

PROGRAM STRUCTURE AND SYLLABUS

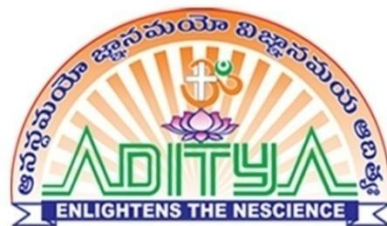
(I to VIII Semesters)

MECHANICAL ENGINEERING

for

B. TECH. FOUR YEAR DEGREE PROGRAM

(Applicable for the batches admitted in 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 preferred knowledge hub in Mechanical Engineering towards critical thinking, quality research and innovation.

MISSION

M1: Provide infrastructure for design and development of modern-day solutions.

M2: Impart leadership & interpersonal skills towards critical thinking and innovation.

M3: Collaborate with industry, academia, & R&D organizations for excellence in teaching, research and consultancy services

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of the Program will

PEO 1	Model and analyze complex engineering systems
PEO 2	Use professional Knowledge to solve real-time engineering challenges for societal development
PEO 3	Demonstrate interpersonal skills in the chosen area of profession for lifelong learning

PROGRAM OUTCOMES (POs)

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

PO 1	Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
PO 2	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 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 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	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	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	Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of, and need for sustainable development.
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
PO 9	Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
PO 10	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	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	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	Apply techniques in design, analysis and fabrication of high end automotive solutions
PSO 2	Demonstrate essential skills to analyze the thermal, fluid systems and processes

Mission of the department – PEOs mapping

PEOs Statements	M1	M2	M3
PEO 1: Model and analyze complex engineering systems	3	2	2
PEO 2: Use professional Knowledge to solve real-time engineering challenges for societal development	2	3	3
PEO 3: Demonstrate interpersonal skills in the chosen area of profession for lifelong learning	2	2	2

Note:.

Mapping / Correlation levels

- 1: Slight (Low)
- 2: Moderate (Medium)
- 3: Substantial (High)

INDUCTION PROGRAMME

S.No.	Course Name	Category	L-T-P-C
1	Physical Activities -- Sports, Yoga and Meditation, Plantation	MC	0-0-6-0
2	Career Counselling	MC	2-0-2-0
3	Orientation to all branches -- career options, tools etc.	MC	3-0-0-0
4	Orientation on admitted Branch -- corresponding labs, tools and platforms	EC	2-0-3-0
5	Proficiency Modules & Productivity Tools	ES	2-1-2-0
6	Assessment on basic aptitude and mathematical skills	MC	2-0-3-0
7	Remedial Training in Foundation Courses	MC	2-1-2-0
8	Human Values & Professional Ethics	MC	3-0-0-0
9	Communication Skills -- focus on Listening, Speaking, Reading, Writing skills	BS	2-1-2-0
10	Concepts of Programming	ES	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	-	-	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	-	-	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
TOTAL							21

III Semester

S.No.	Course Code	Course Title	Course Component	L	T	P	Credits
1	231BS3T03	Numerical Methods and Transform Techniques	BSC	3	0	0	3
2	231HS3T01	Universal Human Values	HSMC	2	1	0	3
3	231ES3T03	Thermodynamics	ESC	2	0	0	2
4	231ME3T01	Mechanics of Solids	PCC	3	0	0	3
5	231ME3T02	Material Science and Metallurgy	PCC	3	0	0	3
6	231ME3L01	Mechanics of Solids and Materials Science Lab	PCC	0	0	3	1.5
7	231ME3L02	Computer-aided Machine Drawing	PCC	0	0	3	1.5
8	231ES3L01	Python programming Lab	ESC	0	0	2	1
9	231ME3S01	Embedded Systems and IoT	SC	0	1	2	2
10	231ME3P01	Community Service Project	PROJ	0	0	2	-
11	231MC3T03	Cognitive English For Engineers – II	MC	2	0	0	-
TOTAL							20

IV Semester

S.No.	Course Code	Course Title	Course Component	L	T	P	Credits
1	231HS4T03	Industrial Management	HSMC	2	0	0	2
2	231BS4T01	Complex Variables, Probability and Statistics	BSC	3	0	0	3
3	231ME4T01	Manufacturing processes	PCC	3	0	0	3
4	231ME4T02	Fluid Mechanics & Hydraulic Machines	PCC	3	0	0	3
5	231ME4T03	Theory of Machines	PCC	3	0	0	3
6	231ME4L01	Fluid Mechanics & Hydraulic Machines Lab	PCC	0	0	3	1.5
7	231ME4L02	Manufacturing processes Lab	PCC	0	0	3	1.5
8	231ME4S01	Soft Skills	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	-
TOTAL							21

V Semester

S.No.	Course Code	Course Title	Course Component	L	T	P	Credits
1	231ME5T01	Machine Tools and Metrology	PCC	3	0	0	3
2	231ME5T02	Thermal Engineering	PCC	3	0	0	3
3	231ME5T03	Design of Machine Elements	PCC	3	0	0	3
4		Professional Elective-I	PEC-I	3	0	0	3
5		Open Elective-I	OEC-I	3	0	0	3
6	231ME5L01	Thermal Engineering Lab	PCC	0	0	3	1.5
7	231ME5L02	Theory of Machines Lab	PCC	0	0	3	1.5
8	231ME5S01	Machine tools and Metrology Lab	SEC	0	0	4	2
9	231ME5L03	Tinkering Lab	PCC	0	0	2	1
10	231ME5P01	Industry Internship-1	ECSI	-	-	-	2
11	231MC5T01	Professional Ethics and Human Value	MC	2	0	0	-
TOTAL							23

VI Semester

S.No.	Course Code	Course Title	Course Component	L	T	P	Credits
1	231ME6T01	Heat Transfer	PCC	3	0	0	3
2	231ME6T02	Artificial Intelligence and Machine Learning	PCC	3	0	0	3
3	231ME6T03	Finite Element Methods	PCC	3	0	0	3
4		Professional Elective-II	PEC-II	3	0	0	3
5		Professional Elective-III	PEC-III	3	0	0	3
6		Open Elective – II	OEC-II	3	0	0	3
7	231ME6L01	Heat Transfer Lab	PCC	0	0	3	1.5
8	231ME6L02	Artificial Intelligence and Machine Learning Lab	PCC	0	0	3	1.5
9	231ME6S01	Robotics and Drone Technologies Lab	SEC	0	0	4	2
10	231MC6T01	Technical paper writing and IPR	MC	2	0	0	-
TOTAL							23
Mandatory Industry Internship-2 of 08 weeks duration during summer vacation							

VII Semester

S.No.	Course Code	Course Title	Course Component	L	T	P	Credits
1	231ME7T01	CAD/CAM	PCC	2	0	0	2
2	231HS7T03	Operations Research	HSMC	2	0	0	2
3	231ME7L01	CAD/CAM Lab	PCC	0	0	2	1
4	-	Professional Elective-IV	PEC-IV	3	0	0	3
5	-	Professional Elective-V	PEC-V	3	0	0	3
6	-	Open Elective – III	OEC-III	3	0	0	3
7	-	Open Elective-IV	OEC-IV	3	0	0	3
8	231ME7S01	Skill Oriented Course-V Mechatronics Lab	SEC	0	0	4	2
9	231MC7T01	Research Methodology	MC	2	0	0	-
10	231ME7P01	Industry Internship-II	Internship	-	-	-	2
							21

VIII Semester								
Course Code	Course Title	Course Component	Course Type	Total Number of contact hours				Credits (C)
				Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
231ME8P01	Project (Full Semester Internship)	PROJ	Project	0	0	24	24	12
Total				0	0	24	24	12

BSC: Basic Sciences Courses;

HSMC: Humanities and Social Sciences including Management Courses;

ESC: Engineering Sciences Courses;

PCC: Professional Core Courses;

PEC: Professional Elective Courses;

OEC: Open Elective Courses;

MC: Mandatory Courses;

PROJ: Project.

PROFESSIONAL ELECTIVES

Professional Elective – I (V Semester)			Professional Elective – II (VI Semester)		
S. No.	Course Code	Course Title	S. No.	Course Code	Name of the Course
1	231ME5E01	Design for Manufacturing	1	231ME6E01	Mechanical Vibrations
2	231ME5E02	Conventional and futuristic vehicle technology	2	231ME6E02	Advanced Manufacturing Processes
3	231ME5E03	Renewable Energy Technologies	3	231ME6E03	Micro Electro Mechanical Systems
4	231ME5E04	Non-destructive Evaluation	4	231ME6E04	Sensors and Instrumentation
		MOOCS-NPTEL/SWAYAM			MOOCS-NPTEL/SWAYAM
Professional Elective – III (VI Semester)			Professional Elective – IV (VII Semester)		
S. No.	Course Code	Name of the Course	S.No.	Course Code	Course Title
1	231ME6E05	Energy Storage Technologies	1	231ME7E01	Mechatronics
2	231ME6E06	Industrial Hydraulics and Pneumatics	2	231ME7E02	Computational Fluid Dynamics
3	231ME6E07	Industrial Robotics	3	231ME7E03	Advanced Material Science
4	231ME6E08	Refrigeration & Air-Conditioning	4	231ME7E04	Embedded Systems and Programming
		MOOCS-NPTEL/SWAYAM			MOOCS-NPTEL/SWAYAM
Professional Elective – V (VII Semester)					
S. No.	Course Code	Name of the Course			
1	231ME7E05	Hydrogen and Fuel Cell Technology			
2	231ME7E06	Smart manufacturing			
3	231ME7E07	Cryogenics			
4	231ME7E08	Electrical drives and actuators			
		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.	231EC5O01	Principles of Signals and Systems	ECE
12.	231EC5O02	Introduction to Internet of Things	ECE
13.	231EC5O03	Digital Electronics and Logic Design	ECE
14.	231CS5O01	Database Management Systems	CSE
15.	231DS5O01	Python Programming	DS
16.	231IT5O01	Computer Organization	IT
17.	231AM5O01	Object Oriented Programming Through Java	AIML
18.	231PT5O01	Introduction to Petroleum Engineering	PT
19.	231PT5O02	Introduction to Petroleum Geology	PT
20.	231PT5O03	Introduction to Well Logging	PT
21.	231MI5O01	Introduction to Underground Mining	Min.E
22.	231MI5O02	Introduction to Surface Mining	Min.E
23.	231MI5O03	Tunnelling and Underground Space Design	Min.E
24.	231MI5O04	Introduction to Mine Environment	Min.E
25.	231AG5O01	Basic Crop Production Practices	Ag.E
26.	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.	231EE6O01	Fundamentals of Electric Vehicles	EEE
5.	231EE6O02	Electrical Wiring Estimation and Costing	EEE
6.	231ME6O01	Introduction to Industrial Robotics	ME
7.	231ME6O02	Industrial Management	ME
8.	231ME6O03	Additive Manufacturing	ME
9.	231ME6O04	Vehicle Technology	ME
10.	231ME6O05	Industrial Safety	ME
11.	231EC6O01	Principles of Communications	ECE
12.	231EC6O02	Biomedical Engineering	ECE
13.	231EC6O03	ECAD Tools	ECE
14.	231CS6O01	Web Technologies	CSE
15.	231DS6O01	Introduction to Data Science	DS
16.	231IT6O01	Operating Systems	IT
17.	231AM6O01	Computer Organization and Architecture	AIML
18.	231PT6O01	Introduction to Drilling Technology	PT
19.	231PT6O02	Introduction to Well Completions	PT
20.	231PT6O03	Introduction to Petroleum Production Engineering	PT
21.	231MI6O01	Mineral Economics	Min.E
22.	231MI6O02	Landslides & Slope Stability Engineering	Min.E
23.	231MI6O03	Remote Sensing and GIS	Min.E
24.	231MI6O04	Geostatistics	Min.E
25.	231AG6O01	Engineering Properties of Agricultural Produce	Ag.E
26.	231AG6O02	Plastic Applications In Agriculture	Ag.E

OPEN ELECTIVE - III (VII Semester)			
S. No	Course Code	Course Name	Offered By Department
1.	231CE7O01	Industrial Wastewater 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	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 Development in Mining Industry	Min.E
23.	231MI7O03	Mine Reclamation	Min.E
24.	231MI7O04	Impacts of Mining on 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 Equipments	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

Course Code and Definition:

Course Code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
PCC-CS	Professional Core Courses
PEC-CS	Professional Elective Courses
OEC-CS	Open Elective Courses
MC	Mandatory Courses
SEC	Skill Enhancement course
ES	Engineering Science
ECSI	Evaluation of Community Service Internship
PR	Project
AC	Audit Course
Internship	Internship

ENGINEERING PHYSICS

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

I Semester**Course Code: 231BS1T01****L**
3**T**
0**P**
0**C**
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	-	-	-	-	-	-	-	-	-	-
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, NewAge 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/P O	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 CIVILL 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)

Textbook:

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-yearengineering.html>

COMMUNICATIVE ENGLISH**(Common to all branches)****I Semester****Course Code: 231HS1T01****L****2****T****0****P****0****C****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**L T P C****Course Code: 231ES1L02****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 of Engineering)

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, 2003.
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://assembleyourpc.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:

- i) Organizing health awareness programmes in community
- ii) Preparation of health profile
- iii) 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:

- i) 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 vivavoce on the subject.

I Semester

Course Code: 231MC1T01

L	T	P	C
2	0	0	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-JMnBIyQ>
4. https://www.youtube.com/watch?v=3RDGV5i82_Q

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

II Semester	L	T	P	C
Course Code: 231BS2T04	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**3****T****0****P****0****C****3**

Course Outcomes: At the end of the course, students 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	-	-	-	-	-	-	-	-	-	-
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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-
CO6	-	-

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>

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, 2008.
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)

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

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 micronutrients 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**
0 **T**
0 **P**
3 **C**
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 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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-
CO6	-	-

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 experiments 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 IC

List of Augmented Experiments:

(Any one of the following experiments 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. Chitralkha 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	2	2	2	-	1	-	-	-	2	2	-	-
CO2	2	2	3	-	1	-	-	-	2	2	-	-
CO3	2	2	3	-	1	-	-	-	2	2	-	-
CO4	2	3	3	-	1	-	-	-	2	2	-	-
CO5	2	2	3	-	1	-	-	-	2	2	-	-

List of Experiments:**Develop the following programs using ‘C’****Week 1: Explore different platforms**

- Basic Linux environment and its editors like Vi, Vim & Emacs etc.
- Exposure to Turbo C, gcc
- Explore to Hacker Rank or any other Online coding platform and compiler environment.
- “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>
- 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

- Sum and Difference of 2 numbers
Objective: Learn int and float data types.
<https://www.hackerrank.com/challenges/sum-numbers-c/problem?isFullScreen=true>
- 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>
- 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>
- 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/ccc-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>

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 up to 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
- copy into another array in reverse order.
 - accept a number to search and how many times that number is found and print the positions at which it is found.
 - accept the delete position and delete that position value from the array.
 - accept a value and a position to insert the accepted value into that position.
 - accept delete value and delete that value from array.
 - and place the even numbers in one array and odd numbers in another array.
 - count number of even, odd values and display.
 - find the Maximum and Minimum number of the array.
 - sort the elements in Ascending order.
 - 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, 5th Edition, McGrawHill Education.
2. Hibbeler R.C., Engineering Mechanics: Statics and Dynamics, 14th 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 & Ag.E)

II Semester**Course Code:231HS2L03**

L	T	P	C
0	0	1	0.5

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

- CO1:** Understand 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 & Guides/Community Service activities, career guidance.

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.
- Organizing 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:**

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.

- i) Conducting awareness programs on Health-related issues such as General Health, Mental health, Spiritual Health, HIV/AIDS,
- ii) Conducting consumer Awareness. Explaining various legal provisions etc.
- iii) Women Empowerment Programmes- Sexual Abuse, Adolescent Health and Population Education.
- iv) 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 teacher concerned for 15 marks, totalling to 90 marks.
- A student shall be evaluated by the teacher concerned for 10 marks by conducting vivavoce on the subject.

*** **

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

II Semester
Course Code: 231MC2T01

L T P C
2 0 0 0

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO12
CO1	-	-	-	-	-	3	-	1	2	-	-	-
CO2	-	-	-	-	-	2	-	1	3	-	-	-
CO3	-	-	-	-	-	3	-	2	3	-	-	-
CO4	-	-	-	-	-	3	-	2	1	-	-	-
CO5	-	-	-	-	-	2	-	1	3	-	-	-
CO6	-	-	-	-	-	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. New Delhi.
2. Subash Kashyap, Indian Constitution, National Book Trust.

Reference Books:

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

Web Links:

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

COGNITIVE ENGLISH FOR ENGINEERS - I**(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)****II Semester****Course Code: 231MC2T02****L****0****T****0****P****2****C****0****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*, (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

NUMERICAL METHODS AND TRANSFORM TECHNIQUES**(Common to ME, Min. E & PT)****Semester: III****Course Code: 231BS3T03**

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Apply numerical methods to find the solution of non linear equations and interpolate the polynomials.
- CO2:** Apply numerical methods to find the solution of initial value problems and problems involving integration.
- CO3:** Apply Laplace transform to solve initial value problems.
- CO4:** Compute Fourier series of a function.
- CO5:** Compute Fourier transform of a function.

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										

Unit – I: Iterative Methods:

Solution of algebraic and transcendental equations: Introduction – Bisection method – Secant method – Method of false position – Iteration method – Newton-Raphson method (One variable and simultaneous Equations).

Interpolation: Interpolation with unequal intervals – Lagrange's interpolation formula, Newton's divided difference formula-Interpolation with equal intervals-Newton's forward and backward formulae for interpolation.

Unit – II: Numerical Integration and Numerical Solution of ordinary differential equation:**Numerical Integration:**

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

Numerical Solution of 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**Laplace Transforms:**

Definition of Laplace transform - Laplace transforms of standard functions – Properties of Laplace Transforms – Shifting theorems – Transforms of derivatives and integrals – Unit step function – Dirac's delta function – Inverse Laplace transforms – Convolution theorem (without proof).

Applications: Solving ordinary differential equations (initial value problems) and integro differential equations using Laplace transforms.

UNIT – IV**Fourier series:**

Introduction– Periodic functions – Fourier series of periodic function – Dirichlet's conditions – Even and odd functions – Change of interval– Half-range sine and cosine series.

UNIT – V**Fourier Transforms:**

Fourier integral theorem (without proof) – Fourier sine and cosine integrals – Infinite Fourier transforms – Sine and cosine transforms – Properties– Inverse transforms – Convolution theorem (without proof) – Finite Fourier transforms.

Text Books:

1. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 44th Edition.
2. Higher Engineering Mathematics, B. V. Ramana, Tata Mc. Graw Hill Education, Edition,

Reference Books:

1. Numerical Methods for Scientific and Engineering Computation, M. K. Jain, S.R.K. Iyengar and R.K. Jain, New Age International Publications
2. Higher Engineering Mathematics, Dass H.K. Rajnish Verma. Er, S. Chand Co. Pvt. Ltd, Delhi.
3. Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, Wiley-India
4. Applied Numerical Methods with MATLAB for Engineering and Science, Steven C. Chapra, Tata Mc. Graw Hill Education.

Weblinks:

1. https://swayam.gov.in/nd1_noc19_ma21/preview
2. https://onlinecourses.nptel.ac.in/noc20_ge20/preview
3. https://onlinecourses.nptel.ac.in/noc23_ma43/preview.
4. https://onlinecourses.nptel.ac.in/noc22_ma62/preview

UNIVERSAL HUMAN VALUES**Semester: III****L T P C****Course Code: 231HS3T01****2 1 0 3****Course Outcomes:**

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

- CO1:** Understand the core principles and significance of Universal Human Values.
- CO2:** Analyze the relationship between individual values, cultural norms, and societal expectations
- CO3:** Evaluate the role of empathy, compassion, and self-awareness in fostering positive relationships and building strong communities.
- CO4:** Apply Universal Human Values to resolve conflicts, promote social justice, and address global challenges.
- CO5:** Demonstrate ethical decision-making and problem-solving skills in personal and professional contexts.

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			
CO3							2	1	1			
CO4							2	1	1			
CO5							2	1	1			

Unit 1

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 Fulfill the Basic Human Aspirations

Tutorial: Practice Session

1. Sharing about Oneself
2. Exploring Human Consciousness
3. Exploring Natural Acceptance

Unit 2

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

1. Exploring the difference of Needs of self and body
2. Exploring Sources of Imagination in the self
3. Exploring Harmony of self with the body

Unit 3

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, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order.

