Method; Oxygen Consumption and Workload Analysis of Mine Workers..

**Text Books:**

1. Engineering Safety: Fundamentals, Techniques and Applications by B. S. Dhillon; World Scientific Publisher.
2. Mine Health and Safety Management – Edited by Michael Karmis.
3. Kejriwal, B. K., Safety in mines, Lovely Prakashan.

**Reference Books:**

1. Dhillon, B. S. (2008). Mining equipment reliability, maintainability, and safety (Springer Series in Reliability Engineering). Springer.
2. Dhillon, B. S. (2010). Mine safety: A modern approach (Springer Series in Reliability Engineering). Springer..

**Web Links:**

1. [https://www.dgms.gov.in/writereaddata/UploadFile/History\\_of\\_Mine\\_Safety\\_in\\_India.pdf](https://www.dgms.gov.in/writereaddata/UploadFile/History_of_Mine_Safety_in_India.pdf)
2. [https://miningandblasting.files.wordpress.com/2009/09/risk\\_management\\_in\\_mining.pdf](https://miningandblasting.files.wordpress.com/2009/09/risk_management_in_mining.pdf)
3. <https://www.slideshare.net/slideshow/system-safety-engineering-and-risk-analysis/23457298>

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**MINERAL EXPLORATION****Open Elective-IV****VII Semester****L T P C****Course Code: 231MI7O08****3 0 0 3****Course Outcomes:** At the end of the Course, Student will be able to:

- CO1: Explain fundamental concepts of geological prospecting and exploration techniques.  
 CO2: Apply appropriate sampling and ore reserve estimation methods in exploration.  
 CO3: Identify geochemical cycles and pathfinder elements used in mineral exploration.  
 CO4: Interpret geochemical survey results and recognize geochemical anomalies.  
 CO5: Evaluate exploration data across geological, feasibility, and economic dimensions.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO2   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO4   | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | 2    | 3    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |

**UNIT – I**

Geological Prospecting and Exploration: Definitions and Principles; Methods of Prospecting; Methods of Exploration.

**UNIT – II**

Sampling: theory and methods; Geological plans and sections for orebody evaluation; Exploration drilling, drill core logging and sampling Cut-off grade concepts and applications; Resources and Reserves. Estimation of reserves – methods and practice.

**UNIT – III**

Geochemical Exploration: Introduction, Geochemical cycle, geochemical mobility and association of elements. Pathfinder and target elements for geochemical exploration. Principles of geophysical exploration methods.

**UNIT – IV**

Primary and secondary dispersions of elements; Determination of background, and geochemical anomalies; Geo-chemical methods of mineral exploration: Procedures for geochemical sampling; Interpretation of geochemical surveys. Indian case studies.

**UNIT – V**

Collection of data along Geological (G), Feasibility (F) and Economic (E) axes during various stages of exploration.

**Text Books:**

1. Techniques in Mineral Exploration: Reedman, J H., 1979. Applied Science Publishers Ltd, UK
2. Exploration and Mining Geology (2nd Ed.), Peters, W.C. 1987. John Wiley & Sons, New York.

**Reference Books:**

1. Tables for Mineral Identification, Sharma, N L and Agarwal Y K.
2. Ore Geology and Industrial minerals- An introduction (III edn.) Geo-science, A.M.

**Web Links:**

1. <https://www.nptel.ac.in/courses/105/105/105105076/>
2. [https://miningandblasting.files.wordpress.com/2009/09/mineral\\_exploration\\_notes.pdf](https://miningandblasting.files.wordpress.com/2009/09/mineral_exploration_notes.pdf)
3. <https://www.slideshare.net/slideshow/geochemical-exploration/23792569>

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## AGRICULTURAL STRUCTURES AND PROTECTED CULTIVATION

### (Open Elective-IV)

|                        |          |          |          |          |
|------------------------|----------|----------|----------|----------|
| VII Semester           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| Course Code: 231AG7002 | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**Course Outcomes: At the end of the Course, Student will be able to:**