Tutorial: Practice Session

1. Exploring the Feeling of Trust,
2. Exploring the Feeling of Respect,
3. Exploring Systems to fulfill Human Goal

Unit 4

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

1. Exploring the Four Orders of Nature,
2. Exploring Co-existence in Existence.

Unit 5

Implications of the Holistic Understanding – a Look at Professional Ethics: 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

1. Exploring Ethical Human Conduct,
2. Exploring Humanistic Models in Education,
3. Exploring Steps of Transition towards Universal Human Order.

Text Books:

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

Reference Books:

1. Jeevan Vidya: Ek. Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi,
3. How to practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Subhas Palekar, Amravati.
4. Fundamentals of Ethics for Scientists & Engineers, E G Seebauer & Robert L. Berry, Oxford University Press.

Weblinks:

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

THERMODYNAMICS

Semester: III

Course Code: 231ES3T03

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO1:** Explain the thermodynamic concepts to analyze the system, equilibrium, processes, and irreversibility.
- CO2:** Apply the zeroth and first laws of thermodynamics to the thermodynamic processes.
- CO3:** Apply the second law of thermodynamics to the thermodynamic processes.
- CO4:** Analyze thermodynamic properties of pure substances using steam tables and steam calorimetry.
- CO5:** Explain the working of various Refrigeration system and Psychrometric process.

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	PSO1	PSO2
CO1:		3
CO2:		3
CO3:		3
CO4:		3
CO5:		3

Unit - I

Introduction:

Basic Concepts: System, boundary, Surrounding, control volume, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle – Reversibility – Quasi static Process, Irreversible Process, Causes of Irreversibility.

Unit -II

Zeroth and First Law:

Energy in State and in Transition, Types, Work and Heat, Point and Path function. Zeroth Law of Thermodynamics – PMM-I, Joule's Experiment – First law of Thermodynamics and applications. Limitations of the First Law – Enthalpy, Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance.

Unit - III**Second Law of Thermodynamics**

Kelvin-Planck and Clausius Statements and their Equivalence / Corollaries, PMM-II, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase – Energy Equation, Availability and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics.

Unit - IV**Pure Substances**

P-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations – Triple point at critical state properties during change of phase, Dryness Fraction – Clausius – Clapeyron Equation Property tables. Mollier charts – Various Thermodynamic processes and energy Transfer – Steam Calorimetry.

Unit – V

Introduction to Refrigeration: Components, Working of Air refrigeration system, Vapour compression refrigeration system, COP, Refrigerants.

Introduction to Air Conditioning: Psychrometric properties & processes – characterization of sensible and latent heat loads. Requirements of human comfort and concept of effective temperature- comfort chart –comfort air conditioning.

Text Books:

1. Engineering Thermodynamics, P. K. Nag, Tata McGraw Hill, 5th Edition.
2. Thermodynamics – An Engineering Approach, Y.A. Cengel & M.A. Boles, McGraw Hill, 7th edition.

Reference Books:

1. Engineering Thermodynamics, J.B. Jones, and R.E. Dugan, Prentice Hall, 1st Edition.
2. Thermodynamics, J. P. Holman, McGraw-Hill Education, 4th Edition.
3. Engineering Thermodynamics, P. Chattopadhyay, Oxford University Press, 1st edition.
4. Refrigeration and Air-conditioning, CP Arora, McGraw Hill, 4th edition 2021.

Weblinks:

1. <https://archive.nptel.ac.in/courses/112/106/112106310>.
2. <https://www.youtube.com/watch?v=7NI5P4KqrAs&t=1s>.
3. <https://www.coursera.org/learn/thermodynamics-intro>

MECHANICS OF SOLIDS

Semester: III

Course Code: 231ME3T01

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Calculate stress and strain in bodies of varying cross-section and composite bars, principal stresses and strain energy.
- CO2:** Determine the shear force and bending moment diagrams for beams of various loads.
- CO3:** Analyse the variation of bending and shear stresses across a beam.
- CO4:** Compute the slope and deflection for beams of varying loads and support arrangements and torsional rigidity of a solid and hollow shaft.
- CO5:** Analyze the stresses and stability characteristics of thin, thick cylinders and columns.

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	2	-								
CO2:	3	3	2	1								
CO3:	3	3	2	1								
CO4:	3	3	2	1								
CO5:	3	3	2	1								

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1:	3	
CO2:	3	
CO3:	3	
CO4:	3	
CO5:	3	

UNIT– I

Simple Stresses & Strains: Elasticity and plasticity – Types of stresses & strains–Hooke’s law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson’s ratio & volumetric strain – Bars of varying section – composite bars – Temperature stresses- Complex Stresses - Stresses on an inclined plane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses - Mohr’s circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT–II

Shear Force And Bending Moment: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads – Point of contra

flexure – Relation between S.F., B.M and rate of loading at a section of a beam.

UNIT–III

Flexural Stresses: Theory of simple bending, Derivation of bending equation, Determination of bending stresses – section modulus of rectangular, circular, I and T sections– Design of simple beam sections.

Shear Stresses: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I and T sections.

UNIT–IV

Deflection of Beams: Bending into a circular arc – slope, deflection and radius of curvature - Differential equation for the elastic line of a beam – Double integration and Macaulay's methods - Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, UDL and UVL. Mohr's theorem and Moment area method - application to simple cases.

Torsion: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

UNIT– V

Thin And Thick Cylinders: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in diameter, and volume of thin cylinders– Thin spherical shells. Wire wound thin cylinders. Lamé's equation – cylinders subjected to inside & outside pressures – compound cylinders.

Columns: Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula.

Text Books:

1. Strength of materials, GH Ryder, Palgrave Macmillan publishers India Ltd.
2. Strength of materials, B.C. Punmia, Lakshmi publications Pvt. Ltd, 10th Edition, New Delhi, 2018.

Reference Books:

1. Mechanics of materials, Gere & Timoshenko, CBS publications, 2nd Edition
2. Strength of Materials, Andrew Pytel and Ferdinand L. Singer, Longman Publications, 4th edition.
3. Mechanics of Solids, Popov, New Pearson Education, 2nd edition.

Weblinks:

1. https://onlinecourses.nptel.ac.in/noc19_ce18/preview.
2. https://youtube/iY_ypychVNY?si=310htc4ksTQJ8Fv6.
3. https://www.youtube.com/watch?v=WEy939Rkd_M&t=2s.
4. <https://www.classcentral.com/course/swayam-strength-of-materials-iitm-184204>.
5. <https://www.coursera.org/learn/mechanics-1>

MATERIAL SCIENCE & METALLURGY**Semester: III****Course Code: 231ME3T02**

L	T	P	C
2	0	0	2

Course Outcomes:

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

- CO1:** Explain the concepts of structure of metals and equilibrium diagrams.
CO2: Analyze the ferrous and non-ferrous metals and alloys in industrial applications
CO3: Analyze the heat treatment on steels.
CO4: Explain the methods of making metal powders and applications of powder metallurgy.
CO5: Summarize the properties and applications of ceramic and composite 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
CO1:	3	1										
CO2:	2	2										
CO3:	2	2										
CO4:	2	1										
CO5:	2	1										

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	
CO2:	2	
CO3:	2	
CO4:	2	
CO5:	2	

UNIT- I

Structure of Metals and Constitution of alloys: Crystallization of metals, Packing Factor SC, BCC, FCC & HCP-line density, plane density. Grain and grain boundaries, effect of grain boundaries—determination of grain size. Imperfections, Slip and Twinning. Necessity of alloying, types of solid solutions, Hume Rothery's rules, intermediate alloy phases, and electron compounds.

Equilibrium Diagrams: Experimental methods of construction of equilibrium diagrams, Isomorphous alloy systems, equilibrium cooling and heating of alloys, Lever rule, coring miscibility gaps, eutectic systems, congruent melting intermediate phases, peritectic reaction. Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of binary phase diagrams such as Cu-Ni and Fe-Fe₃C.

UNIT-II

Ferrous metals and alloys: Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheroidal graphite cast iron, Alloy cast iron. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, tool and die steels.

Non-ferrous Metals and Alloys: Structure and properties of copper and its alloys, Aluminium and its alloys, Titanium and its alloys, Magnesium and its alloys, Super alloys.

UNIT-III

Heat treatment of Steels: Effect of alloying elements on Fe-Fe₃C system, annealing, normalizing, hardening, TTT diagrams, tempering, harden ability, surface - hardening methods, age hardening treatment, Cryogenic treatment.

UNIT-IV

Powder Metallurgy: Basic processes- Methods of producing metal powders- milling atomization- Granulation-Reduction-Electrolytic Deposition. Compacting methods – Sintering - Methods of manufacturing sintered parts. Secondary operations, Applications of powder metallurgical products.

UNIT- V

Ceramic and Advanced materials: Crystalline ceramics, glasses, cermets, abrasive materials, Classification of composites, manufacturing methods, particle reinforced composites, fiber reinforced composites, PMC, MMC, CMC and CCCs. Introduction to Nano materials and smart materials.

Text Books:

1. Introduction to Physical Metallurgy, Sidney H Avner, TMH Publications, 2nd Edition
2. Materials Science and Metallurgy, V.D. Kodgire, Everest Publishing House, 39th Edition

Reference Books:

1. Materials Science and Engineering, An Introduction, William D. Callister, Wiley Publications, 9th Edition.
2. Mechanical Metallurgy George Ellwood Dieter, David Bacon. McGraw- Hill Book company.
3. Engineering Materials & Metallurgy, R.K. Rajput, S. Chand Publications, 2nd Edition.
4. Essentials of Material Science, Donald Askeland, SI Edition, 3rd Edition.

Weblinks:

1. <https://archive.nptel.ac.in/courses/113/106/113106032/>
2. <https://www.youtube.com/watch?v=9Sf278j1GTU>
3. <https://www.coursera.org/learn/fundamentals-of-materials-science>
4. <https://www.coursera.org/learn/material-behavior>.

MECHANICS OF SOLIDS & MATERIALS SCIENCE LAB**Semester: III****Course Code: 231ME3L01****L****0****T****0****P****3****C****1.5****Course Outcomes:**

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

- CO1:** Demonstrate the material mechanical behaviour under various direct loads
CO2: Calculate the mechanical strength of spring
CO3: Demonstrate the materials mechanical behaviour under various indirect loads.
CO4: Analyse the microstructures of pure metals and alloys.
CO5: Find the hardenability of steel using jominy end quench apparatus.

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:	3	2				1			2	1		1
CO2:	2	3				1			2	1		1
CO3:	2	2				1			2	1		1
CO4:	3	2				1			2	1		1
CO5:	3	3				1			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	

NOTE: Any 6 experiments from each section A and B.**List of Experiments:****A) MECHANICS OF SOLIDS LAB:**

1. To conduct direct tension test on mild steel bar.
2. To conduct Bending test on
 - a) Simply supported beam
 - b) Cantilever beam
3. To determine Modulus of rigidity of given specimen by conducting Torsion test on circular shafts
4. To determine hardness value for the given metal specimen using
 - a) Brinell hardness tester
 - b) Rockwell hardness test.
 - c) Vickers hardness test
5. To conduct compression and tension test on springs.

6. To determine Impact test

- a) Charpy test
- b) Izod test

B) MATERIAL SCIENCE LAB:

- 1) Preparation and study of the Microstructure of pure metals.
- 2) Preparation and study of the Microstructure of Mild steel, medium carbon steels, and High carbon steels.
- 3) Study of the Microstructures of Cast Irons.
- 4) Study of the Microstructures of Non-Ferrous alloys.
- 5) Study of the Microstructures of Heat-treated steels.
- 6) Hardenability of steels by Jominy End Quench Test.

Virtual lab:

- 1. To investigate the principal stresses σ_a and σ_b at any given point of a structural element or machine component when it is in a state of plane stress. (<https://virtual-labs.github.io/editionxp-rockwell-hardness-experiment-iiith/objective.html>).
- 2. To find the impact resistance of mild steel and cast iron. (<https://sm-nitk.vlabs.ac.in/editionxp/izod-impact-test>).
- 3. To find the impact resistance of mild steel. (<https://sm-nitk.vlabs.ac.in/editionxp/charpy-impact-test/index.html>).
- 4. To find the Rockwell hardness number of mild steel, cast iron, brass, aluminum and spring steel etc. (<https://sm-nitk.vlabs.ac.in/editionxp/rockwell-hardness-test>).
- 5. To determine the indentation hardness of mild steel, brass, aluminum etc. using Vickers hardness testing machine. (<https://sm-nitk.vlabs.ac.in/editionxp/vickers-hardness-test>).

Reference Books:

- 1. Strength of Materials, R. K. Rajput, S. Chand Publications 4th edition
- 2. Introduction to Physical Metallurgy, Sidney H Avener, TMH 2nd edition.

Weblinks:

- 1. http://www.iitk.ac.in/mseold/mse_new/facilities/laboratories/Material_Testing_Lab/MSE313A.pdf
- 2. <http://web.mit.edu/emech/dontindex-build/>

COMPUTER-AIDED MACHINE DRAWING**Semester: III****Course Code: 231ME3L02**

L	T	P	C
0	0	3	1.5

Course Outcomes:

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

- CO1:** Discuss the conventional representation of materials and machine components.
- CO2:** Apply the principles of engineering drawing in machine drawing.
- CO3:** Sketch various types of temporary and permanent fasteners.
- CO4:** Construct assembly drawings from the given part drawings for manufacturing.
- CO5:** Construct part drawings from the given assembly drawing.

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	1		1
CO2:	2				2				2	1		1
CO3:	2				2				2	1		1
CO4:	2				2				2	1		1
CO5:	2				2				2	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1:	3	
CO2:	3	
CO3:	3	
CO4:	3	
CO5:	3	

List of Experiments:

- 1. Introduction to standard conventions:** Conventional representation of materials, common machine elements and parts.
- 2. Detachable joints:** Drawing of thread profiles, hexagonal and square-headed bolts and nuts, bolted joint with washer and locknut, stud joint, screw joint and foundation bolts.
- 3. Riveted joints:** Drawing of rivet, lap joint, butt joint with single strap, single riveted, riveted double strap joints.
- 4. Welded joints:** Lap joint and T joint with fillet, butt joint with conventions.
- 5. Keys:** Taper key, sunk taper key, round key, saddle key, feather key, woodruff key.
- 6. Couplings:** Rigid – Muff, flange; flexible – bushed pin-type flange coupling, universal coupling, Oldham's coupling.
- 7. Sectional views:** Creating solid models of complex machine parts and sectional views.

Assembly drawings:

8. Lathe tool post, tool head of shaping machine, tail-stock.
9. Machine vice, gate valve, carburetor.
10. Piston, connecting rod, eccentric, screw jack, plumber block.

List of Augmented Experiments:

1. **Assembly Drawings:** Axle bearing, pipe vice, clamping device, Geneva cam, universal coupling.
2. **Production drawing:** Representation of limits, fits and tolerances for mating parts. Use any four parts of above assembly drawings and prepare manufacturing drawing with dimensional and geometric tolerances.

Text Books:

1. Machine Drawing, K. L. Narayana, P. Kannaiah and K. Venkat Reddy, New Age International Publishers, 3rd edition.
2. Machine drawing, N. Sideswar, P. Kannaiah, V.V.S. Sastry, TMH Publishers.

Reference Books:

1. Computer Aided Engineering Drawing, Cecil Jensen, Jay Helsel and Donald D. Voisinet, Tata McGraw-Hill, NY.
2. Engineering Drawing for Manufacture, James Barclay, Brain Griffiths, Kogan Page Science.
3. Machine Drawing, N.D.Bhatt, Charotar Publishers, 50th edition.

Weblinks:

1. <https://editionedocs.wordpress.com/wpcontent/uploads/2014/02/machinedrawing.pdf>
2. <https://archive.nptel.ac.in/courses/112/105/112105294/>.
3. https://www.youtube.com/watch?v=0bQkS3_3Fq4.

Python Programming lab

Semester: III

Course Code: 231ES3L01

Course Outcomes:

L	T	P	C
0	0	2	1

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

- CO1:** Develop programs using python fundamentals
- 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:** Make use of Exception Handling to handle runtime errors

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	1						1
CO2	3			1	1							
CO3	3	2			1	1						1
CO4	3				1							1
CO5	3	2		1	1							

- Write a program to find the largest element among three Numbers.
 - Write a Program to display all prime numbers within an interval
 - Write a program to swap two numbers without using a temporary variable.
- Demonstrate the following Operators in Python with suitable examples.
 - Arithmetic Operators
 - Relational Operators
 - Assignment Operators
 - Logical Operators
 - Bit wise Operators
 - Ternary Operator
 - Membership Operators
 - Identity Operators
- Write a program to add and multiply complex numbers
 - Write a program to print multiplication table of a given number.
 - Write a program to define a function with multiple return values.
- Write a program to define a function using default arguments.
 - Write a program to find the length of the string without using any library functions.
- Write a program to check if the substring is present in a given string or not.
 - Write a program to perform the given operations on a list: i. addition ii. Insertion iii. slicing
 - Write a program to perform any 5 built-in functions by taking any list.
- Write a program to create tuples (name, age, address, college) for at least two members and concatenate the tuples and print the concatenated tuples.
 - Write a program to count the number of vowels in a string (No control flow allowed).
- Write a program to check if a given key exists in a dictionary or not.
 - Write a program to add a new key-value pair to an existing dictionary.
 - Write a program to sum all the items in a given dictionary
- Write a program to sort words in a file and put them in another file. The output file should have only lower-case words, so any upper-case words from source must be lowered.
 - Python program to print each line of a file in reverse order.
 - Python program to compute the number of characters, words and lines in a file.
- Write a program to create, display, append, insert and reverse the order of the items in the array.
 - Write a program to add, transpose and multiply two matrices.
 - Write a Python program to create a class that represents a shape. Include methods to

calculate its area and perimeter. Implement subclasses for different shapes like circle, triangle, and square.

10. Python program to check whether a JSON string contains complex object or not.
 - a) Python Program to demonstrate NumPy arrays creation using array () function.
 - b) Python program to demonstrate use of ndim, shape, size, dtype.
11. Python program to demonstrate basic slicing, integer and Boolean indexing.
 - a) Python program to find min, max, sum, cumulative sum of array

List of Augmented Experiments:

1. Create a dictionary with at least five keys and each key represent value as a list where this list contains at least ten values and convert this dictionary as a pandas data frame and explore the data through the data frame as follows:
 - a) Apply head () function to the pandas data frame
 - b) Perform various data selection operations on Data Frame
2. Select any two columns from the above data frame, and observe the change in one attribute with respect to other attribute with scatter and plot operations in matplotlib

Reference Books:

1. Gowrishankar S, Veena A., Introduction to Python Programming, CRC Press.
2. Python Programming, S Sridhar, J Indumathi, V M Hariharan, 2ndEdition, Pearson, 2024
3. Introduction to Programming Using Python, Y. Daniel Liang, Pearson

Web Links:

1. <https://www.coursera.org/learn/python-for-applied-data-science-ai>
2. <https://www.coursera.org/learn/python?specialization=python#syllabus>

EMBEDDED SYSTEMS & IoT

Semester: III
Course Code: 231ME3S01

L T P C
0 1 2 2

Course Outcomes:

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

- CO1:** Make use of embedded c programs for Various applications.
- CO2:** Develop the connections of HyperTerminal for communication purpose.
- CO3:** Perform interfacing of Raspberry Pi Board to various devices.
- CO4:** Make use of interfacing with Arduino Board functionality.
- CO5:** Demonstrate the interfacing of Node MCU Board with peripheral devices for different 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	PO 11	PO 12
CO1:	3	1	2		1				1	1		1
CO2:	3	2	2		1				1	1		1
CO3:	3	1	2		1				1	1		1
CO4:	3	2	2		1				1	1		1
CO5:	3	1	2		1				1	1		1

Embedded Systems Experiments: (Any 5 experiments from the following)

1. Measure Analog signal from Temperature Sensor.
2. Generate PWM output.
3. Drive single character generation on Hyper Terminal.
4. Drive a given string on Hyper Terminal.
5. Full duplex Link establishment using Hyper terminal.
6. Drive a given value on a 8 bit DAC consisting of SPI.
7. Drive Stepper motor using Analog GPIOs.
8. Drive Accelerometer and Display the readings on Hyper Terminal.

COMPONENTS/ BOARDS: 1. Arduino Duemilanove Board 2. Arduino Software IDE.

Internet of Things Experiments: (Any 5 experiments from the following)

1. Getting started with Raspberry Pi, Install Raspian on your SD card.
2. Python-based IDE (integrated development environments) for the Raspberry Pi and how to trace and debug Python code on the device.
3. Using Raspberry pi a. Calculate the distance using distance sensor. b. Basic LED functionality.
4. Raspberry Pi interact with online services using public APIs and SDKs.
5. Study and Install IDE of Arduino and different types of Arduinos.
6. Study and Implement Zigbee Protocol using Arduino / Raspberry Pi.
7. Calculate the distance using distance sensor Using Arduino.
8. Basic LED functionality Using Arduino.