**CO1:** Classify the poultry houses, dairy barn planning and requirements.

**CO2:** Differentiate the different grain storage structures.

**CO3:** Classify polyhouses based on construction materials.

**CO4:** Apply different irrigation techniques in green house.

**CO5:** Plan fertilizer scheduling, rate of application of fertilizers and methods of application.

**Mapping of Course Outcomes with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | 1    | -    | -    | -     | -     | -     |
| CO2   | 1    | 2    | 1    | 1    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO3   | 1    | -    | 2    | -    | -    | -    | -    | -    | -    | -     | -     | 1     |
| CO4   | 2    | -    | 1    | -    | -    | -    | -    | -    | -    | -     | -     | -     |
| CO5   | -    | -    | -    | 2    | -    | -    | 1    | -    | -    | -     | -     | -     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO 1 | PSO 2 |
|--------|-------|-------|
| CO1    | 1     | 2     |
| CO2    | -     | 2     |
| CO3    | 2     | -     |
| CO4    | 3     | -     |
| CO5    | 3     | -     |

#### Unit - I

Planning and layout of farmstead. Scope, importance and need for environmental control, physiological reaction of livestock environmental factors, environmental control systems and their design, control of temperature, humidity and other air constituents by ventilation and other methods.

**Unit – II**

Livestock production facilities, BIS Standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc

**Unit – III**

Storage of grains and Causes of spoilage. Water activity for low and high moisture food grains and its limits for storage, Moisture and temperature changes in grain bins; Traditional storage structures and their improvements, Improved storage structures (CAP, hermetic storage, Pusa bin, RCC ring bins). Design consideration for grain storage godowns, Bag storage structures, Shallow and Deep bin, Calculation of pressure in bins and Storage of seeds

**Unit – IV**

Protected cultivation: Introduction, History, origin, development, national and International Scenario, components of green house, perspective, Types of green houses, polyhouses /shed nets, Cladding materials, Plant environment interactions – principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment. Design and construction of greenhouses – site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment, Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators, evaporative cooling, different shading material fogging, combined fogging and fan- pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care etc.

**Unit – V**

Planting techniques in green house cultivation. Irrigation in greenhouse and net house – Water quality, types of irrigation system, components, design, installation and material requirement. Fogging system for greenhouses and net houses – introduction, benefits, design, installation and material requirement. Fertilization – nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application. Greenhouse climate measurement, control and management.

**Text Books:**

1. Pandey, P.H. Principles and practices of Agricultural Structures and Environmental Control, Kalyani Publishers, Ludhiana.
2. Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag, New Delhi.

**Reference Books:**

1. Venugopal Rao, P. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi.
2. Sahay, K.M. and Singh, K.K. Unit Operations of Agricultural Processing, Vikaspublishing pvt. Ltd, Noida.
3. Singh Brahma and Balraj Singh. 2014. Advances in protected cultivation, New India Publishing Company.
4. Sharma P. 2007. Precision Farming. Daya Publishing House New Delhi.

**Web Links:**

1. <https://nptel.ac.in/courses/104103020/3>
2. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=618>
3. <https://agrimoon.com/agricultural-structures-and-environmental-control-pdfbook>



## MATLAB

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE7S01</b> | <b>0</b> | <b>0</b> | <b>2</b> | <b>2</b> |

Module 1: Introduction to MATLAB and Basic Operations Overview of MATLAB interface and workspace  
Basic arithmetic and logical operations Data types, variables, and assignment MATLAB help and documentation

Module 2: Matrix operations (addition, subtraction, multiplication, division) Transpose, inverse, and determinant of matrices, Element-wise operations

Module 3: Plotting and Data Visualization  
Creating 2D plots (line plots, scatter plots, bar graphs) Formatting plots (labels, legends, grid, title)  
Multiple plots in one figure Exporting and saving plots