9. Calculate temperature using temperature sensor Using Arduino.
10. Calculate the distance using distance sensor Using Node MCU.
11. Basic LED functionality Using Node MCU.

Reference Books:

1. Embedded Systems Architecture- By Tammy Noergaard, Elsevier Publications.
2. Embedded Systems-By Shibu. K.V-Tata McGraw Hill Education Private Limited.
3. Embedded System Design, Frank Vahid, Tony Givargis, John Wiley Publications,
4. Embedded Systems-Lyla B.Das-Pearson Publications.
5. Internet of Things - A Hands-on Approach, Arsheep Bahga & Vijay Madiseti, Orient Blackswan Private Limited, 1/e, - New Delhi.
6. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD).

Weblinks:

1. https://onlinecourses.nptel.ac.in/noc21_cs17/preview
2. https://onlinecourses.nptel.ac.in/noc20_ee98/preview
3. <https://archive.nptel.ac.in/courses/108/105/108105057/>
4. [Virtual Labs - http://vlabs.iitkgp.ac.in/rtes/](http://vlabs.iitkgp.ac.in/rtes/)
5. [Virtual Labs - https://cse02-iiith.vlabs.ac.in/](https://cse02-iiith.vlabs.ac.in/)
6. [Virtual Labs - https://iotvirtuallab.github.io/vlab/Experiments/index.html](https://iotvirtuallab.github.io/vlab/Experiments/index.html)

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

Semester: III	L	T	P	C
Course Code: 231MC3T01	0	0	2	0

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:

- Walden Infotech
- Young India Films
- Cambridge Empower

Text Books:

- 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.
3. Hewing's, Martin. Cambridge Academic English (B2). CUP.
4. J. Sethi & P.V. Dhamija. A Course in Phonetics and Spoken English, (2nd Ed), Kindle.
5. Cambridge Empower – Second Edition B2 Level

Web Links:

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

INDUSTRIAL MANAGEMENT**Semester: IV****Course Code: 231HS4T03**

L	T	P	C
2	0	0	2

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:

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
CO2:	2	1										2
CO3:	3					1						2
CO4:						1		2				2
CO5:		1				1		2				2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1:	1	
CO2:	1	
CO3:	1	
CO4:	1	
CO5:	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 Management, Bhattacharya DK, S. Chand, publishers.
2. Operations Management, J.G Monks, McGraw Hill Publishers, 3rd edition.
3. Industrial Engineering and Management Science, T. R. Banga, S. C. Sharma, N. K. Agarwal, Khanna Publishers.
4. Principles of Management, Koontz O' Donnell, McGraw Hill Publishers, 4th edition.
5. Statistical Quality Control, R.C. Gupta, Khanna Publishers.
6. Industrial Engineering and Management, NVS Raju, Cengage India Private Limited 1st edition.

Weblinks:

1. https://onlinecourses.nptel.ac.in/noc21_me15/preview
2. https://onlinecourses.nptel.ac.in/noc20_mg43/preview
3. <https://www.edx.org/learn/industrial-engineering>
4. <https://youtube.com/playlist?list=PL299B5CC87110A6E7&si=TghLCbEobuxjEaXi>

COMPLEX VARIABLES AND STATISTICAL METHODS
(Common to ME, Min.E & PT)

Semester: IV

Course Code: 231BS4T01

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Find the continuity, analyticity of functions of complex variables and different types of complex integrals.
- CO2:** Find Taylor's and Laurent series expansions, residues for complex functions.
- CO3:** Apply various Probability distributions for both discrete and continuous random variables.
- CO4:** Compute mean and variance of sample means with replacement and without replacement and estimating maximum errors.
- CO5:** Apply various tests to test the hypothesis concerning mean, proportion and variance.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2										
CO2	3	2										
CO3	3	2										
CO4	2	3										
CO5	3	2										

UNIT- I:**Functions of a complex variable and Complex integration:**

Introduction–Continuity –Differentiability–Analyticity –Cauchy-Riemann equations in Cartesian and polar coordinates–Harmonic and conjugate harmonic functions– Milne–Thompson method. Complex integration: Line integral –Cauchy's integral theorem –Cauchy's integral formula–Generalized integral formula (all without proofs) and problems on above theorems.

UNIT – II:**Series expansions and Residue Theorem:**

Radius of convergence – Expansion of function in Taylor's series, Maclaurin's series and Laurent series. Types of Singularities: Isolated – Essential singularities – Pole of order m – Residues – Residue theorem (without proof) – Evaluation of real integral of the type $\int_{-\infty}^{\infty} f(x)dx$ and $\int_c^{c+2\pi} f(\cos \theta, \sin \theta)d\theta$.

UNIT-III:**Probability and Distributions:**

Probability – Conditional probability and 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)–Central limit theorem (without proof)– point and interval estimations – maximum error of estimate

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 –Z-test, t-test, F-test, χ^2 -test.

Text Books:

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

Reference Books:

1. Complex Variables and Applications, J.W.Brown and R.V.Churchill, Mc- Graw Hill, 9th edition.
2. Fundamentals of Mathematical Statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons Publications, 11th edition.
3. Probability and statistics, T.K.V.Iyengar, B. Krishna Gandhi, S Ranganatham, MVSSN Prasad, S.Chand publishers

Weblinks:

1. <https://archive.nptel.ac.in/courses/111/103/111103070/>
2. https://onlinecourses.nptel.ac.in/noc20_ma50/preview
3. https://onlinecourses.nptel.ac.in/noc21_ma74/preview
4. <http://mathworld.wolfram.com/topics/ProbabilityandStatistics.html>.
5. <https://www.khanacademy.org/math/statistics-probability>

MANUFACTURING PROCESSES

Semester: IV

Course Code: 231ME4T01

L	T	P	C
3	0	0	3

Course Outcomes:

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

CO1: Explain the principles of applications of casting processes

CO2: Analyze the welding processes with applications.

CO3: Demonstrate the different types of bulk forming processes.

CO4: Explain the sheet metal and high energy metal forming techniques.

CO5: Summarize the types of additive manufacturing 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:	2	1				1						
CO2:	2	1				1						
CO3:	2	1			1	1						
CO4:	2	1			1	1						
CO5:	2	1			1	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

Casting

Steps involved in making a casting – Advantage of casting and its applications. Patterns and Pattern making – Types of patterns – Materials used for patterns, pattern allowances and their construction, Molding, different types of cores, Principles of Gating, Risers, casting design considerations. Methods of melting and types of furnaces, Solidification of castings and casting defects- causes and remedies. Basic principles and applications of special casting processes - Centrifugal casting, Die casting, Investment casting and shell molding.

UNIT-II

Welding

Classification of welding processes, types of welded joints and their characteristics, Gas welding, Different types of flames and uses, Oxy – Acetylene Gas cutting. Basic principles of Arc welding, power characteristics, Manual metal arc welding, submerged arc welding, TIG & MIG welding. Electro-slag welding. Resistance welding, Friction welding, Friction stir welding, Forge welding, Explosive welding; Thermit welding, Plasma Arc welding, Laser welding, electron beam welding, Soldering & Brazing. Heat affected zones in welding; pre & post heating, welding defects –causes and remedies.

UNIT–III**Bulk Forming**

Plastic deformation in metals and alloys-recovery, recrystallization and grain growth. Hot working and Cold working-Strain hardening and Annealing. Bulk forming processes: Forging-Types of Forging, forging defects and remedies; Rolling – fundamentals, types of rolling mills and products, Forces in rolling and power requirements. Extrusion and its characteristics. Types of extrusion, Impact extrusion, Hydrostatic extrusion; Wire drawing and Tube drawing.

UNIT– IV

Sheet metal forming: Blanking and piercing, Forces and power requirement in these operations, Deep drawing, Stretch forming, Bending, Spring back and its remedies, Coining, Spinning, Types of presses and press tools.

High energy rate forming processes: Principles of explosive forming, electromagnetic forming, Electrohydraulic forming, rubber pad forming, advantages and limitations.

UNIT -V**Additive manufacturing**

Steps in Additive Manufacturing (AM), Classification of AM processes, Advantages of AM, and types of materials for AM, VAT photo polymerization AM Processes, Extrusion - Based AM Processes, Powder Bed Fusion AM Processes, Direct Energy Deposition AM Processes, Post Processing of AM Parts, Applications

Text Books:

1. Manufacturing Processes for Engineering Materials, Kalpakjain S and Steven R Schmid, Pearson Publications, 5th edition.
2. Manufacturing Technology -Vol I, P.N. Rao, McGraw Hill Education, 5th edition, 2018.

Reference Books:

1. Manufacturing Science, A. Ghosh & A. K. Malik, East West Press Pvt. Ltd.
2. Processes and materials of manufacture, Lindberg and Roy, Prentice Hall India Learning Private Limited, 4th edition.
3. Production Technology, R.K. Jain, Khanna Publishers, 2022.

Weblinks:

1. <https://archive.nptel.ac.in/courses/112/107/112107144/#>
2. <https://msvs-dei.vlabs.ac.in/mem103/mem.html>
3. <https://engineeringproductdesign.com/knowledge-base/manufacturing-processes/>

FLUID MECHANICS & HYDRAULIC MACHINES**Semester: IV****L****T****P****C****Course Code: 231ME4T02****3****0****0****3****Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Explain the basic concepts of fluid properties and estimate the stability of a floating body by calculating meta center height.
- CO2:** Analyse the mechanics of fluids in static and dynamic conditions.
- CO3:** Apply the boundary layer theory, flow separation and dimensional analysis in fluid analysis
- CO4:** Estimate the hydro dynamic forces of jet on vanes indifferent positions.
- CO5:** Explain the working principles and performance evaluation of hydraulic pump and turbines.

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:	2	3										
CO3:	2	3										
CO4:	3	2										
CO5:	3	2										1

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1:		3
CO2:		3
CO3:		3
CO4:		3
CO5:		3

UNIT I

Fluid statics: Dimensions and units: physical properties of fluids - specific gravity, viscosity and its significance, surface tension, capillarity, vapor pressure, Atmospheric, gauge and vacuum pressure, Measurement of pressure – Manometers - Piezometer, U-tube, inverted and differential manometers. Pascal's & hydrostatic laws.

Buoyancy and floatation: Meta center, stability of floating body. Submerged bodies. Calculation of metacenter height. Stability analysis and applications.

UNIT II

Fluid Kinematics: Introduction, types of flow, Equation of continuity for one dimensional flow, circulation and vorticity, Streamline, path line and streak lines and stream tube, Stream function and velocity potential function, differences and relation between them, Condition for irrotational flow, flow net, source and sink, doublet and vortex flow.

Fluid dynamics: surface and body forces –Euler's and Bernoulli's equations for flow along a streamline, momentum equation and its applications, force on pipe bend, Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and pipes in parallel total energy line hydraulic gradient line.

UNIT III

Boundary Layer Theory: Introduction, momentum integral equation, displacement, momentum and energy thickness, separation of boundary layer, control of flow separation, Stream lined body, Bluff body and its applications, basic concepts of velocity profiles.

Dimensional Analysis: Dimensions and units, Dimensional Homogeneity, Non depersonalization of equations, Method of repeating variables and Buckingham Pi Theorem.

UNIT IV

Basics of turbo machinery: Hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.

Hydraulic Turbines: Classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design –draft tube-theory-functions and efficiency.

UNIT V

Performance of hydraulic turbines: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer. Hydraulic systems- hydraulic ram, hydraulic lift, hydraulic coupling. Fluidics - amplifiers, sensors and oscillators. Advantages, limitations and applications.

Centrifugal pumps: classification, working, work done – manometric head- losses and efficiencies-specific speed- pumps in series and parallel-performance characteristic curves, cavitation & NPSH.

Reciprocating pumps: Working, Discharge, slip, indicator diagrams.

Text Books:

1. Fluid Mechanics, Fundamentals and Applications, Y.A. Cengel, J.M. Cimbala, McGraw Hill Publications, 6th edition, 2019.
2. Hydraulics & Fluid Mechanics including Hydraulics Machines, P N Modi and S M Seth, Standard Book House, 2017

Reference Books:

1. Fluid Mechanics and Hydraulic Machines, RK Bansal, Laxmi Publications (P) Ltd, 10th edition, 2019.
2. Fluid Mechanics and Hydraulic Machines, Rajput, S Chand & Company, 2019.
3. Fluid Mechanics and Fluid Power Engineering, D.S. Kumar, S K Kataria.

Weblinks:

1. <https://archive.nptel.ac.in/courses/112/105/112105206/>.
2. <https://archive.nptel.ac.in/courses/112/104/112104118/>.
3. <https://www.edx.org/learn/fluid-mechanics>.
4. https://onlinecourses.nptel.ac.in/noc20_ce30/previewnptel.ac.in.
5. www.coursera.org/learn/fluid-powerera.

THEORY OF MACHINES**Semester: IV****Course Code: 231ME4T03**

L	T	P	C
3	0	0	3

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

- CO1:** Explain the Inversions of Four bar chain
CO2: Calculate the velocity and acceleration of links using graphical method
CO3: Explain the gyroscopic effects and gear train properties
CO4: Analyze the balancing of rotating masses by using analytical and graphical method
CO5: Construct the cam profiles for different follower motion
CO6: Analyze the vibrations for one Degree of Freedom and design of the flywheel

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	3	3										
CO3	3	2										
CO4	3	2										
CO5	3	3										
CO6	3	2	2									

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I: Simple Mechanisms

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, mobility – Grashof's law, kinematic inversions of four bar chain and slider crank chains- Limit positions – Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line mechanisms – Universal Joint – Rocker mechanisms.

UNIT – II: Plane and motion analysis

Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations – kinematic analysis of simple mechanisms – slider crank mechanism dynamics – Coincident points – Coriolis component of acceleration.

UNIT – III: Gyroscope & Gear Profile

Gyroscope: Principle of gyroscope, gyroscopic effect in an aeroplane, ship, car and two-wheeler, simple problems.

Gear Profile: Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting – helical, bevel, worm, rack& pinion gears, epicyclic and regular gear train kinematics.

UNIT – IV:**Balancing of Rotating masses & Cams**

Balancing of Rotating masses: Need for balancing, balancing of single mass and several masses in different planes, using analytical and graphical methods.

Cams: Classification of cams and followers- Terminology and definitions – Displacement diagrams– Uniform velocity, parabolic, simple harmonic and cycloidal motions – derivatives of follower motions- specified contour cams- circular and tangent cams –pressure angle and undercutting

UNIT – V:**Vibrations & Turning Moment Diagrams and Flywheels**

Vibrations: Introduction, degree of freedom, types of vibrations, free natural vibrations, Newton method and energy method for single degree of freedom. Damped vibrations- under damped, critically damped; and over damped systems, forced vibrations with and without damping in single degree of freedom; Vibration isolation and transmissibility.

Turning Moment Diagrams and Flywheels: Turning moment diagrams for steam engine, I.C engine and Multi Cylinder Engine. Crank effort – coefficient of fluctuation of energy, coefficient of fluctuation of speed – Fly Wheel and their design, fly wheels for punching press.

Text Books:

1. Theory of Machines, S.S. Rattan, Tata Mc-Graw Hill, 4th edition.
2. Theory of Machines & Mechanisms, P. L. Ballaney, Khanna Publishers, 25th edition, Delhi.

Reference Books:

1. Dynamics of Machines, F. Haidery, Nirali Prakashan, 5th edition, Pune.
2. Theory of Machines and Mechanisms, J. E. Shigley, Oxford, 4th edition, 2019
3. Mechanical Vibrations, G. K. Groover, Nemchand Bros, 8th edition.

Web Links:

1. <https://nptel.ac.in/courses/112/104/112104121/>
2. <https://nptel.ac.in/courses/112/104/112104114/>

FLUID MECHANICS & HYDRAULIC MACHINES LAB**Semester: IV****L****T****P****C****Course Code: 231ME4L01****0****0****3****1.5****Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Explain the devices used for measuring flow.**CO2:** Calculate major losses or friction factor in pipes.**CO3:** Compute minor losses in pipes.**CO4:** Estimate the performance characteristics of centrifugal and reciprocating pumps**CO5:** Estimate the performance characteristics of impulse and reaction turbines**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					1	2	1		
CO2	2	3	2					1	2	1		
CO3	2	3	2					1	2	1		
CO4	2	3	2					1	2	1		
CO5	2	3	2					1	2	1		

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1		2
CO2		2
CO3		2
CO4		2
CO5		2

List of Experiments

1. Calibration of Orifice meter.
2. Calibration of Venturi meter.
3. To determine the velocity of flow at any point in a pipe using Pitot tube.
4. Determination of friction factor for a given pipeline.
6. Determination of loss of head due to sudden contraction in a pipeline.
7. Performance Test on Reciprocating Pump.
8. Performance Test on Centrifugal Pump.
9. Performance Test on Pelton Wheel.
10. Performance Test on Francis Turbine.
11. Performance Test on Kaplan Turbine.

List of Augmented Experiments:

1. To determine the co-efficient of discharge of a Rotameter.
2. Impact of jets on Vanes

Virtual Lab:

1. To study different patterns of a flow through a pipe and correlate them with the Reynolds number of the flow. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/reynolds/introduction.html>)
2. To calculate Total Energy at different points of venturimeter. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/bernoulli/introduction.html>).
3. To calculate the flow (or point) velocity at center of the given tube using different flow rates. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/pitot/introduction.html>)
4. To determine the hydrostatic force on a plane surface under partial submergence and full submergence condition. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/cop/introduction.html>).
5. To determine the discharge coefficient of a triangular notch. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/notch/introduction.html>)
6. To determine the coefficient of impact of jet on vanes. (<https://fm-nitk.vlabs.ac.in/editionxp/impact-of-jet>).
7. To determine friction in pipes. (<https://fm-nitk.vlabs.ac.in/editionxp/friction-in-pipes/index.html>).

Reference Books:

1. Hydraulic Machines by Banga & Sharma, Khanna Publishers, 6th Edition.
2. Hydraulics and Fluid mechanics including Hydraulics machines, P.N. Modi & S. M. Seth, Rajsons publications pvt ltd Standard Book House, 2019 edition.
3. Fluid Mechanics and Hydraulic Machines, R.K. Rajput, S. Chand publishers

Weblinks:

1. https://web.itu.edu.tr/~bulu/fluid_mechanics_uk.htm.
2. <https://archive.nptel.ac.in/courses/112/104/112104118/>.

MANUFACTURING PROCESSES LAB**Semester: IV****Course Code: 231ME4L02**

L	T	P	C
0	0	3	1.5

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

- CO1:** Demonstrate the sand properties testing, design and making of a pattern and mould.
- CO2:** Demonstrate the Arc, Gas, TiG & Spot welding and brazing processes.
- CO3:** Demonstrate the injection and blow moulding processes.
- CO4:** Fabricate different types of components using metal forming.
- CO5:** Explain different types of 3d Printing 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:	2		2					1	3	1		
CO2:	2		2					1	3	1		
CO3:	2		2					1	3	1		
CO4:	2		2					1	3	1		
CO5:	2		2					1	3	1		

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1:	3	
CO2:	3	
CO3:	3	
CO4:	3	
CO5:	3	

List of Experiments**1. Design and making of pattern**

- Single piece pattern
- Split pattern

2. Sand properties testing

- Sieve analysis (dry sand)
- Clay content test
- Moisture content test
- Permeability test

3. Mould preparation

- Straight pipe
- Bent pipe

4. Sand Mould

- Dumble
- Gear blank

5. Arc Welding

- a) T-Lap joint
- b) Corner joint

6. Welding

- a) To weld using Spot welding machine
- b) To make weldments using TIG/MIG welding

7. Injection Moulding Method**8. Blow Moulding****9. Simple models using sheet metal operations**

- a) Blanking and Punching
- b) V-bend

10. Brazing**List of Augmented Experiments:**

1. To make simple parts on a 3D printing machine
2. Demonstration of metal casting.

Virtual Lab:

1. To study and observe various stages of casting through demonstration of casting process. (<https://virtual-labs.github.ioeditionxp-sand-casting-process-dei/theory.html>)
2. To weld and cut metals using an oxyacetylene welding setup. (<https://virtual-labs.github.ioeditionxp-gas-cutting-processes-iitkgp/index.html>).
3. To simulate Fused deposition modelling process (FDM) (<https://3dpdei.vlabs.ac.ineditionxp/simulation-modelling-process>)
4. <https://altair.com/inspire-mold/>
5. <https://virtual-labs.github.ioeditionxp-simulation-cartesian-system-dei/theory.html>

Reference Books:

1. Workshop Technology, Chapman W.A.J, Vol. I and Vol. II, Arnold Publisher, 4th Edition.
2. Elements of Workshop Technology Manufacturing processes Vol-I, S. K. Hajra Choudhary, A. K Hajra Choudhary, Nirjhar Roy, Media Promoters & Pub. Pvt. Ltd.

Weblinks:

1. <http://www.sme.org/fmp>.
2. <https://cosmolearning.org/courses/manufacturing-processes-i-538/video-lectures>.

SOFT SKILLS**Semester: IV****L T P C****Course Code: 231ME4S01****0 1 2 2****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
2. www.bankersadda.com

ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE**Semester: IV****L T P C****Course Code: 231MC4T01****2 0 0 0****Course Outcomes: At the end of the Course, Student will be able to:**

- CO1:** Understand the fundamental principles and concepts of Indian Traditional Knowledge.
- CO2:** Analyse 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2	1	1				
CO2						2	1	1				
CO3						2	1	1				
CO4						2	1	1				
CO5						2	1	1				

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

Text Books:

1. Traditional Knowledge System in India by Amit Jha.

Reference Books:

1. Knowledge Traditions and Practices of India

Weblinks:

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

DESIGN THINKING & INNOVATION**Semester: IV****Course Code: 231ES4T04****L
1****T
0****P
2****C
2****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
CO1	-	-	-	-	-	-	-	2	2	-	-	-
CO2	-	-	-	-	-	-	-	-	-	2	-	-
CO3	-	-	-	-	-	-	-	-	-	3	-	-
CO4	-	-	-	-	-	-	-	1	1	2	-	-
CO5	-	-	-	-	-	-	-	-	-	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) 2nd 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, 2nd 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
2. 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

MACHINE TOOLS AND METROLOGY**Semester: V****Course Code: 231ME5T01**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:**CO1:** Discuss the concepts of machining processes.**CO2:** Apply the principles of lathe, shaping, slotting and planning machines.**CO3:** Apply the principles of drilling, milling and boring processes.**CO4:** Analyse the concepts of finishing processes and the system of limits and fits.**CO5:** Learn the concepts of surface roughness and optical measuring instruments.**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	3	2	-	-	-	-	-	-	-	2	-	2
CO2	3	2	-	-	-	-	-	-	-	2	-	2
CO3	3	2	-	-	-	-	-	-	-	2	-	2
CO4	3	2	-	-	-	-	-	-	-	2	-	2
CO5	3	2	-	-	-	-	-	-	-	2	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

Unit – I**Fundamentals of Machining:**

Elementary treatment of metal cutting theory – element of cutting process – Single point cutting tools, nomenclature, tool signature, mechanism of metal cutting, types of chips, mechanics of orthogonal and oblique cutting –Merchant's force diagram, cutting forces, Taylor's tool life equation, Tool wear, tool wear mechanisms, machinability, economics of machining, coolants, tool materials and properties.

Unit – II**Lathe Machines:**

Introduction- types of lathe - Engine lathe – principle of working - construction - specification of lathe - accessories and attachments – lathe operations – taper turning methods and thread cutting – drilling on lathes.

Shaping, Slotting and Planning Machines: Introduction - principle of working – principle parts – specifications - operations performed - slider crank mechanism - machining time.

Unit – III

Drilling & Boring Machines: Introduction – construction of drilling machines – types of drilling machines - principles of working – specifications- types of drills - operations performed – machining time - Boring Machines – types.

Milling Machines: Introduction - principle of working – specifications – milling methods - classification of Milling Machines –types of cutters - methods of indexing- machining time.

Unit – IV

Finishing Processes: Classification of grinding machines- types of abrasives- bonds, specification and selection of a grinding wheel- Lapping, Honing & Broaching operations- comparison to grinding.

Systems of Limits and Fits: Types of fits -Unilateral and bilateral tolerance system, hole and shaft basis systems- interchangeability & selective assembly- International standard system of tolerances, Taylor's principle – design of go and no-go gauges; plug, ring, snap, gap, taper, profile and position gauges.

Linear Measurement: Length standards, end standards, slip gauges- calibration of the slip Gauges, dial indicators, micrometers.

Unit – V

Angular Measurement: Bevel protractor, angle slip gauges- angle dekkor- spirit levels- sine bar- sine table.

Surface Roughness Measurement: Differences between surface roughness and surface waviness, Profilograph, Talysurf, ISI symbols.

Optical Measuring Instruments: Tools maker's microscope, Autocollimators, Optical projector, Optical flats-working principle, construction, merits, demerits and their uses. optical comparators.

Text Books:

- T1** Manufacturing Processes / JP Kaushish/ PHI Publishers-2nd Edition
- T2** Manufacturing Technology Vol-II/P.N Rao/Tata McGraw Hill
- T3** Engineering Metrology – R.K. Jain/Khanna Publishers

Reference Books:

- R1** Metal cutting and machine tools /Geoffrey Boothroyd, Winston A.Knight/Taylor & Francis
- R2** Production Technology / H.M.T. Hand Book (Hindustan Machine Tools).
- R3** Production Engineering/K.C Jain & A.K Chitaley/PHI Publishers
- R4** Technology of machine tools/S.F. Krar, A.R. Gill, Peter SMID/ TMH
- R5** Manufacturing Processes for Engineering Materials-Kalpak Jian S & Steven R Schmid/Pearson Publications 5th Edition

Weblinks:

- W1** <https://archive.nptel.ac.in/courses/112/105/112105233/>
- W2** <https://archive.nptel.ac.in/courses/112/106/112106179/>
- W3** <https://archive.nptel.ac.in/courses/112/104/112104250/>

THERMAL ENGINEERING**Semester: V**

L	T	P	C
3	0	0	3

Course Code: 231ME5T02**Course Outcome: At the end of the course, students will be able to**

- CO1:** Analyse the working principles, thermodynamic cycles, and subsystems of internal combustion engines.
- CO2:** Analyse IC engine performance by comparing theoretical and actual cycles and evaluating forced induction systems (supercharging/turbocharging).
- CO3:** Understand & analyse the steam power cycles, boiler systems, and draught mechanisms used in thermal power plants.
- CO4:** Analyse the working principles and performance of steam nozzles, turbines, and condensers used in steam power plants.
- CO5:** Evaluate gas turbine systems using the Brayton cycle and performance enhancement 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
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	1	-	-	-	-	-	-	-	-
CO3	3	2	-	1	-	-	-	-	-	-	-	-
CO4	3	3	-	1	-	-	-	-	-	-	-	-
CO5	3	3	-	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PO	PSO1	PSO2
CO1	-	3
CO2	-	3
CO3	-	3
CO4	-	3
CO5	-	3

UNIT– I**IC Engines**

Basics of IC Engines: Classification (SI, CI, two-stroke, four-stroke), Working Principles (Otto, Diesel Cycles—P-V & T-S Diagrams), Valve Timing Diagrams (SI & CI Engines)

Engine Systems Overview: Fuel systems (Carburettor for SI, Fuel injection for CI), Ignition systems (Battery vs. Magneto), Cooling & Lubrication systems

UNIT–II**Performance & Efficiency of IC Engines**

Air Standard vs. Actual Cycles: Heat losses, friction losses, volumetric efficiency:

Supercharging & Turbocharging: Principles, advantages, and applications.

Engine Testing & Performance Metrics: Brake Power (BP), Indicated Power (IP), BSFC, Efficiency.

UNIT -III

Introduction to Steam Power Cycles: Rankine Cycle, Schematic Layout, and Methods to Improve Cycle Performance—Regeneration & Reheating

Boilers & Steam Generation: Introduction to Boilers: Fire-Tube vs. Water-Tube Boilers (HP & LP), Boiler Mountings & Accessories

Draught Systems: Natural, forced, and induced draught

UNIT -IV

Steam Nozzles: Types, Flow Analysis, Critical Pressure Ratio

Steam Turbines: Impulse (De Laval) & Reaction (Parson's) Turbines, Velocity Diagrams, Blade Efficiency.

Steam Condensers: Classification, Working, Jet & Surface Condensers

UNIT -V

Gas Turbines: Simple gas turbine plant, Brayton cycle - P-V & T-S diagrams, essential components, performance enhancement methods - Regeneration, Intercooling, and Reheating Cycle

Text Books:

T1: Heat Engineering, V.P. Vasandani and D.S Kumar, Metropolitan Book Company, New Delhi, 6th Edition.

T2: Thermodynamics and Heat Engines, Volume- II, R.Yadav, Central publishing house, 6th Edition.

References:

R1: Thermal Engineering (Engineering Thermodynamics & Energy Conversion Techniques) Khanna publishers. 25th Edition.

R2: Thermal Engineering, M.L.Mathur & Mehta, Jain bros, 6th Edition.

R3: Gas Turbines, V. Ganesan , Tata McGraw-Hill Education, 3rd Edition.

R4: Thermal Engineering, R.K. Rajput, Laxmi Publications, 10th Edition.

Web Links:

W1: <https://archive.nptel.ac.in/courses/112/103/112103262/>

W2: <https://nptel.ac.in/courses/112/103/112103277/>

DESIGN OF MACHINE ELEMENTS**Semester: V****Course Code: 231ME5T03**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:**CO1:** Analyse the stresses in machine members subjected to static and dynamic loads.**CO2:** Design different types of bolted and welded joints.**CO3:** Evaluate the strength, stiffness and fatigue of shafts and couplings for power transmission.**CO4:** Explain the functional principles and types of clutches, brakes, and springs.**CO5:** Apply the design principles to select bearings and gears.**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	3	2	2	-	-	-	-	-	-	-	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-
CO5	3	2	2	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT-I: Introduction, Design for Static and Dynamic loads**Mechanical Engineering Design:** Design process, Design considerations, Codes and Standards of designation of materials, Selection of materials.**Design for Static Loads:** Modes of failure - Design of components subjected to axial, bending, torsional and impact loads - Theories of failure for static loads.**Design for Dynamic Loads:** Endurance limit - Fatigue strength under axial, bending and torsion - Stress concentration, Notch sensitivity, Types of fluctuating loads, Fatigue design for infinite life - Soderberg, Goodman and modified Goodman criterion for fatigue failure - Fatigue design under combined stresses.**UNIT-II: Design of Bolted and Welded Joints****Design of Bolted Joints:** Threaded fasteners, Preload of bolts, Various stresses induced in the bolts, Torque requirement for bolt tightening, Gasketed joints.**Welded Joints:** Strength of lap and butt welds, Joints subjected to bending and torsion.**UNIT-III: Power transmission shafts and Couplings****Power Transmission Shafts:** Design of shafts subjected to bending, torsion and axial loading. Shafts are subjected to fluctuating loads using shock factors.**Couplings:** Design of flange and bushed pin couplings, Universal coupling.

UNIT-IV: Design of Clutches, Brakes and Springs

Friction Clutches: Torque transmitting capacity of Disc and Centrifugal clutches - Uniform wear theory and uniform pressure theory.

Brakes: Different types of brakes, Concept of self-energizing and self-locking of brake, Band and block brakes, disc brakes.

Springs: Design of helical compression, tension, torsion and leaf springs.

UNIT-V: Design of Bearings and Gears

Design of Sliding Contact Bearings: Lubrication modes, Bearing modulus, McKee's equations, Design of journal bearing. Bearing Failures.

Design of Rolling Contact Bearings: Static and dynamic load capacity, Stribeck's Equation, Equivalent bearing load, Load-life relationships, Load factor, Selection of bearings from manufacturer's catalogue.

Design of Gears: Spur gears, Beam strength, Lewis equation, Design for dynamic and wear loads.

Note: Data book is allowed.

Text Books:

T1 V.B.Bhandari, Design of Machine Elements, 5/e, Tata McGraw Hill, 2020.

T2 Dr. N. C. Pandya & Dr. C. S. Shah, Machine design, 20/e, Charotar Publishing House Pvt. Ltd, 2015.

Reference Books:

R1 J.E. Shigley, Mechanical Engineering Design, 10/e, Tata McGraw Hill, 2015.

R2 R.L. Norton, Machine Design - An Integrated approach, 6/e, Pearson Education, 2020.

R3 M.F.Spotts and T.E.Shoup, Design of Machine Elements, 8/e, Prentice Hall (Pearson Education), 2013.

R4 R.K. Jain, Machine Design, 9/e, Khanna Publications, 2016.

Weblinks:

W1 <https://nptel.ac.in/courses/112105124>

W2 <https://nptel.ac.in/courses/112105125>

W3 <https://nptel.ac.in/courses/112105234>

DESIGN FOR MANUFACTURING**(Professional Elective-1)****Semester: V****Course Code: 231ME5E01**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:**CO1:** Explain the basic concepts of design for manual assembly.**CO2:** Identify basic design procedure of various machining processes. .**CO3:** Illustrate the design considerations metal casting, extrusion and sheet metal work**CO4:** Interpret the design considerations of various metal joining process.**CO5:** Explain the basic design concepts involved in the assembly automation.**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	-	1	-	-	-	-	-	-	1	-	1
CO2	2	-	1	-	-	-	-	-	-	1	-	1
CO3	2	-	1	-	-	-	-	-	-	1	-	1
CO4	2	-	1	-	-	-	-	-	-	1	-	1
CO5	2	-	1	-	-	-	-	-	-	1	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	2	-
CO2	2	-
CO3	2	-
CO4	2	-
CO5	2	-

Unit - I

Introduction to DFM, DFMA: How Does DFMA Work? Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design? Typical DFMA Case Studies, Overall Impact of DFMA on Industry.

Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, weight on Handling Time, Effects of Combinations of Factors and application of the DFA Methodology.

Unit -II

Machining processes: Overview of various machining processes-general design rules for machining dimensional tolerance and surface roughness-Design for machining – ease –redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

Unit - III

Metal casting: Appraisal of various casting processes, selection of casting process,-general design considerations for casting-casting tolerance-use of solidification, simulation in casting design product design rules for sand casting.

Extrusion & Sheet metal work: Design guidelines extruded sections-design principles for punching, blanking, bending, and deep drawing-Keeler Goodman forging line diagram – component design for blanking

Unit - IV

Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints-design of brazed joints. Forging: Design factors for forging – closed die forging design – parting lines of dies –drop forging die design – general design recommendations.

Unit – V

Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated assembly systems, Quantitative analysis of Assembly systems,

Design for Additive Manufacturing:

Introduction to AM, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining and Interlocking Features.

Text Books:

- T1** Design for manufacture, John cobert, Adisson Wesley. 1995
T2 Product Design for Manufacture and Assembly, Geoffrey Boothroyd Second Edition/ CRC press

Reference Books:

- R1** Product design and Manufacturing, A.K. Chitale and R.C. Gupta, Prentice Hall of India, New Delhi
R2 Design for Manufacturing and assembly , O. Molloy, S. Tilley and E.A. Warman, First Edition, Chapman & Hall, London, UK
R3 Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development, D.E. Whitney, Oxford University Press, New York
R4 Process selection: from design to manufacture, K G Swift and J D Booker, London: Arnold, 1997.

Weblinks:

- W1** <https://nptel.ac.in/courses/112/101/112101005/>
W2 <https://www.digimat.in/nptel/courses/video/112107258/L02.html>
W3 <https://nptel.ac.in/courses/112/104/112104230/>

CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY (Professional Elective-I)

Semester: V

Course Code: 231ME5E02

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course the students would 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
CO1	3	2	-	-	-	-	1	-	-	1		1
CO2	3	3		-		-	1	-	-	1		1
CO3	3	2	2	-		-	1	-	-	1		1
CO4	3	3	2	-	2	-	1	-	-	1		1
CO5	3	2	2	-	2	-	1	-	-	1		1

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	2
CO2	-	2
CO3	-	2
CO4	-	2
CO5	-	2

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.

UNIT – IV: HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED)

Conventional Hybrids, Modern Hybrids (RCCI/GDCI Engine + Battery), Pure Electric Vehicle Technology – Challenges.

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:

- T1** Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
T2 Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines. ISBN 978-3-319-68507-6 , SPRINGER

Reference Books:

- R1** Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
R2 James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
R3 Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998
R4 Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

Weblinks:

- W1** https://www.perkins.com/en_GB.html
W2 <https://www.garrettmotion.com/>

RENEWABLE ENERGY TECHNOLOGIES**(Professional Elective-1)****Semester: V****Course Code: 231ME5E03**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:**CO1:** Explain the importance of Renewable energy Sources and Solar radiation.**CO2:** Illustrate working of Solar Energy collectors and PV modules.**CO3:** Explain the functioning of wind energy systems**CO4:** Describe the process of energy extraction from Biomass, Geothermal and Hydro power.**CO5:** Discuss the principles of harnessing energy from ocean waves, tides, 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
CO1	2	-	-	-	-	3	-	-	-	-	-	-
CO2	2	-	-	-	-	3	-	-	-	-	-	-
CO3	2	-	-	-	-	3	-	-	-	-	-	-
CO4	2	-	-	-	-	3	-	-	-	-	-	-
CO5	2	-	-	-	-	3	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

Unit – I**Renewable Energy Sources**

Types of Renewable Energy sources, Importance, and limitations of renewable sources of energy, Sustainable Design and development, Present Indian and international energy scenario of conventional and RE sources.

Solar Energy: Fundamental Physics of Solar radiation, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation and sun shine, solar radiation data.

Unit – II

Solar Energy Collection, Storage and Applications: Flat plate and concentrating collectors, Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications.

Solar PV module and PV systems

PV Module Circuit Design, Module Structure, Interconnections, 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, Application and Selection of Batteries for Solar PV System.

Unit – III**Wind Energy**

Power in the Wind – Types of Wind Power Plants (WPPs)–Components of WPPs–Working of WPPs–Betz criteria, Siting of WPPs–Grid integration issues of WPPs.

Unit – IV**Biomass Energy**

Introduction, Bio mass resources, Energy from Bio mass, conversion processes, Biomass Cogeneration, Environmental Benefits. I.C. engine operation and economic aspects.

Geothermal Energy: Basics, Direct Use, Geothermal Electricity. Mini/micro hydro power: Classification of hydropower schemes, Classification of water turbine, Turbine theory, Essential components of hydroelectric system.

Unit – V**Other Energy Sources**

Tidal Energy: Energy from the tides, Barrage and Non-Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC)- Hydrogen Production and Storage.

Fuel cells: Principle of working- various types - construction and applications. Energy Storage System- Hybrid Energy Systems.

Text Books:

- T1** Non-conventional energy source, B.H. Khan, McGraw Hill Education India Private Limited, 3rd edition, 2017
- T2** Renewable Energy Sources and Emerging Technologies, D.P. Kothari, K.C Singal, Rakesh Ranjan PHI Learning Pvt.Ltd, New Delhi, 3rd edition, 2021.

Reference Books:

- R1** Sustainable Energy, Richard A. Dunlap, Cengage Learning India Private Limited, Delhi, 2015
- R2** Renewable energy, Godfrey Boyle, Open University, Oxford University Press in association with the Open University, 2004
- R3** Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki , PHI Learning Private Limited, New Delhi, 2011
- R4** Photovoltaic Systems: Analysis and Design, A.K. Mukerjee and Nivedita Thakur, PHI Learning Private Limited, New Delhi, 2011

Weblinks:

- W1** <https://nptel.ac.in/courses/112105051>
- W2** <https://www.eia.gov/energyexplained/renewable-sources/>

NON-DESTRUCTIVE EVALUATION**(Professional Elective-1)**

Semester: V	L	T	P	C
Course Code: 231ME5E04	3	0	0	3

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

CO1: Explain about the concepts of the radiography test.

CO2: Interpret the principles and procedure of ultrasonic test.

CO3: Explain the principles and procedure of Liquid penetration test.

CO4: Illustrate the principles and procedure of Magnetic particle test.

CO5: Explain the principles and procedure of Eddy current test.

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	3	2	2	2	3	2	-	-	-	-	-	-
CO2	3	3	2	3	3	2	1	-	-	-	-	1
CO3	3	2	2	2	2	2	-	-	-	-	-	-
CO4	3	2	2	2	3	2	-	-	-	-	-	-
CO5	3	3	2	3	3	2	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

Unit - I

Radiographic Test: Sources of X and Gamma Rays and their interaction with Matter, Radiographic Equipment, Radiographic Techniques. Applications of Industrial Radiography, Span of NDE Activities in Railways, Nuclear, Non-nuclear, Aerospace Industries and Automotive Industries.

Unit -II

Ultrasonic Test: Principle of Wave Propagation, Reflection, Refraction, Diffraction, Mode Conversion and Attenuation, Sound Field, Piezo-electric Effect, Ultrasonic Transducers and their Characteristics, Test Equipment, Test Variables, Guidelines for Acceptance and Rejection - Effectiveness and Limitations. Applications of Ultrasonic test in Castings, Railways, Nuclear, Non-Nuclear & Steel Industries

Unit - III

Liquid Penetrant Test: Basic Concepts, Liquid Penetrant System, Test Procedure, Effectiveness and Limitations of Liquid Penetrant Testing. Applications of Liquid penetrant testing in Aerospace, Castings, Welding and Pressure vessels

Unit – IV

Magnetic Particle Test: Magnetic Materials, Magnetization of Materials, Demagnetization of Materials, Principle of Magnetic Particle Test and Procedure, Equipment's required, Standardization and Calibration, Interpretation and Evaluation, Advantages and Limitations, Applications of magnetic particle test in Surface detection.