Module 4: File Handling and Data Management Reading and writing text and Excel files Storing and retrieving data in MAT-files Managing workspace and clearing variables Handling missing and erroneous data

Module 5: Mini Project and Applications Hands-on project integrating learned concepts Real-world applications of MATLAB Debugging and performance optimization Q&A and discussion on advanced topics

## SUMMER INTERNSHIP-II

|                               |          |          |          |          |
|-------------------------------|----------|----------|----------|----------|
| <b>VII Semester</b>           | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
| <b>Course Code: 231CE7P01</b> | <b>0</b> | <b>0</b> | <b>0</b> | <b>2</b> |

### Guidelines:

1. The internship is a team activity comprises of 3-4 students.
2. The internship mainly focuses on the field-oriented experience and also software related any civil engineering projects.
3. The internship relates to Surveying, Engineering materials, Structural, Transportation, Environmental and Water Resources Engineering.
4. Internship should cater to a small system required in laboratory or real life.
5. Artwork and Layout should be made using Auto-CAD software. Based on the project the advanced softwares like STAAD.pro, Sap 2000, Primevera, Sketchup, ETABS, REVIT, Arc.GIS etc., can be used for effective completion of the project.
6. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of mini project.
7. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.
8. The student is expected to exert on design, development and testing of the proposed work as per the schedule.

**Course Outcomes:** At the end of the Course, Student will be able to:

- CO1:** Conduct a technical survey to identify a real world engineering problem.
- CO2:** Analyze the industrial plant layout using technical expertise.
- CO3:** Compare theoretical and real work environments in technical perspective.
- CO4:** Identify the challenges in the execution of operations.
- CO5:** Execute the operations and report the results of assigned tasks using modern tools adhering to professional ethics.

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|------------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| <b>CO1</b> | 2    | 2    | 2    | -    | -    | -    | 2    | 3    | 2    | 2     | 1     | 1     |
| <b>CO2</b> | 2    | 2    | 2    | -    | -    | -    | 2    | 3    | 2    | 2     | 1     | 1     |
| <b>CO3</b> | 2    | 2    | 2    | -    | -    | -    | 2    | 3    | 2    | 2     | 1     | 1     |
| <b>CO4</b> | 2    | 2    | 2    | -    | -    | -    | 2    | 3    | 2    | 2     | 1     | 1     |
| <b>CO5</b> | 2    | 2    | 2    | -    | 2    | -    | 2    | 3    | 2    | 2     | 1     | 1     |

**Mapping of Course Outcomes with Program Specific Outcomes:**

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 2    | -    |
| CO2    | 2    | -    |
| CO3    | 2    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

## RESEARCH METHODOLOGY

**Semester: VII**

**L      T      P      C**

**Course Code: 231MC7T01**

**2      0      0      0**

**Course Outcomes: At the end of the course, student will be able to:**

- CO1** Explain the characteristics and process of research.  
**CO2** Select the research problem by applying problem identification techniques.  
**CO3** Formulate and execute research design process.  
**CO4** Report the results of research process adhering to professional ethics.  
**CO5** Analyze the results of research using statistical measures of central tendency, coefficient of variation, correlation and regression

### Mapping of Course Outcomes with Program Outcomes:

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|
| CO1   | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | 2     | -     | 1     |
| CO2   | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | 2     | -     | 1     |
| CO3   | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | 2     | -     | 1     |
| CO4   | 1    | -    | -    | 2    | -    | -    | -    | 3    | -    | 2     | -     | 1     |
| CO5   | 1    | -    | -    | 2    | 2    | -    | -    | -    | -    | 2     | -     | 1     |

### Mapping of Course Outcomes with Program Specific Outcomes:

| CO/PSO | PSO1 | PSO2 |
|--------|------|------|
| CO1    | 2    | -    |
| CO2    | 2    | -    |
| CO3    | 2    | -    |
| CO4    | 2    | -    |
| CO5    | 2    | -    |

### UNIT – I

**Meaning of Research** - Function of Research - Characteristics of Research – Steps involved in Research – Research in Pure and Applied Sciences - Inter Disciplinary Research. Factors which hinder Research – Significance of Research - Research and scientific methods – Research Process– Criteria of good Research – Problems encountered by Researchers – Literature Review.