Unit – V

Eddy Current Test: Principle of Eddy Current, Eddy Current Test System, Eddy Current Testing Effectiveness. Applications of eddy current test in Offshore Gas and Petroleum Projects, Coal Mining Industry, Castings, Railways.

Text Books:

- T1** Non-destructive test and evaluation of Materials, J Prasad, CGK Nair, Second Edition, McGraw Hill Education, 2017
- T2** Non - Destructive Testing, Ramachandran S, Anderson A, Raja Santhosh Kumar T, First Edition, Airwalk Publications, 2017

Reference Books:

- R1** Ultrasonic inspection training for NDT: E. A. Gingel, Prometheus Press
- R2** ASTM Standards, Vol 3.01, Metals and alloys
- R3** Non-Destructive Testing Hand Book – R. Hamchand

Web links:

- W1** <https://archive.nptel.ac.in/courses/113/106/113106070/>
- W2** <https://asnt.org>
- W3** <https://www.nde-ed.org>

WASTE WATER MANAGEMENT (Open Elective-I)

Semester: V	L	T	P	C
Course Code: 231CE5001	3	0	0	3

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 wastewater characteristics

CO5: Outline various wastewater 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
CO1	2	1	-	-	-	2	-	-	-	-	-
CO2	1	1	1	-	-	1	-	-	-	-	-
CO3	3	2	1	-	-	1	-	-	-	-	-
CO4	2	1	-	2	-	2	-	-	-	-	-
CO5	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 wastewater–generation of wastewater– types – collection and conveyance of wastewater– 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:

Sewage Analysis and Treatment Sewage characteristics-sampling and analysis of wastewater– physical, chemical, and biological examination– measurement of BOD, COD. Preliminary and primary treatment– screens– grit chambers– grease traps– 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 wastewater recycling.

Text Books:

- T1** Wastewater Engineering: Treatment and Resource Recovery, Metcalf & Eddy, 5th Edition, McGraw-Hill, New York, 2014.
- T2** Wastewater Engineering Treatment and Reuse, Metcalf & Eddy, Tata McGraw-Hill edition, 2018

Reference Books:

- R1** Environmental Engineering-II: Sewage disposal and Air pollution Engineering, Garg & S.K., Khanna Publications.
- R2** Environmental Engineering by D. Srinivasan, PHI Learning private Limited, New Delhi, 2011

Web links:

- W1** <https://archive.nptel.ac.in/courses/113/106/113106070/>
- W2** <https://asnt.org>
- W3** <https://www.nde-ed.org>

CONSTRUCTION TECHNOLOGY AND MANAGEMENT**(Open Elective-I)****Semester: V****Course Code: 231CE5002**

L	T	P	C
3	0	0	3

Course Outcomes:

- 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
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 – economic 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)

Text Books:

- T1** Construction Planning, Equipment and Methods' by Peurifoy and Schexnayder, Shapira, Tata McGraw hill.
T2 Construction Project Management Theory and Practice' by Kumar NeerajJha (2011), Pearson

Reference Books:

- R1** Construction Project Management-An Integrated Approach 'by Peter Fewings, Taylor and Francis.
R2 Construction Management Emerging Trends and Technologies' by Trefor Williams , Cengage learning

Web links:

- W1** [NPTEL :: Civil Engineering - NOC:Principles of Construction Management](#)
W2 [NPTEL :: Civil Engineering - Construction Planning and Management](#)

GREEN BUILDINGS**(Open Elective-I)**

Semester: V
Course Code: 231CE5O03

L T P C
3 0 0 3

Course Outcomes:

- 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
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:

- T1** Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.
- T2** Green Building Hand Book by Tom woolley and Samkimings, 2009.
Recommended

Reference Books:

- R1** Complete Guide to Green Buildings by Trish Riley, The Lyons Press, 2009.
- R2** Standard for the Design of High-Performance Green Buildings by Kent Peterson, ASHRAE, 2009

Web links:

- W1** <https://nptel.ac.in/courses/105107213>
- W2** <https://nptel.ac.in/courses/105107213>

RENEWABLE ENERGY SOURCES (OPEN ELECTIVE-I)

Semester: V**Course Code: 231EE5001**

L	T	P	C
3	0	0	3

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

- CO1** Analyze 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
CO1	3	2	2	-	1	-	-	-	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	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

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:

T1 G.D.Rai, Non-Conventional Energy Sources, Khanna Publications, 2011.

T2 John Twidell& Tony Weir, Renewable Energy Sources, Taylor & Francis, 2013.

Reference Books:

R1 S.P.Sukhatme&J.K.Nayak, Solar Energy-Principles of Thermal Collection and Storage, TMH, 2011.

R2 John Andrews & Nick Jelly, Energy Science- principles, Technologies and Impacts, Oxford, 2nd edition, 2013.

Web links:

W1 <https://archive.nptel.ac.in/courses/103/103/103103206>

W2 <http://archive.nptel.ac.in/courses/103/107/103107157>

**CONCEPTS OF ENERGY AUDITING & MANAGEMENT
(OPEN ELECTIVE-I)**

Semester: V**Course Code: 231EE5002**

L	T	P	C
3	0	0	3

Course Outcome At the end of the course, students 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** Analyze the methods to improve the power factor and identify the energy instruments for various real time applications.
- CO5** Evaluate the computational techniques regarding 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
CO1	3	2	2	-	1	-	-	-	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	-

Mapping Course Outcomes with Program Specific Outcomes:

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

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:

T1 Energy management by W.R.Murphy & G.Mckay Butter worth - Heinemann publications - 1982.

T2 Energy management hand book by W.CTurner - John wiley and sons - 1982.

Reference Books:

R1 Energy efficient electric motors by John.C.Andreas - Marcel Dekker Inc Ltd-2nd edition - 1995.

R2 Energy management by Paul o' Callaghan - Mc-graw Hill Book company-1st edition - 1998.

Web links:

W1 <https://nptel.ac.in/courses/108106022>

W2 <https://archive.nptel.ac.in/courses/108/106/108106022>

SUSTAINABLE ENERGY TECHNOLOGIES
(OPEN ELECTIVE-I)

Semester: V

Course Code: 231ME5001

L	T	P	C
3	0	0	3

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
CO1:	2	-	-	-	-	3	-	-	-	-	-	-
CO2:	2	-	-	-	-	3	-	-	-	-	-	-
CO3:	2	-	-	-	-	3	-	-	-	-	-	-
CO4:	2	-	-	-	-	3	-	-	-	-	-	-
CO5:	2	-	-	-	-	3	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

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 bioconversion, 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:

T1 Non-conventional energy source, B.H. Khan, McGraw Hill Education India Private Limited, 3rd edition, 2017

T2 Renewable Energy Sources and Emerging Technologies, D.P. Kothari, K.C Singal, Rakesh Ranjan PHI Learning Pvt.Ltd, New Delhi, 3rd edition, 2021.

Reference Books:

R1 Sustainable Energy, Richard A. Dunlap, Cengage Learning India Private Limited, Delhi, 2015

R2 Renewable energy, Godfrey Boyle, Open University, Oxford University Press in association with the Open University, 2004

R3 Solar Photovoltaics: Fundamentals, Technologies and Applications, Chetan Singh Solanki , PHI Learning Private Limited, New Delhi, 2011

R4 Photovoltaic Systems: Analysis and Design, A.K. Mukerjee and Nivedita Thakur, PHI Learning Private Limited, New Delhi, 2011

Weblinks:

W1 <https://nptel.ac.in/courses/112105051>

W2 <https://www.eia.gov/energyexplained/renewable-sources/>

**APPLIED OPERATIONS RESEARCH
(OPEN ELECTIVE-I)**

Semester: V
Course Code: 231ME5002

L T P C
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 analyse 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
CO1:	2	1	1	-	-	2	-	-	-	-	1	-
CO2:	1	1	1	-	-	1	-	-	-	-	1	-
CO3:	3	2	1	-	-	1	-	-	-	-	1	-
CO4:	2	1	1	-	-	2	-	-	-	-	1	-
CO5:	2	1	1	-	-	2	-	-	-	-	1	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

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:

T1 Operations Research-An Introduction/Hamdy A Taha/Pearson publishers

T2 Operations Research –Theory & publications / S.D.Sharma Kedarnath/McMillan publishers India Ltd

Reference Books:

R1 Introduction to O.R/Hiller & Libermann/TMH

R2 Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.

Web links:

W1 <https://ocw.mit.edu/courses/find-b-topic/#cat=engineering&subcat=operationsresearch>

W2 <https://nptel.ac.in/courses/112/107/112107209/>

NANO TECHNOLOGY (OPEN ELECTIVE-I)

Semester: V**Course Code: 231ME5003**

L	T	P	C
3	0	0	3

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
CO1:	3	-	-	-	-	-	-	-	-	-	-	-
CO2:	3	-	-	-	-	-	-	-	-	-	-	-
CO3:	3	-	-	-	-	-	-	-	-	-	-	-
CO4:	3	-	-	-	2	-	-	-	-	-	-	-
CO5:	3	-	-	-	-	1	1	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

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 (FIM), 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:

T1 Introduction to Nano Technology by Charles. P. Poole Jr & Frank J. Owens. Wiley India Pvt. Ltd.

T2 Nano Materials- A.K. Bandyopadhyay/ New Age Publishers.

Reference Books:

R1 Solid State physics by Pillai, Wiley Eastern Ltd

R2 Introduction to solid state physics 7th edition by Kittel. John Wiley & sons (Asia) Pvt Ltd.

Web links:

W1 <https://ocw.mit.edu/courses/find-b-topic/#cat=engineering&subcat=operationsresearch>

W2 <https://nptel.ac.in/courses/112/107/112107209/>

THERMAL MANAGEMENT OF ELECTRONIC SYSTEMS (OPEN ELECTIVE-I)

Semester: V
Course Code: 231ME5004

L	T	P	C
3	0	0	3

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	PO 12
CO1:	3	2	1	-	-	-	-	-	-	-	-	1
CO2:	3	3	1	1	-	-	-	-	-	-	-	1
CO3:	3	3	2	2	1	-	-	-	-	-	-	1
CO4:	3	2	2	2	1	-	-	-	-	-	-	1
CO5:	3	2	1	2	1	-	-	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

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:

T1 Thermal Analysis and Control of Electronic Equipment – Allan D. Kraus and Avram BarCohen, McGraw Hill, New York, NY, 1983.

T2 Fundamentals of Microelectronics Packaging – Ed: Rao Tummala, McGraw Hill, New York, NY, 2001.1.

T3 Packaging of Electronic Systems – James W. Dally, McGraw Hill, New York, NY, 1990

Reference Books:

R1 Fundamentals of Microelectronics Packaging – Edited by Rao Tummala, McGraw Hill, New York, NY, 2001.

R2 Heat Transfer: Thermal Management of Electronics – Younes Shabany, CRC Press, 2009

R3 HoSung Lee, Thermal Design: Heat Sinks, Thermoelectrics, Heat Pipes, Compact Heat Exchangers, and Solar Cells, 2011 John Wiley & Sons, Inc.

Weblinks:

W1 <https://nptel.ac.in/courses/108108110>

W2 https://ocw.mit.edu/courses/6-622-power-electronics-spring-2023/resources/mit6_622s23_lecture_01_mp4/

W3 <https://www.coursera.org/courses?query=electronics>

ENTREPRENEURSHIP (OPEN ELECTIVE-I)

Semester: V

Course Code: 231ME5005

L	T	P	C
3	0	0	3

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	PO 12
CO1:	2	-	-	-	-	1		-	1	-	2	-
CO2:	2	-	-	-	-	1	2	-	1	-		-
CO3:	2	-	-	-	-	1		-	1	-	1	-
CO4:	2	-	-	-	-	1		-	1	-	1	-
CO5:	2	-	-	-	-	1		-	1	-	2	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

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 Organizational 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:

T1 Robert D Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2013.

T2 Dr. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 2001

Reference Books:

R1 Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 1996..

R2 Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra ,2nd Edition ,2005

R3 P.Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai -1997.

R4 Arya Kumar. Entrepreneurship. Pearson. 2012

Weblinks:

W1 <https://www.nptel.ac.in/courses/127105007>

W2 <https://www.youtube.com/watch?v=7NI5P4KqrAs&t=1s>

PRINCIPLES OF SIGNALS & SYSTEMS (Open Elective-I)

Semester: V**Course Code: 231EC5001**

L	T	P	C
3	0	0	3

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:

T1 Signals and Systems - A.V. Oppenheim, A.S. Willsky, and S.H. Nawab, PHI, 2nd Edition, 2016

T2 Signals, Systems & Communications - B.P. Lathi, BS Publications, 2003.

Reference Books:

R1 Signals & Systems - Simon Haykin and Van Veen, Wiley, 2nd Edition

R2 Signals and Systems – A. Anand Kumar, PHI, 4th Edition, 2017

Weblinks:

W1 <https://freevidelectures.com/course/3540/signals-and-systems-i>(Signals and Systems I by Prof. K.S.Venktesh IIT Kanpur)

W2 <https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/>

INTRODUCTION TO INTERNET OF THINGS (Open Elective-I)

Semester: V
Course Code: 231EC5002

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

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	-	-	-	-	-	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:

- T1** Internet of Things- A Hands-on Approach, Arshdeep Bahgaand Vijay Madisetti, Universities Press, 2015, ISBN:9788173719547
- T2** Getting Started with RaspberryPi, Matt Richardson & Shawn Wallace, O'Reilly(SPD), 2014, ISBN:9789350239759.

Reference Books:

- R1** Adrian McEwen, Hakim Cassimally “Designing the Internet of Things”, John Wiley & Sons, 2014.
- R2** Peter Friess,’ Internet of Things—From Research and Innovation to Market Deployment’, River Publishers, 2014

Weblinks:

- W1** <https://onlinecourses.nptel.ac.in/noc2lee85/course>
- W2** <https://onlinecourses.nptel.ac.in/noc2lcs17/preview>

DIGITAL ELECTRONICS AND LOGIC DESIGN (Open Elective-I)

Semester: V
Course Code: 231EC5003

L **T** **P** **C**
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:

T1 Digital Design, Morris Mano, Pearson, 3rd Edition, 2002.

T2 Fundamentals of Logic Design, Charles H. Roth Jr., Jaico Publishers, 2004

Reference Books:

R1 Modern Digital Electronics, RP Jain, Tata Mc Graw Hill, 4th Edition, 2010.

R2 Introduction to Switching Theory and Logic Design, Fredriac J. Hill, Gerald R. Peterson, 3rd Edition, John Wiley & Sons Inc., 1982

Weblinks:

W1 <http://nptel.ac.in/courses/117/106/117106086/> (By Prof. Goutam Saha, Electronics & Electrical Communication Engineering Dept, IIT Kharagpur).

W2 <https://www.nptelvideos.in/2012/12/digital-circuits-and-systems.html> (By Prof. Santanu Chattopadhyay, Electronics & Electrical Communication Engineering Dept, IIT Kharagpur).

DATA BASE MANAGEMENT SYSTEMS (Open Elective-I)

Semester: V
Course Code: 231CS5001

L	T	P	C
3	0	0	3

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	PO 12
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.

Text Books:

T1 Database Management Systems, 3/e, Raghurama Krishnan, Johannes Gehrke, TMH

T2 Database System Concepts, 5/e, Silberschatz, Korth, TMH

Reference Books:

R1 Introduction to Database Systems, 8/e C J Date, PEA

R2 Database Management System, 6/e Ramez Elmasri, Shamkant B. Navathe, PEA

Weblinks:

W1 <https://nptel.ac.in/courses/106/105/106105175/>

W2 <https://www.geeksforgeeks.org/introduction-to-nosql/>

PYTHON PROGRAMMING (Open Elective-I)

Semester: V
Course Code: 231DS5O01

L	T	P	C
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	PO12
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

CO/PSO	PSO 1	PSO 2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-
CO6	-	-

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 Loop

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 over loading 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(), read line () and read lines (), Understanding write functions, write() and write lines (), 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:

- T1** Fundamentals of Python First Programs, Kenneth. A. Lambert, Cengage, 2018
- T2** Beginning Python: from Novice to Professional, Lie Hetland, Magnus, 2nd Edition, 2005

Reference Books:

- R1** Introduction to Python Programming, Gowrishankar.S, Veena A, CRC Press
- R2** Introduction to Programming Using Python, Y. Daniel Liang, Pearson, 2017.

Weblinks:

- W1** <https://www.coursera.org/courses?query=Python%20programming>
- W2** https://www.tutorialspoint.com/python3/python_tutorial.pdf

COMPUTER ORGANIZATION (Open Elective-I)

Semester: V
Course Code: 231IT5001

L T P C
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	1	-	-	-	-	-	-	-	-
CO2	3	1	1	2	-	-	-	-	-	-	-	-
CO3	2	2	2	3	-	-	-	-	-	-	-	-
CO4	2	1	3	2	-	-	-	-	-	-	-	-
CO5	2	3	1	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

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.

Text Books:

- T1** Computer System Architecture, M. Morris Mano, Third Edition, Pearson, 2008
T2 Computer Organization, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, 5/e, McGraw Hill, 2002.

Reference Books:

- R1** Computer Organization and Architecture, William Stallings, 6/e, Pearson, 2006.
R2 Structured Computer Organization, Andrew S. Tanenbaum, 4/e, Pearson, 2005.

Weblinks:

- W1** <https://www.udemy.com/course/computer-architecture-computer-organization-course/>
W2 <http://www.cuc.ucc.ie/CS1101/David%20Tarnoff.pd>

OBJECT ORIENTED PROGRAMMING THROUGH JAVA (OPEN ELECTIVE-I)

Semester: V**Course Code: 231AM5001**

L	T	P	C
3	0	0	3

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	PO 12
CO1	3	-		-	3	-	-	-	-	-	-	-
CO2	3	-	3	-	3	-	-	-	-	-	-	-
CO3	2	3	2	-	3	-	-	-	-	-	-	-
CO4	3	2	3	-	3	-	-	-	-	-	-	-
CO5	3	3	3	-	3	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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.

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)

Text Books:

- T1** JAVA one step ahead, Anitha Seth, B.L.Juneja, Oxford.
- T2** Joy with JAVA, Fundamentals of Object Oriented Programming, Debasis Samanta, Monalisa Sarma, Cambridge, 2023.
- T3** JAVA 9 for Programmers, Paul Deitel, Harvey Deitel, 4th Edition, Pearson.

Reference Books:

- R1** The complete Reference Java, 11th edition, Herbert Schildt, TMH
- R2** Introduction to Java programming, 7th Edition, Y Daniel Liang, Pearson

Web Links:

- W1** <https://nptel.ac.in/courses/106/105/106105191/>
- W2** https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012880464547618816347_shared/overview

INTRODUCTION TO PETROLEUM ENGINEERING**(OPEN ELECTIVE-I)****Semester: V****Course Code: 231PT5O01**

L	T	P	C
3	0	0	3

Course Outcomes:

- 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.
 CO5: 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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

- T1** Oil and Gas Production Handbook: An Introduction to Oil & Gas Production, Havard Devold, ABB ATPA Oil and Gas, 2006
- T2** Introduction to Petroleum Engineering, John R. Fanchi and Christiansen, R.L., John Wiley & Sons, 2017.

Reference Books:

- R1** Petroleum engineering handbook: Production operations engineering, volume IV, Joe Dunn Clegg, 2009
- R2** Petroleum engineering hand book: Larry .W.lake, SPE, volume II, 2006

Weblinks:

- W1** <https://nptel.ac.in/courses/106/105/106105191/>
- W2** https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012880464547618816347_shared/overview

INTRODUCTION TO PETROLEUM GEOLOGY (OPEN ELECTIVE-I)

Semester: V**L T P C****Course Code: 231PT5O02****3 0 0 3****Course Outcomes:**

- 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/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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

T1 Bell, F.G., Engineering Geology, 2nd Edition, ButterworthHeimann, 2007.

T2 Mukharje, P.K., Text book of Geology, P.K The World Press PvtLtd., 2005

Reference Books:

R1 Gribble, C. D., Rutley's Elements of Mineralogy, 27th Edition. CBS Publishers, 2005

R2 David Duff, Homes' Principles of Physical Geology, Nelson Thornes Ltd; 4th Revised edition, 1992

Weblinks:

W1 <https://www.udemy.com/course/computer-architecture-computer-organization-course/>

W2 <http://www.cuc.ucc.ie/CS1101/David%20Tarnoff.pd>

INTRODUCTION TO WELL LOGGING (OPEN ELECTIVE-I)

Semester: V

Course Code: 231PT5O03

	L	T	P	C
3	0	0	3	

Course Outcomes:

- 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.
 CO5: 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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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 (Rt) 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 Rt 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:

T1 Formation evaluation, Edward J. Lynch, Harper & Row, 1962.

T2 Well logging and formation evaluation, Toby Darling, Elsevier, New York, 2005.

Reference Books:

R1 Hydrocarbon well logging recommended practice, Society of professional well log analysts

R2 Open – Hole log analysis and formation evaluation, Richard M. Batemans, International Human Resources Development Corporation, Bostan, 1985.

Weblinks:

W1 <https://nptel.ac.in/courses/106/105/106105191/>

W2 https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012880464547618816347_shared/overview

INTRODUCTION TO UNDERGROUND MINING (OPEN ELECTIVE – I)

Semester: V
Course Code: 231MI5001

L	T	P	C
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& P method 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.

Text Books:

- T1** Principles and Practices of Modern Coal Mining–R.D. Singh, New Age International,1997.
- T2** Modern Coal Mining Technology–S.K.Das, 2ndedition, Lovely PrakashanPublishers,1994.

Reference Books:

- R1** Under ground Coal Mining Methods–J.G.Singh, BrajKalpa Publishers, Varnasi,2000
- R2** Coal Mining – I.C.F. Statham, Vol. I, II, III and Vol. III. The Caxton Publishing CompanyLtd.Inc.1958

Weblinks:

- W1** <https://arlweb.msha.gov/Fatals/AccidentClassifications.asp>
- W2** [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)

Semester: V
Course Code: 231MI5002

L T P C
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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

T1 Surface Mining Technology by S.K.Das, Lovely Prakashan, Dhanbad,1994

T2 Surface Mining by G.B. Mishra, Dhanbad Publishers,1978

Reference Books:

R1 Elements of Mining Technology, Vol.–I, D.J.Deshmukh, 6thEdition, Central Techno Publications, Nagpur,1998

R2 Opencast Mining–R.T.Deshmukh, M.Publications, Nagpur,1996

Weblinks:

W1 <http://www.sciencedirect.com/topics/earth-and-planetary-sciences/rock-mechanics>

W2 <https://arlweb.msha.gov/Fatals/AccidentClassifications.asp>

TUNNELLING & UNDERGROUND SPACE DESIGN (OPEN ELECTIVE – I)

Semester: V
Course Code: 231MI5003

L T P C
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	-	-	-	-	-	-	-	-	-	PSO3
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:

- T1** Hudson, J.A., Rock Engineering Systems Theory and Practice, Ellis Horwood, England
T2 Clark G.B., (1987), Principles of Rock Fragmentation, John Wiley and Sons, New York.

Reference Books:

- R1** Lohanson, John and Mathiesen, C.F., Modern trends in Tunnelling and Blast Design, AA Balkima, 154 P, 2000
R2 Bickel J.O., Kuesel T.R. and King E.H., Tunnel Engineering Hand Book, Chapman & Hill Inc., New York and CBS Publishers, New Delhi 2nd addition.

Weblinks:

- W1** <https://arlweb.msha.gov/Fatals/AccidentClassifications.asp>
W2 http://www.hsa.ie/eng/Topics/Managing_Health_and_Safety/Safety_Statement_and_

INTRODUCTION TO MINE ENVIRONMENT (OPEN ELECTIVE – I)

Semester: V
Course Code: 231MI5004

L	T	P	C
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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

T1 Mine Environment By G.B. Mishra

T2 Elements of Mining Tech. Vol.2 by D. J. Deshmukh

Reference Books:

R1 Mine fires by Dr. Ramlu

R2 Underground Mine Environment, M. Mcpherson

Weblinks:

W1 <https://arlweb.msha.gov/Fatals/AccidentClassifications.asp>

W2 http://www.hsa.ie/eng/Topics/Managing_Health_and_Safety/Safety_Statement_and_

BASIC CROP PRODUCTION PRACTICES
(Open Elective-I)

Semester: V
Course Code: 231AG5001

L T P C
3 0 0 3

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:

- T1** Rajendra Prasad, Text Book of Field Crop Production. Directorate of Information and Publication, Krishi Anusandhan Bhavan, Pusa, New Delhi, 2015.
- T2** Reddy T. Sankara G.H. Yellamanda Reddi, Principles of Agronomy, Kalyani Publishers, New Delhi, 2005.

Reference Books:

- R1** Bose T. K. and L.P.Yadav. Commercial Flowers, Naya Prakash, Calcutta.1989
- R2** Crop Production Guide, Tamil Nadu Agricultural University Publication, Coimbatore. 2005.

Weblinks:

- W1** [https://www.careerlauncher.com/cbse-ncert/class-8/Science/CBSE-CropProduction and Management- Notes.html#:~:text=%E2%80%A2%20Basic%20Practices%20](https://www.careerlauncher.com/cbse-ncert/class-8/Science/CBSE-CropProductionandManagement-Notes.html#:~:text=%E2%80%A2%20Basic%20Practices%20)
- W2** <http://www.apagrisnet.gov.in/pdf/farmerbook.pdf>

GROUNDWATER, WELLS AND PUMPS (Open Elective-I)

Semester: V**Course Code: 231AG5002**

L	T	P	C
3	0	0	3

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	-	-	-	-	-	-	1

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:

- T1** Water Well and Pumps, Michael AM, Khepar SD. and SK Sondhi, 2nd Edition, Tata Mc-Graw Hill, 2008.
- T2** Irrigation-Theory and Practice, Michael AM., 2nd Edition. Vikas Publishing House Pvt. Ltd, 2018.

Reference Books:

- R1** Land and Water Management Engineering, Murthy, V.V.N and Jha, M.K. Sixth Edition, Kalyani Publishers, Ludhiana, 2011.
- R2** Ground Water, Third Edition, New Age International, Raghunath, H.M. Publishers, New Delhi, 2007

Weblinks:

- W1** <http://ecoursesonline.iasri.res.in/course/view.php?id=513>
- W2** <https://nptel.ac.in/courses/105/105/105105042/>

Thermal Engineering LAB

Semester: V

Course Code: 231ME5L01

L	T	P	C
0	0	3	1.5

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

- CO1:** Determine the two stroke and four stroke compression and spark ignition engines for various characteristics.
- CO2:** Explain the flash point, fire point, calorific value of different fuels using various apparatus.
- CO3:** Perform engine friction, heat balance test, volumetric efficiency, load test of petrol and diesel engines.
- CO4:** Perform speed test, performance test and cooling temperature on petrol and diesel engines.
- CO5:** Utilize air compressor for its performance test and to determine efficiency.

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	3	2	-	1	-	-	-	1	1	-	-	-
CO2	2	3	-	1	-	-	-	1	1	-	-	-
CO3	2	3	-	1	-	-	-	1	1	-	-	-
CO4	2	3	-	1	-	-	-	1	1	-	-	-
CO5	2	2	-	1	-	-	-	1	1	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	2
CO2	-	3
CO3	-	3
CO4	-	3
CO5	-	2

List of Experiments:

- To determine the actual Valve Timing diagram of a four stroke Compression Ignition Engine.
- To determine the actual Port Timing diagram of a two stroke Spark Ignition Engine.
- Determination of Flash & Fire points of Liquid fuels .
- Determination of Viscosity of Liquid Fuels using Redwood Viscometer.
- Determination of Calorific value of Liquid Fuels using Bomb Calorimeter
- Evaluation of engine friction by conducting Morse test on 4-stroke multi cylinder petrol/diesel engine.
- Evaluation of Engine Friction by Motoring Test on a Single Cylinder 4 Stroke Petrol.
- To perform the Heat Balance Test on Single Cylinder four Stroke Diesel Engine.
- To conduct a load test on a single cylinder Petrol/Diesel engine to study its performance under various loads.
- To conduct a performance test on a VCR engine, under different compression ratios and determine its heat balance sheet.

List of Augmented Experiments:

1. To conduct a performance test on an air compressor and determine its different efficiencies.
2. Dis-assembly / assembly of different parts of two wheelers & 4 wheelers. Tractor & Heavy duty engines covering 2-stroke and 4 stroke, SI and CI engines.
3. Determination of viscosity using Saybolt Viscometer.

Reference Books:

1. Internal Combustion Engines, V. Ganesan, TMH Publication. 4th Edition.
2. Internal Combustion Engines Fundamentals, John. B. Heywood,

Web Links:

1. <https://www.scribd.com/doc/38559760/Thermal-Lab-Manual>.
2. <http://www.ksrct.ac.in/page/thermal-engineering-lab.html>

THEORY OF MACHINES LAB**Semester: V****Course Code: 231ME5L02****L****0****T****0****P****3****C****1.5****Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Demonstrate the principles of gyroscopic motion.**CO2:** Evaluate the performance characteristics of various types of governors through experimental investigation.**CO3:** Determine and interpret the natural frequencies of damp and undamped vibrating systems under free and forced conditions.**CO4:** Analyze the motion characteristics of common mechanisms using graphical and experimental methods.**CO5:** Identify and demonstrate the construction and working principles of different types of gears used in mechanical systems.**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	3	2	-	-	1	-	-	-	-	-	-	-
CO2	3	3	-	-	2	-	-	-	-	-	-	-
CO3	3	3	-	-	2	-	-	-	-	-	-	-
CO4	3	3	-	-	2	-	-	-	-	-	-	-
CO5	2	2	-	-	2	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

List of Experiments:

1. To determine whirling speed of shaft theoretically and experimentally.
2. To determine the position of sleeve against controlling force and speed of a Hartnell governor and to plot the characteristic curve of radius of rotation.
3. To analyse the motion of a motorized gyroscope when the couple is applied along its spin axis
4. To determine the frequency of undamped free vibration of an equivalent spring mass system.
5. To determine the frequency of damped force vibration of a spring mass system
6. To study the static and dynamic balancing using rigid blocks.
7. To find the moment of inertia of a flywheel.

8. To plot follower displacement vs cam rotation for various Cam Follower systems.
9. To plot slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism/Four bar mechanism.
10. To find the coefficient of friction between the belt and pulley.
11. To study simple and compound screw jack and determine the mechanical advantage, velocity ratio, and efficiency.
12. To study various types of gears- Spur, Helical, Worm and Bevel Gears.

REFERENCES:**Text Books:**

- T1** Theory of Mechanisms & Machines by Jagadeesh lal, Metropolitan Pvt. Ltd.
T2 Theory of Machines by Thomas Bevan/ CBS Publishers.

Reference Books:

- R1** Theory of Machines – S. S Rattan- TMH Publishers
R2 Theory of machines and Machinery-Vickers - Oxford.

Weblinks:

- W1** <https://mm-nitk.vlabs.ac.in>
W2 <https://ems-iitr.vlabs.ac.in>
W3 <http://vlabs.iitkgp.ac.in/kdm/>

MACHINE TOOLS AND METROLOGY LAB**Semester: V****Course Code: 231ME5S01****L****0****T****0****P****3****C****1.5****Course Outcomes: At the end of the Course, Student will be able to:****CO1:** Perform various operations on Lathe & Drilling machines.**CO2:** Perform various operations Shaper & Slotter machine.**CO3:** Perform different operations on milling & surface grinding machines.**CO4:** Demonstrate the calibration experiments with vernier calipers, micrometer, height and dial gauges.**CO5:** Measure angular and taper measurements, straightness, surface roughness.**Mapping of Course Outcomes with Program Outcomes:**

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

List of Experiments

Week 1: Introduction of general-purpose machines -Lathe, Drilling machine, Milling machine, Shaper, Planning machine, Slotting machine, Cylindrical grinder, Surface grinder and Tool and cutter grinder.

Week 2: Operations on Lathe machine

1. Step turning and Knurling
2. Taper turning and Knurling
3. Thread cutting and knurling

Week 3: Operations on Drilling machine

1. Drilling and tapping

Week 4: Operations on Shaper & Slotter machine

1. Plane surface
2. T – Slots

Week 5: Operations on milling machines

1. Gear manufacturing

Week 6: Calibration of vernier calipers, micrometer, vernier height gauge and dial

gauges.

Week 7: Measurement of bores by internal micrometers and dial bore indicators.

Week 8: Use of gear tooth vernier caliper for tooth thickness inspection for checking the chordal thickness of spur gear.

Week 9: Angle and taper measurements with bevel protractor, Sine bar, Slip Gauges.

Week 10: Use of spirit level in finding the straightness of a bed and flatness of a surface.

List of Augmented Experiments:

1. To plane a surface on a Surface Grinding machine.
2. Measure the flatness and straightness of a surface using Autocollimator.

Virtual Lab:

1. To study and observe various stages of metal cutting through demonstration of metal cutting process. (<https://fab-coep.vlabs.ac.in/exp/3d-machining/theory.html>)
2. To evaluate the contact angle measurement of materials. (<https://mrmsmtbs-iitk.vlabs.ac.in/exp/contact-angle-measurement/>).
3. Experiments on metrology (<http://vlabs.iitkgp.ac.in/metro/>)
4. <https://learn.toolingu.com/manufacturing-products-services/virtual-labs/>

TINKERING LAB**Semester: V****Course Code: 231ME5L03**

L	T	P	C
0	0	2	1

Course Outcomes: At the end of the Course, Student will be able to:**CO1:** Construct simple circuits and explain their working**CO2:** Interface basic sensors and actuators with microcontrollers**CO3:** Use simulation tools (like Tinker cad) and Arduino IDE**CO4:** Design and fabricate 3D models**CO5:** Develop IoT-based real-time monitoring systems**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	-	3	-	2	-	-	-	-	-	-	-
CO2	2	2	3	-	3	-	-	-	-	-	-	-
CO3	-	2	3	2	3	-	-	-	-	-	-	-
CO4	-	-	3	-	3	-	-	-	-	-	-	-
CO5	2	2	3	2	3	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	3	-
CO2	3	2
CO3	3	3
CO4	2	3
CO5	3	3

List of Experiments:

Install and explore CPRog software features and safety protocols for IGUS robot

Program an IGUS robot for pick and place task using a magnetic or vacuum gripper

Program an IGUS robot for pick and place task using coordinate-based commands

Build a distance-based LED alert system using Arduino, ultrasonic sensor, and LEDs

Interface IR sensor and servo motor with Arduino

Use Arduino and a potentiometer to control DC motor speed

Control an LED using a mobile app via Bluetooth or Wi-Fi

Create a simple geometric shape using CAD software

Design and assemble multiple CAD components with proper fit

Develop a 3D parametric model by adjusting key parameters

Slice a 3D model and print a simple part using a 3D printer

Print and assemble multiple 3D-printed components, ensuring proper fit

Weblinks:

- W1** <https://aim.gov.in/pdf/Level-1.pdf>
- W2** <https://atl.aim.gov.in/ATL-Equipment-Manual/>
- W3** <https://aim.gov.in/pdf/Level-2.pdf>
- W4** <https://aim.gov.in/pdf/Level-3.pdf>

INDUSTRY INTERNSHIP-I**Semester: V****Course Code: 231ME5P01**

L	T	P	C
0	0	0	2

Course Outcomes: At the end of the Course, Student will be able to:**CO1: Apply Technical Knowledge in a Real-World Setting** – Students will utilize discipline-specific skills and academic learning to solve practical problems in an industrial or corporate environment.**CO2: Develop Professional Competencies** – Students will demonstrate workplace skills such as punctuality, teamwork, communication, and adherence to industry standards and ethics.**CO3: Gain Industry Exposure and Best Practices** – Students will observe and analyze operational workflows, technologies, and management strategies used in the industry.**CO4: Enhance Problem-Solving and Critical Thinking** – Students will identify challenges in the workplace, propose solutions, and document their learning through reports or presentations.**CO5: Build Career Readiness and Networking Skills** – Students will engage with professionals, understand organizational culture, and reflect on career aspirations based on internship experiences.**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	3	-	-	-	-	1	1	-	-	-	-	1
CO3	3	-	-	-	-	-	-	-	-	1	1	1
CO4	1	1	3	2	-	-	-	-	-	-	-	-
CO6	-	-	-	-	3	-	-	2	1	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	1
CO2	1	1
CO3	1	2
CO4	1	1
CO5	1	2

Guidelines:

1. The Internship is a team activity of 3 to 4 students.
2. The students can undergo Industrial Training / Internship at Govt. Organizations, software MNCs or do Research projects in National Laboratories/Academic Institutions like IITs, NITs etc. during summer breaks after completion of IV Semester.
3. An industrial related Project is an alternative to the Summer Internship, whenever there is an exigency and students cannot pursue their Summer Internship. A group of students or even a single student can take up the Community Service Project during summer breaks. However, a student can opt for this only once. The students must identify social problems existing in any geographical area/village and try to solve them technically or suggest people the necessary solutions for solving these problems.
4. Prior letter and approval from the Head of the Department must be taken before applying to any organization for the course.
5. Every student should put in a minimum of 180 hours for the Industry related Project

during the summer vacation.

6. Each class/section should be assigned with a Project Coordinator.
7. The students are motivated to do projects based on societal needs using emerging technologies like IoT, Machine Learning, Deep Learning, Cyber security, cloud computing etc.,
8. After successful completion, students shall submit a summer internship technical report to the department concerned.
9. The student shall appear for the oral presentation before the Project Review Committee (PRC)* and an External Examiner.

PROFESSIONAL ETHICS AND HUMAN VALUES

(Common to all branches)

Semester: V

Course Code: 231MC5T01

L
2T
0P
0C
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 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/s Involuntary 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:

- T1** A Text Book On Professional Ethics And Human – R.S.Naagarazan
- T2** Professional Ethics And Human Values By – M.P.Raghavan's – Scitech Publications (Indian Pvt., 2013).

Reference Books:

- R1** Engineering Ethics & Human Values By M.Govindarajan, S.Natarajan And V.S.Senthil Kumar-PHI Learning Pvt. Ltd – 2009.
- R2** Human Values And Professional Ethics By Jayshree Suresh And B. S. Raghavan, S.Chand Publications

Weblinks:

- W1** <https://nptel.ac.in/courses/109104068>
- W2** http://nptel.ac.in/courses/122106031/Pdfs/2_1.pdf

HEAT TRANSFER**Semester: VI****Course Code: 231ME6T01**

L	T	P	C
3	0	0	3

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

- CO 1:** Explain the principle of conductive heat transfer for different bodies.
- CO 2:** Analyse the dimensional analysis principle and heat transfer rate through forced convection.
- CO 3:** Analyse the heat transfer rate through free convection in various bodies.
- CO 4:** Explain the principle of boiling, condensation, and the performance of the heat exchanger.
- CO 5:** Evaluate the law of radiation and heat transfer rate through radiation.

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	-	-	-	-	-	-	-	-	-	-
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**Conductive Heat Transfer:**

Fourier rate equation – general heat conduction equation in Cartesian and cylindrical coordinates, heat transfer through homogeneous slabs, hollow cylinders, overall heat transfer coefficient, electrical analogy, a critical radius of insulation, Variable thermal conductivity, systems with heat sources or heat generation. Extended surface (fins) heat transfer – long fin, short fin with insulated tip.

Transient Conduction: Lumped parameter system, Significance of Biot and Fourier numbers, Heisler Chart.

UNIT-II

Convective Heat Transfer: Classification of convective heat transfer, dimensional analysis for heat transfer study, Buckingham Pi Theorem for forced and free convection, Significance of non-dimensional numbers.

Forced Convection

External Flows: Concepts of the hydrodynamic and thermal boundary layer, using empirical correlations for convective heat transfer through flat plates and cylinders.

Internal Flows: Concepts about hydrodynamic and thermal entry lengths, division of internal flow based on this, use of empirical relations for horizontal pipe flow and annulus flow.

UNIT-III

Free Convection: Development of hydrodynamic and thermal boundary layer along with a vertical plate, Heat transfer through constant heat flux and isothermal vertical Plate and cylinders in different orientations, and empirical relations for vertical plates and pipes.

UNIT-IV

Heat Exchangers: Classification of heat exchangers, overall heat transfer coefficient and fouling factor, LMTD and NTU methods concepts.

Boiling: Pool boiling regimes, calculations on nucleate boiling, critical heat flux and film boiling.

Condensation: Film wise and dropwise condensation, Nusselt's theory of condensation on a vertical plate - film condensation on vertical and horizontal cylinders using empirical correlations.

UNIT-V

Radiative Heat transfer: Emission characteristics and laws of black body radiation, Irradiation, total and monochromatic quantities, Planck law, Wien displacement law, Kirchhoff, Stefan and Boltzmann law, heat exchange between two black bodies, concepts of shape factor, Emissivity, heat exchange between grey bodies, radiation shields, and radiation network analysis.