### UNIT – II

**Identification of Research Problem :** Selecting the Research problem – Necessity of defining the problem – Goals and Criteria for identifying problems for research. Perception of Research problem – Techniques involved in defining the problem.

**UNIT – III**

**Research Design:** Formulation of Research design – Need for Research design – Features of a good design – Important concepts related to Research design

**UNIT – IV**

**Interpretation and Report Writing:** Meaning and Technique of interpretation – Precautions in interpretation – Significance of report writing – Different steps in writing a report – Layout of a Research report.

**UNIT – V**

**Statistical Techniques and Tools: Introduction** of statistics – Functions – Limitations – Measures of central tendency - Arithmetic mean – Median – Mode – Standard deviation – Co-efficient of variation (Discrete series and continuous series) – Correlation - Regression

**Text Books:**

- 1 Research Methodology Methods & Techniques, C.R. Kothari – New Age international Publishers, Reprint 2008
- 2 A Hand Book of Methodology of Research, Rajammall, P. Devadoss and K. Kulandaivel, RMM Vidyalaya press, 1976

**Reference Books:**

- 1 Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd., 1997.
- 2 Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi, 2011
- 3 Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi, 1999.

**Web Links:**

- 1 <https://nptel.ac.in/courses/127106227>
- 2 [https://www.youtube.com/watch?v=IZLn9\\_PA\\_4s](https://www.youtube.com/watch?v=IZLn9_PA_4s)

### Project (Full Semester Internship)

|                               |          |          |           |           |
|-------------------------------|----------|----------|-----------|-----------|
| <b>Semester: VIII</b>         | <b>L</b> | <b>T</b> | <b>P</b>  | <b>C</b>  |
| <b>Course Code: 231CE8P01</b> | <b>0</b> | <b>0</b> | <b>24</b> | <b>12</b> |

#### Guidelines for Project:

The objective of this project work is to enable the student to take up investigative study in the field of Agricultural

Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the department for four to six students in a group, under the guidance of a supervisor. This is expected to provide a good initiation for the students in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic.
2. Working out a preliminary Approach to the Problem relating to the assigned topic.
3. Conducting preliminary Analysis/Modeling/Simulation/Experiment/Design/Feasibility.
4. Preparing a Written Report on the Study conducted for presentation to the Department
5. Review and finalization of the Approach to the Problem relating to the assigned topic.
6. Preparing an Action Plan for conducting the investigation, including team work.
7. Detailed Analysis/Modeling/Simulation/Design/Problem Solving/Experiment as needed.
8. Final development of product/process, testing, results, conclusions and future directions.
9. Preparing a paper for Conference presentation/Publication in Journals, if possible.
10. Preparing a Dissertation in the standard format for being evaluated by the Department.
11. Final Project Presentation before a Departmental Committee.

#### Course Outcomes: At the end of the Course, Student will be able to: CO1:

Find a problem statement by carrying out technical survey.

**CO2:** Demonstrate technical data by collecting and analyse the skills.

**CO3:** Develop potential solutions to the significant issues that have been highlighted by the data analysis.

**CO4:** Identify, analyse, and solve problems creatively through sustained critical investigation. **CO5:** Provide concrete methods for implementing social, and professional ethical standards **CO6:** Apply cutting-edge methods for data analysis to get fastidious results from the project.

**CO7:** Evaluate the solution that was achieved with in the context of engineering framework that supports the environmental considerations.

**CO8:** Practice the skills, diligence, and commitment to excellence needed to engage in lifelong learning.

**CO9:** Preparation of technical report and presentation.

**CO10:** Demonstrate communication skills effectively to work as a team.