Note: Heat Transfer Data book is to be allowed in the Examinations

Text Books:

- T1** Fundamentals of Engg. Heat and Mass Transfer, R.C.Sachdeva, New Age International Publications, 5th edition.
- T2** Heat and Mass Transfer - Fundamentals and Applications, Yunus A. Cengel and Afshin J. Ghajar, McGraw Hill Publications, 5th edition.

Reference Books:

- R1** Heat Transfer, P.K.Nag, TMH Publications, 3rd edition.
- R2** Principles of Heat and Mass Transfer, Frank P. Incropera, David P. Dewitt, Theodore L, Adrienne S. Lavine, Wiley Publications, 7th edition.
- R3** Heat and Mass Transfer, D.S.Kumar, S.K.Kataria & Sons Publications, 3^d edition.
- R4** Heat Transfer, J.P. Holman, McGraw Hill Education; 10th edition

Weblinks:

- W1** <https://nptel.ac.in/courses/112/108/112108149/>
- W2** <https://nptel.ac.in/courses/112/105/112105271/>
- W3** <https://nptel.ac.in/courses/112/107/112107256/>

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**Semester: VI****L T P C****Course Code: 231ME6T02**

3 0 0 3

Course Outcomes at the end of the Course, Student will be able to:**CO1:** Discuss basic concepts of artificial intelligence**CO2:** Apply the principles of knowledge representation and reasoning.**CO3:** Discuss about bayesian and computational learning and machine learning.**CO4:** Explain various machine learning techniques**CO5:** Apply the machine learning analytics and deep learning 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
CO1	1	1	1	1	-	-	-	-	-	-	-	-
CO2	2	1	3	2	-	-	-	-	-	-	-	-
CO3	3	1	1	2	-	-	-	-	-	-	-	-
CO4	2	2	2	3	-	-	-	-	-	-	-	-
CO5	1	3	1	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

Unit – I**Introduction:** Definition of Artificial Intelligence, Evolution, Need, and applications in real world.

Intelligent Agents: Agents and environments; Good Behavior-The concept of rationality, the nature of environments, structure of agents.

Unit – II**Knowledge–Representation and Reasoning:** Logical Agents: Knowledge based agents, the Wumpus world, logic. Patterns in Propositional Logic, Inference in First-Order Logic-Propositional vs first order inference, unification and lifting**Unit – III****Bayesian and Computational Learning:** Bayes theorem , concept learning, maximum likelihood, minimum description length principle, Gibbs Algorithm, Naïve Bayes Classifier, Instance Based Learning- K-Nearest neighbour learning**Introduction to Machine Learning (ML):** Definition, Evolution, Need, applications of ML in industry and real world, classification; differences between supervised and unsupervised learning paradigms.

Unit – IV

Basic Methods in Supervised Learning Distance-based methods, Nearest-Neighbors, Decision Trees, Neural Networks and Genetic Algorithms, Support Vector Machines, Nonlinearity and Kernel Methods.

Unsupervised Learning: Clustering, K-means, Dimensionality Reduction, PCA and kernel.

Unit – V

Machine Learning Algorithm Analytics: Evaluating Machine Learning algorithms, Model, Selection, Ensemble Methods (Boosting, Bagging, and Random Forests).

Modeling Sequence/Time-Series Data and Deep Learning: Deep generative models, Deep Boltzmann Machines, Deep auto-encoders, Applications of Deep Networks.

Text Books:

T1 Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2/e, Pearson Education, 2010

T2 Tom M. Mitchell, Machine Learning, McGraw Hill, 2013

Reference Books:

R1 Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004

R2 Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.

Weblinks:

W1 <https://faculty.eng.ufl.edu/navid-asadi/.../Lecture-16-Introduction-to-AI.pdf>

W2 https://en.wikipedia.org/wiki/Knowledge_representation_and_reasoning

FINITE ELEMENT METHODS

Semester: VI

Course Code: 231ME6T03

L T P C

3 0 0 3

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

CO1: Explain 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
CO1	3	2	2	1	-	-	-	-	-	-	-	-
CO2	3	2	2	1	-	-	-	-	-	-	-	-
CO3	3	2	2	1	-	-	-	-	-	-	-	-
CO4	3	2	2	1	-	-	-	-	-	-	-	-
CO5	3	2	2	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	3	1
CO2	3	1
CO3	3	1
CO4	3	1
CO5	3	1

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.

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:

- T1 Introduction to Finite Elements in Engineering, T.R. Chandrupatla and A.D. Belegundu, PHI publications, 4th Edition, 2011.
- T2 A First Course in the Finite Element Method, Daryl L. Logan, Cengage Learning India Private Limited, 6th edition, 2017.

Reference Books:

- R1 An Introduction to the Finite Element Method, J.N. Reddy, McGraw Hill Education, 4th Edition, 2020.
- R2 Concepts and Applications of Finite Element Analysis, Cook et al, Wiley Publications, 4th edition, 2007.

Weblinks:

- W1 <https://nptel.ac.in/courses/112/104/112104193/>
- W2 <https://nptel.ac.in/courses/112/104/112104205/>

MECHANICAL VIBRATIONS (Professional Elective – II)

Semester: VI

Course Code:231ME6E01

L	T	P	C
3	0	0	3

CO1: Describe the fundamental concepts of vibrational analysis**CO2:** Interpret the concepts of free and forced multi-degree-of-freedom systems**CO3:** Summarize the concepts of torsional vibrations**CO4:** Solve the problems on critical speed of shafts**CO5:** Apply and analyse the systems subjected to Laplace transformations response to different inputs**Course Outcomes: At the end of the Course, Student will be able to:****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	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

Unit - I**Fundamentals of Vibrational Analysis and Single-Degree-of-Freedom Systems:**

Relevance of and need for vibrational analysis – Basics of SHM - Mathematical modelling of vibrating systems - Discrete and continuous systems - single-degree freedom systems - free and forced vibrations, damped and undamped systems.

Unit -II**Analysis of Multi-Degree-of-Freedom Systems:**

Free and forced vibrations of multi-degree freedom systems in longitudinal, torsional and lateral modes - Matrix methods of solution- normal modes - Orthogonality principle-Energy methods, Eigen values and Eigen vectors, modal analysis.

Unit – III**Vibrations of Continuous Systems:**

Torsional vibrations - Longitudinal vibration of rods - transverse vibrations of beams – Governing equations of motion - Natural frequencies and normal modes - Energy methods, Introduction to non-linear and random vibrations

Unit – IV**Vibration Measuring Instruments and Critical Speeds of Shafts:**

Vibrometers, Accelerometer, Frequency measuring instruments and Problems. Critical speed of a light shaft having a single disc without damping and with damping, critical speeds of shaft having multiple discs, secondary critical speed, critical speeds light cantilever shaft with a large heavy disc at its end.

Unit – V**Laplace Transform Methods and Phase Plane Analysis:**

Laplace transformations response to an impulsive input, response to a step input, response to pulse(rectangular and half sinusoidal pulse), phase plane method

Text Books:

- T1** Mechanical Vibrations , S.S.Rao, Prentice Hall, 5th Edition, , 2011.
- T2** Elements of vibration Analysis, L.Meirovitch, McGraw-Hill, 2nd Edition, New York, 1985.

Reference Books:

- R1** W.T. Thomson, M.D. Dahleh, and C. Padmanabhan, “Theory of Vibration with Applications” 5th Edition,Pearson Education, 2008.
- R2** M.L.Munjal, “Noise and Vibration Control” World Scientific, 2013.
- R3** Beranek and Ver, “Noise and Vibration Control Engineering: Principles and Applications” JohnWiley and Sons, 2006.
- R4** Randall F. Barron, “Industrial Noise Control and Acoustics” Marcel Dekker, Inc., 2003.

Weblinks:

- W1** <https://archive.nptel.ac.in/courses/112/103/112103111/>
- W2** <https://ocw.mit.edu/courses/2-003sc-engineering-dynamics-fall-2011/pages/mechanical-vibration/>

ADVANCED MANUFACTURING PROCESSES (Professional Elective – II)

Semester: VI

Course Code: 231ME6E02

L	T	P	C
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:** Describe 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
CO1	3	-	-	-	1	2	-	-	-	-	-	1
CO2	3	-	-	-	1	2	-	-	-	-	-	1
CO3	3	-	-	-	1	2	-	-	-	-	-	1
CO4	3	-	-	-		2	-	-	-	-	-	1
CO5	3	-	-	-	1	2	-	-	-	-	-	1

Mapping Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	2	-
CO2	2	-
CO3	2	-
CO4	2	-
CO5	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:

- T1** Manufacturing Engineering and Technology, Serope Kalpakjian and Steven R. Schmid, Pearson Education, 8th Edition, 2023.
- T2** Process and Materials of Manufacturing, R. A. Lindburg, Prentice Hall India Learning Private Limited, 4th Edition, 1990.

Reference Books:

- R1** Advanced Machining Processes, V. K. Jain, Allied Publications, 2002.
- R2** Introduction to Nanoscience and Nano Technology, K. K. Chattopadhyay & A. N. Banerjee, PHI Learning, 2009.
- R3** MEMS & Micro Systems Design and Manufacture, Tai Run Hsu, McGraw Hill Education, 1st edition, 2017.
- R4** Introduction to Manufacturing Processes, John A Schey, McGraw-Hill Education, 3rd edition, 1999.

Weblinks:

- W1** <https://archive.nptel.ac.in/courses/112/107/112107077/> .
- W2** <https://archive.nptel.ac.in/courses/112/103/112103306/>
- W3** <https://archive.nptel.ac.in/courses/112/105/112105053/>

MICRO ELECTRO MECHANICAL SYSTEMS (Professional Elective – II)

Semester: VI

Course Code: 231ME6E03

L	T	P	C
3	0	0	3

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

- CO1:** Discuss basics of Micro Electromechanical Systems (MEMS), mechanical sensors and actuators.
- CO2:** Illustrate thermal sensors and actuators used in MEMS.
- CO3:** Apply the principle and various devices of Micro-Opto-Electromechanical Systems (MOEMS), magnetic sensors and actuators.
- CO4:** Analyse applications and considerations on micro fluidic systems.
- CO5:** Illustrate the principles of chemical and biomedical micro systems.

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	-	-	-	-	-	-	-	-	-
CO2	2	2	1	-	-	-	-	-	-	-	-	-
CO3	2	2	1	-	-	-	-	-	-	-	-	-
CO4	2	2	1	-	-	-	-	-	-	-	-	-
CO5	2	2	1	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	1
CO2	-	1
CO3	-	1
CO4	-	1
CO5	-	1

Unit – I

Introduction: Definition of MEMS, MEMS history and development, micromachining, lithography principles & methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micromachining, wafer bonding, LIGA.

Mechanical Sensors and Actuators: Principles of sensing and actuation: beam and cantilever, capacitive, piezo-electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inch worm technology.

Unit – II

Thermal Sensors and Actuators: Thermal energy basics and heat transfer processes, thermistors, thermo devices, thermo couple, micro machined thermo couple probe, Peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA), U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.

Unit – III

Micro-Opto-Electromechanical Systems: Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light

detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement.

Magnetic Sensors and Actuators: Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on-high effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, mag MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe-based storage device.

Unit – IV

Micro Fluidic Systems: Applications, considerations on micro scale fluid, fluid actuation methods, Di electrophoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, Opto electro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, micro fluid dispenser, micro needle, molecular gate, micro pumps. RADIOFREQUENCY (RF) MEMS: RF – based communication systems, RF MEMS, MEMS inductors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter.

Unit – V

Chemical and Biomedical Micro Systems: Sensing mechanism & principle, membrane-transducer materials, chem.-lab-on-a-chip (CLOC) chemo-resistors, chemo-capacitors, chemo-transistors, electronic nose (E-nose), mass sensitive chemo-sensors, fluorescence detection, calorimetric spectroscopy.

Text Books:

- T1** MEMS, Nitaigour Prem Chand Mahalik, Tata McGraw Hill Publishing Company, New Delhi, 2007 ISBN (978-0-07-063445-9)
- T2** MEMS and Microsystems Design and Manufacture, Tai Ran Hsu, Tata McGraw Hill Publishing Company, New Delhi, 2002.

Reference Books:

- R1** Micromechanical transducers: Pressure sensors, accelerometers, and gyroscopes, M.H. Bao, Elsevier, New York, 2000.
- R2** Micro and Smart Systems, G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre, Wiley India, 1st Edition, 2010
- R3** Foundation of MEMS, Chang Liu, Pearson Education, 2016 ISBN (978-81-317-6475-6)

Weblinks:

- W1** <https://nptel.ac.in/courses/117105082>
- W2** https://onlinecourses.nptel.ac.in/noc20_me93/preview

SENSORS AND INSTRUMENTATION (Professional Elective – II)

Semester: VI**Course Code: 231ME6E04**

L	T	P	C
3	0	0	3

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

CO1: Explain measurement principles, types of errors, and sensor calibration methods.

CO2: Classify and describe proximity, position, and ranging sensors.

CO3: Explain force, magnetic, and orientation sensors and their applications.

CO4: Compare optical, pressure, temperature, acoustic, and tactile sensors.

CO5: Design signal conditioning DAQ systems for monitoring.

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	3	2	-	-	-	-	-	-	-	-	-	1
CO2	3	2	2	1	-	-	-	-	-	-	-	1
CO3	3	2		1	-	-	-	-	-	-	-	1
CO4	3	2		1	1	1	1	-	-	-	-	1
CO5	3	2	2	1	1	1	1	-	1	1	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	2	1
CO2	2	2
CO3	2	2
CO4	2	2
CO5	3	3

UNIT I

Introduction

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT II

Motion, Proximity and Ranging Sensors

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III

Force, Magnetic and Heading Sensors

Strain Gauge, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT IV

Optical, Pressure and Temperature Sensors

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT V**Signal Conditioning and Daq Systems**

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

Text Books:

- T1** Ernest O Doebelin, “Measurement Systems – Applications and Design”, Tata McGraw-Hill, 2009.
- T2** Sawney A K and Puneet Sawney, “A Course in Mechanical Measurements and Instrumentation and Control”, Dhanpat Rai & Co, 12th edition New Delhi, 2013.

Reference Books:

- R1** C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.
- R2** Hans Kurt Tönshoff (Editor), Ichiro, “Sensors in Manufacturing” Volume 1, Wiley-VCH April 2001.
- R3** Hans Kurt Tönshoff (Editor), Ichiro, “Sensors in Manufacturing” Volume 1, Wiley-VCH April 2001.
- R4** Patranabis D, “Sensors and Transducers”, 2nd Edition, PHI, New Delhi, 2011.
- R5** Richard Zurawski, “Industrial Communication Technology Handbook” 2nd edition, CRC Press, 2015.

Weblinks:

- W1** nptel.ac.in/courses/108108147
- W2** nptel.ac.in/courses/115107122
- W3** nptel.ac.in/courses/108105064

ENERGY STORAGE TECHNOLOGIES (Professional Elective – III)

Semester: VI**Course Code: 231ME6E05**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:**CO1:** Explain the importance of energy storage systems**CO2:** Explain the chemical and electromagnetic storage systems**CO3:** Explain the principles of electrochemical storage systems**CO4:** Explain the working of super capacitors and fuel cells**CO5:** Design the batteries for transportation**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	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	1	-	-	-	-	-	-	-	-	-	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	3
CO2	-	3
CO3	-	2
CO4	-	2
CO5	-	3

Unit - I

Energy storage systems overview: Scope of energy storage, needs and opportunities in energy storage, Technology overview and key disciplines, comparison of time scale of storages and applications, Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles

Unit -II

Chemical storage system: Hydrogen, Methane, concept of chemical storage of solar energy, application of chemical energy storage system, advantages and limitations of chemical energy storage, challenges, and prospects of chemical storage systems.

Unit - III

Electrochemical storage system: Batteries-Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods, major battery chemistries and their voltages- Li-ion battery& Metal hydride battery vs lead-acid battery

Unit – IV

Super capacitors: 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.

Fuel cell- Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-super capacitor systems.

Unit – V

Battery design for transportation, Mechanical Design and Packaging of Battery Packs for Electric Vehicles, Advanced Battery, Assisted Quick Charger for Electric Vehicles, Charging Optimization Methods for Lithium-Ion Batteries, Thermal run-away for battery systems, Thermal management of battery systems, Recycling of Batteries from Electric Vehicles.

Text Books:

- T1** Frank S. Barnes and Jonah G. Levine, Large Energy Storage Systems Handbook (Mechanical and Aerospace Engineering Series), CRC press (2011)
T2 Ralph Zito, Energy storage: A new approach, Wiley (2010)

Reference Books:

- R1** Pistoia, Gianfranco, and Boryann Liaw. Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost. Springer International Publishing AG, 2018.
R2 Robert A. Huggins, Energy storage, Springer Science & Business Media (2010)

Weblinks:

- W1** https://onlinecourses.nptel.ac.in/noc21_mm34/preview
W2 <https://archive.nptel.ac.in/courses/113/105/113105102/>

INDUSTRIAL HYDRAULICS AND PNEUMATICS

(Professional Elective – III)

Semester: VI

Course Code: 231ME6E06

L	T	P	C
3	0	0	3

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

- CO1: Explain** the laws of fluid flow and properties of hydraulic and pneumatic fluids used in fluid power systems.
- CO2: Compare** the construction, working, and specifications of various hydraulic and pneumatic elements.
- CO3: Design** basic hydraulic and pneumatic circuits using ISO symbols and appropriate logic.
- CO4: Evaluate** the working of hydraulic and pneumatic devices used in automotive and industrial applications
- CO5: Apply** maintenance procedures and **analyse** troubleshooting techniques for hydraulic and pneumatic systems.

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	3		-	-	-	-	-	-		1	-	-
CO2	2	2	-	-	-	-	-	-		1	-	-
CO3		2	3	2	2	-	-	-	2	1	-	-
CO4	2		2			-	-	-	2	1	-	-
CO5	1	2		2		-	-	-	2	2	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	2	1
CO2	3	2
CO3	3	1
CO4	3	3
CO5	3	3

Unit– I

Fluid Power: Power transmission modes, hydraulic systems, pneumatic systems, laws governing fluid flow: Pascal's law, continuity equation, Bernoulli's theorem, Boyle's, Charles', Gay-Lussec' laws, flow through pipes - types, pressure drop in pipes, Working fluids used in hydraulic and pneumatic systems- types, ISO/BIS standards and designations, properties.

Unit– II

Hydraulic and Pneumatic Elements: Hydraulic pipes-Types, standards, designation methods and specifications, pressure ratings, applications and selection criteria, pumping theory, Hydraulic Pumps - types, construction, working principle, applications, selection criteria and comparison, hydraulic Actuators, Control valves, Accessories - their types, construction and working, pneumatic Pipes - materials, designations, standards, properties and piping layout, air compressors, Air receivers, air dryers, Air Filters, Regulators, Lubricators (FRL unit): their types, construction, working, specifications and selection criteria of following air preparation and conditioning elements, pneumatic Actuators and Control valves - types, construction, working, materials and specifications

Unit– III

Hydraulic and Pneumatic Circuits:

ISO symbols used in hydraulic and pneumatic circuit, basic Hydraulic Circuits – types (such as intensifier, regenerative, synchronizing, sequencing, speed control, safety), circuit diagram, components, working and applications, basic Pneumatic Circuits – types (such as speed control, two

step feed control, automatic cylinder reciprocation, time delay, quick exhaust), circuit diagram, components, working and applications, pneumatic Logic circuit design - classic method, cascade method, step counter method, Karnaugh- veitch maps and combinational circuit design.

Unit– IV

Hydraulic and Pneumatic Devices:

Hydraulic and Pneumatic devices – Concept and applications, construction, working principle, major elements, performance variables of: Automotive hydraulic brake, Industrial Fork lift, Hydraulic jack, Hydraulic press, Automotive power steering, Automotive pneumatic brake, Automotive air suspension, Pneumatic drill, Pneumatic gun.

Unit– V

Installation, Maintenance and Trouble-Shooting:

Installation of hydraulic and pneumatic system causes and remedies for common troubles arising in hydraulic elements, maintenance of hydraulic systems, causes and remedies for troubles arising in pneumatic elements, maintenance of pneumatic systems.

Text Books:

- T1** Majumdar, S.R. Oil Hydraulic Systems Tata McGraw-Hill Publication, New Delhi, 3/e, 2013
- T2** Majumdar, S.R. Pneumatic Systems Tata McGraw-Hill Publication, New Delhi, 3/e, 2013

Reference Books:

- R1** Srinivasan, R. Hydraulic and Pneumatic Controls Vijay Nicole Imprints Private, New Delhi, Limited, 2/e, 2008.
- R2** Jagadeesha, T. Fluid Power Generation, Transmission and Control Universities Press (India) Private Limited, New Delhi, 1/e, 2014

Weblinks:

- W1** <https://archive.nptel.ac.in/courses/112/105/112105047/>
- W2** <http://acl.digimat.in/nptel/courses/video/112105423/L42.html>

INDUSTRIAL ROBOTICS

(Professional Elective – III)

Semester: VI

Course Code:231ME6E07

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 components, types, and configurations of industrial robots.
- CO2** Develop and analyse forward and inverse kinematic models of robotic manipulators.
- CO3** Analyse 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
CO1	3	2	-	-	2	-	-	-	-	-	-	-
CO2	3	3	3	2	3	-	-	-	-	-	-	-
CO3	3	3	3	3	3	-	-	-	-	-	-	-
CO4	2	2	3	2	3	-	-	-	-	-	-	-
CO5	2	2	3	-	3	-	-	-	-	-	-	-
CO6	2	2	3	-	3	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	3	-
CO2	3	2
CO3	3	3
CO4	3	3
CO5	2	3
CO6	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:

T1 Industrial Robotics / Groover M P /Mc Graw Hill

T2 Introduction to Industrial Robotics / Ramachandran Nagarajan / Pearson

Reference Books:

R1 Robot Dynamics and Controls / Spony and Vidyasagar / John Wiley

R2 Robot Analysis and control / Asada, Slotine / Wiley Inter-Science

Weblinks:

W1 https://onlinecourses.nptel.ac.in/noc23_me143/preview

W2 https://www.youtube.com/playlist?list=PLXDsvE7qtfNf_N99hJZbdTEM001mOii6_

REFRIGERATION AND AIR-CONDITIONING (Professional Elective – III)

Semester: VI

Course Code: 231ME6E08

L	T	P	C
3	0	0	3

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

- CO1:** Illustrate the principle and applications of air refrigeration system.
- CO2:** Analyse the cooling capacity and COP of vapour compression refrigeration systems.
- CO3:** Calculate COP of vapour absorption refrigeration system and steam jet refrigeration system and understand the properties refrigerants.
- CO4:** Solve cooling load for air conditioning systems and identify the requirements of comfort air conditioning.
- CO5:** Explain different components of refrigeration and air conditioning systems.

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	3	2	-	-	-	-	1	-	-	-	-	1
CO2	2	3	-	-	-	-	1	-	-	-	-	-
CO3	3	2	-	-	-	-	1	-	-	-	-	-
CO4	2	3	-	-	-	-	1	-	-	-	-	1
CO5	3	2	-	-	-	-	1	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	2
CO2	-	2
CO3	-	2
CO4	-	3
CO5	-	3

Unit – I

Introduction To Refrigeration: Necessity and applications, Unit of refrigeration and C.O.P. Mechanical refrigeration, Reversed Carnot cycle. Air refrigeration: Bell Coleman cycle - Open and Dense air systems, Refrigeration systems used in air crafts and its Problem.

Unit -II

Vapor Compression Refrigeration System & Components: Working principle and essential components of the plant, Simple Vapour Compression Refrigeration Cycle, COP, Representation of cycle on T-S and p-h charts, Effect of sub cooling and super heating, cycle analysis, Actual cycle influence of various parameters on system performance, use of p-h charts, numerical problems. Multi Stage Vapour Compression Refrigeration.

Unit - III

Refrigerants: Desirable properties, Classification, Refrigerants, Green Refrigerants, Nomenclature, Ozone Depletion, Global Warming.

Vapor Absorption System: Calculation of maximum COP, Description and Working of NH₃ – water system and Li Br – water (Two shell & Four shell) System, Principle and operation of three fluid absorption system.

Steam Jet Refrigeration System: Working Principle and basic components, principle and operation of thermoelectric refrigerator and vortex tube.

Unit - IV

Introduction to Air Conditioning: Psychometric properties & processes, Characterization of sensible and latent heat loads, Need for Ventilation, Consideration of Infiltration, load concepts of RSHP, GSHP- problems, concept of ESHF and ADP temperature.

Requirements of human comfort and concept of effective temperature- comfort chart –comfort air conditioning – requirements of industrial air-conditioning, air-conditioning load calculations.

Unit – V

Air Conditioning Systems: Classification of equipment, cooling, heating humidification and dehumidification, filters, grills and registers, fans and blowers. heat pump, heat sources, different heat pump circuits.

Note: Refrigeration and Psychrometric tables and charts are allowed.

Text Books:

- T1** Refrigeration and Air-conditioning, Arora C.P., Tata Mc Graw –Hill, 4th edition, 2021. A Course in Refrigeration and Air conditioning / SC Arora & Domkundwar / Dhanpatrai.
- T2** Refrigeration and Air Conditioning, Khurmi R. S., S Chand, Revised edition, 2019.

Reference Books:

- R1** Refrigeration and Air Conditioning, Manohar Prasad, New Age International, Pvt Ltd, 3rd edition 2021.
- R2** Principles of Refrigeration /Dossat / Pearson Education.
- R3** Basic Refrigeration and Air-Conditioning / Ananthanarayanan / TMH.

Data Book:

- 1. Refrigerant and Psychrometric Properties - Tables and Charts [SI Units], Mathur, M. L., and Mehta, F. S., Jain Brothers

Weblinks:

- W1** <https://nptel.ac.in/courses/112105128>.
- W2** <https://www.udemy.com/course/water-cooler-dispenser-working-and-circuit-diagram/?couponCode=ST18MT170625G1>

BASIC CONCRETE TECHNOLOGY (Open Elective-II)

Semester: VI
Course Code: 231CE6001

L T P C
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
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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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

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:

T1 Concrete Technology: Theory and Practice, M.L. Gambhir, McGraw Hill, 5th Edition, 2017.

T2 Concrete Technology, M.S.Shetty, Chand Publication, 2006

Reference Books:

R1 Concrete Technology, A.M. Neville and J.J. Brooks, Pearson, 2019

R2 Concrete Technology, A.R. Santhakumar, Oxford, 2018.

Weblinks:

W1 <https://nptel.ac.in/courses/105102012>

W2 www.brighthubengineering.com › Concrete Technology

BASIC SURVEYING (Open Elective-II)

Semester: VI
Course Code: 231CE6002

L T P C
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
CO1	2	2	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	2	-	-	-	-	-
CO3	2	3	-	-	-	-	-	-	-	-	-
CO4	2	2	1	-	-	2	-	-	-	-	-
CO5	2	2	-	-	-	2	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO 2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

T1 B.C. Punmia, "Surveying Vol.1", Laxmi Publications pvt. Ltd., New Delhi –2017.

T2 Kanetkar T P and S V Kulkarni , Surveying and Leveling Part I, Pune VidyarthiGrihaPrakashan,2015

Reference Books:

R1 S.K. Duggal, "Surveying Vol.1", Tata McGraw Hill Publishing Co. Ltd. New Delhi.2019

R2 K.R. Arora, "Surveying Vol. 1" Standard Book House, New Delhi. –2017

Weblinks:

W1 nptel.iitm.ac.in

W2 <https://nptel.ac.in/courses/105/105/105105176>

REPAIR AND REHABILITATION OF STRUCTURES (Open Elective-II)

Semester: VI
Course Code:231CE6O03

L T P C
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
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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

- T1** Maintenance Repair Rehabilitation & Minor works of Buildings - P.C.Varghese, PHI Publications
- T2** Repair and Rehabilitation of Concrete Structures— P.I.Modi,C.N.Patel,PHI Publications

Reference Books:

- R1** Concrete Technology Theory and Practice-M.S.Shetty,SChandand Company
- R2** Concrete Repair and Maintenance illustrated-PeterHEmmons

Weblinks:

- W1** https://www.academia.edu/30633495/Repair_and_Rehabilitation_of_Structures
- W2** <https://www.vidyarthiplus.com/vp/Thread-CE2071-Repair-and-Rehabilitation-of-Structures-Lecture-Notes>

FUNDAMENTALS OF ELECTRIC VEHICLES (OPEN ELECTIVE-II)

Semester: VI**Course Code:231EE6O01**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, students 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 a suitable electric motor for EV power train
- CO4** Design HEV configuration for a specific application.
- CO5** Analyze various storage systems and battery management systems 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
CO1	3	2	2	-	1	-	-	-	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	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

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:

- T1** Iqbal Hussein - Electric and Hybrid Vehicles: Design Fundamentals - CRC Press - 2021.
T2 [Tom Denton](#), [Hayley Pells](#) - Electric and hybrid vehicles, Third Edition, 2024

Reference Books:

- R1** Kumar - L. Ashok - and S. Albert Alexander. Power Converters for Electric Vehicles. CRC Press - 2020.
R2 Chau - Kwok Tong. Electric vehicle machines and drives: design - analysis and application. John Wiley & Sons - 2015.

Weblinks:

- W1** MOOC at <https://www.edx.org/learn/electric-cars>
W2 <https://archive.nptel.ac.in/courses/108/106/108106170>

ELECTRICAL WIRING ESTIMATION AND COSTING (OPEN ELECTIVE-II)

Semester: VI

L T P C

Course Code: 231EE6002

3 0 0 3

Course Outcomes:**At the end of the course, students 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	PO12
CO1	3	1	1	-	-	1	-	-	-	-	-	1
CO2	2	3	1	-	-	1	-	-	-	-	-	1
CO3	2	2	3	-	-	1	-	-	-	-	-	1
CO4	3	1	1	-	-	1	-	-	-	-	-	1
CO5	2	2	3	-	-	1	-	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

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:

T1 Electrical Design and Estimation Costing - K. B. Raina and S.K.Bhattacharya – New Age International Publishers - 2007

Reference Books:

R1 Electrical wiring estimating and costing – S.L.Uppal and G.C.Garg – Khanna publishers - 6th edition – 1987.

R2 A course in electrical installation estimating and costing – J.B.Gupta – Kataria SK & Sons - 2013.

Weblinks:

W1 https://onlinecourses.swayam2.ac.in/nou25_ec07/preview

W2 https://onlinecourses.swayam2.ac.in/nou25_ec07/preview

INTRODUCTION TO INDUSTRIAL ROBOTICS (OPEN ELECTIVE-II)

Semester: VI
Course Code: 231ME6001

L	T	P	C
3	0	0	3

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
CO1:	3	2	-	-	2	-	-	-	-	-	-	-
CO2:	3	3	3	2	3	-	-	-	-	--	-	-
CO3:	3	3	3	3	3	-	-	-	-	-	-	-
CO4:	2	2	3	2	3	-	-	-	-	-	-	-
CO5:	2	2	3	-	3	-	-	-	-	-	-	-
CO6:	2	2	3	-	3	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-
CO6:	-	-

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:

T1 Industrial Robotics / Groover M P /Mc Graw Hill

T2 Introduction to Industrial Robotics / Ramachandran Nagarajan / Pearson

Reference Books:

R1 Robot Dynamics and Controls / Spony and Vidyasagar / John Wiley

R2 Robot Analysis and control / Asada, Slotine / Wiley Inter-Science

Weblinks:

W1 https://onlinecourses.nptel.ac.in/noc23_me143/preview

W2 https://www.youtube.com/playlist?list=PLXDsvE7qtfNf_N99hJZbdTEM001mOii6

INDUSTRIAL MANAGEMENT (OPEN ELECTIVE-II)

Semester: VI**Course Code: 231ME6002**

L	T	P	C
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
CO1:	-		-	-	-	1	-	2	1	-	-	2
CO2:	2	1	-	-	-		-	-	2	-	-	2
CO3:	3		-	-	-	1	-	-	-	-	-	2
CO4:	-		-	-	-	1	-	2	-	-	-	2
CO5:	-	1	-	-	-	1	-	2	2	-	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

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:

- T1** Industrial Engineering and Production Management, Mart and Telsang, S. Chand & Company Ltd. New Delhi.
- T2** Industrial Engineering and Management, O.P Khanna, Dhanpat Rai Publications (P) Ltd, 2018.

Reference Books:

- R1** Industrial Engineering and Management Science, T. R. Banga, S. C. Sharma, N. K. Agarwal, Khanna Publishers, 12th Edition
- R2** Operations Management, J.G Monks, McGraw Hill Publishers, 3rd edition.
- R3** Principles of Management, Koontz O' Donnell, McGraw Hill Publishers, 4edition.
- R4** Industrial Management, Bhattacharya DK, S. Chand, publishers.

Weblinks:

- W1** https://onlinecourses.nptel.ac.in/noc20_mg43/preview
- W2** https://onlinecourses.nptel.ac.in/noc24_me15/preview

ADDITIVE MANUFACTURING (OPEN ELECTIVE-II)

Semester: VI**Course Code: 231ME6003**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:**CO1:** Demonstrate an 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
CO1:	3	2		1	2	-		-	-	-	-	
CO2:	3	1		1	2	-		-	-	-	-	
CO3:	3	1		1	2	-		-	-	-	-	
CO4:	3	1		1		-		-	-	-	-	
CO5:	3	2				-	3	-	-	-	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

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:

- T1** “Rapid prototyping: Principles and applications”, Chua, C.K., Leong K.F. and Lim C.S., Third edition, World Scientific Publishers, 2010.
- T2** “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Gibson, I., Rosen, D.W. and Stucker, BSpringer, 2015.

Reference Books:

- R1** Additive Manufacturing: A Tool for Industrial Revolution 4.0, M. Manjaiah, K. Raghavendra, N. Balashanmugam, J. Paulo Davim, Woodhead Publishing, Elsevier, 2021
- R2** “Additive Manufacturing: Principles, Technologies and Applications , C.P Paul, A.N Junoop, Second Edition, McGrawHill, 2021.
- R3** Additive Manufacturing, Second Edition, Amit Bandyopadhyay Susmita Bose, CRC Press Taylor & Francis Group, 2020.
- R4** Rapid Tooling: Technologies and Industrial Applications, Hilton, P.D. and Jacobs, P.F., CRC Press, 2000

Weblinks:

- W1** <https://www.nist.gov/additive-manufacturing>
- W2** <https://archive.nptel.ac.in/courses/112/103/112103306/>
- W3** <https://www.open.edu/openlearn/science-maths-technology/additive-manufacturing/content-section-0?active-tab=description-tab>

VEHICLE TECHNOLOGY (OPEN ELECTIVE-II)

Semester: VI**Course Code: 231ME6004**

L	T	P	C
3	0	0	3

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 footprint on the environment.**CO3:** Analyzing the basic characteristics of low carbon fuels, its impact over conventional fuels and achieving sustainable development goals.**CO4:** Discuss the work 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
CO1:	3	2	-	-	-	-	-	-	-	-	-	-
CO2:	3	2	-	-	-	-	-	-	-	-	-	-
CO3:	2	2	-	-	-	-	-	-	-	-	-	-
CO4:	3	2	-	-	-	-	-	-	-	-	-	-
CO5:	3	2	-	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

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:

- T1** Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
- T2** Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines. ISBN 978-3-319-68507-6 , SPRINGER

Reference Books:

- R1** Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
- R2** James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
- R3** Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998
- R4** Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

Weblinks:

- W1** https://onlinecourses.nptel.ac.in/noc20_ee18/preview
- W2** <https://nptel.ac.in/courses/108106170>

INDUSTRIAL SAFETY (OPEN ELECTIVE-II)

Semester: VI**Course Code: 231ME6005**

L	T	P	C
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 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
CO1:	2	-	-	-	1	3	1	1	2	1	-	
CO2:	2	-	-	-	1	1	2	1	2	2	-	
CO3:	2	-	-	-	3	3	2	1	2	3	-	1
CO4:	2	-	-	-	2	2	2	1	2	1	-	
CO5:	2	-	-	-	2	2	2	1	2	1	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

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.

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:

- T1** Industrial Maintenance Management Srivastava, S.K.-S. Chand and Co.
- T2** Occupational Safety Management and Engineering Willie Hammer–Prentice Hall
- T3** Purandare D.D & Abhay D. Purandare, “Hand book on Industrial Fire Safety” P & A publications, New Delhi, 2006
- T4** McElroy, Frank E., “Accident Prevention Manual for Industrial Operations”, NSC, Chicago, 1988
- T5** Green, A.E., “High Risk Safety Technology”, John Wiley and Sons, 1984.

Reference Books:

- R1** Installation, Servicing and Maintenance Bhattacharya, S.N.-S. Chand and Co.
- R2** Jain VK “Fire Safety in Building” New Age International 1996.
- R3** Reliability, Maintenance and Safety Engineering by Dr. A. K. Gupta
- R4** A Text book of Reliability and Maintenance Engineering by Alakesh Manna

Web links:

- W1** <https://nptel.ac.in/courses/110105094>
- W2** https://onlinecourses.swayam2.ac.in/nou23_ge81/preview
- W3** <https://www.youtube.com/watch?v=jFDWIKayrTc>

PRINCIPLES OF COMMUNICATIONS (Open Elective-II)

Semester: VI
Course Code: 231EC6001

L	T	P	C
3	0	0	3

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:** Analyse 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	PSO1	PSO2
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), Amplitude Modulation: Introduction to Amplitude Modulation (AM), Double Sideband Suppressed Carrier ((DSB-SC) Modulation, Introduction to Single Sideband (SSB) Modulation and VSB modulation.

Unit – II

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 – III

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.

Unit – IV

Pulse Digital Modulation: Elements of digital communication systems, advantages of digital communication systems, Elements of PCM: Sampling, Quantization and coding, Quantization error, companding in PCM systems. Differential PCM Systems (DPCM).

Delta Modulation: Delta Modulation, its drawbacks, adaptive delta modulation, comparison of PCM and delta and adaptive delta modulation, noise in PCM and DM systems.

Unit – V

Digital Modulation Techniques: Introduction, BPSK, DPSK, DEPSK, QPSK, M-ary PSK, ASK, QASK, BFSK, M-ary FSK, MSK, Duobinary Encoding, Comparison of digital modulation techniques, Partial response signalling.

Text Books:

T1 Principles of Communication Systems, H Taub, D L Schilling, Gautam Sahe, TMH, 4th Edition, 2017

Communication Systems – B. P. Lathi, BS Publication, 2006

T2

Reference Books:

R1 Principles of Communication Systems - Simon Haykin, John Wiley, 2nd Edition.

R2 Electronics & Communication System – George Kennedy and Bernard Davis, TMH 2004.

Weblinks:

W1 <https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ee08/>, Principles of Communication Systems-I, Prof. Aditya K. Jagannatham, IIT Kanpur.

W2 https://onlinecourses.nptel.ac.in/noc21_ee74/preview, Analog Communication, Prof. Goutam Das, IIT Kharagpur.

BIOMEDICAL ENGINEERING (Open Elective-II)

Semester: VI
Course Code: 231EC6002

L T P C
3 0 0 3

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 the 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:**Text Books:**

- T1** Bio-Medical Instrumentation Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, 2nd edition, PHI, 2011
- T2** Introduction to Bio-Medical Equipment Technology - Joseph J. Carr, John M. Brown, 4th edition, Pearson Publications, 2012.

Reference Books:

- R1** Handbook of Bio-Medical Instrumentation, Khandapur, R.S., McGrawHill, 2nd edition, 2003.
- R2** Medical Instrumentation Application and design, John G. Webster, Wiley India Edition, 2009.

Weblinks:

- W1** https://onlinecourses.nptel.ac.in/noc21_ee17/preview, IIT Kharagpur, By Prof. Sudipta Mukhopadhyay
- W2** <https://www.electrical4u.com/introduction-to-biomedical-instrumentation/>

ECAD TOOLS (Open Elective-II)

Semester: VI
Course Code: 231EC6003

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:

T1 Circuit analysis with PSPICE, Nassir H. Sabah, 2017.

T2 MATLAB and Simulink, Adrian B. Biran, CRC press Taylor& Francis group.

Reference Books:

R1 Electronics Circuits and Systems, Owen Bishop, 4th edition, 2011.

R2 MATLAB for Electrical and computer engineering, Roland Priemer, 2013.

Weblinks:

W1 <https://www.mccormick.northwestern.edu/documents/students/undergraduate/introduction-to-matlab.pdf>

W2 <https://vdocument.in/orcad-pspice-course-material.html>

WEB TECHNOLOGIES (Open Elective-II)

Semester: VI**Course Code: 231CS6O01**

L	T	P	C
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:

- T1** Programming the World Wide Web, 7th Edition, Robert W Sebesta, Pearson.
- T2** Pro Mean Stack Development, 1st Edition, Elad Elrom, Apress O'Reilly.

Reference Books:

- R1** Web Technologies, HTML, JavaScript, PHP, Java, JSP, XML and AJAX, Black book, 1st Edition, Dream Tech.
- R2** An Introduction to Web Design, Programming, 1st Edition, Paul S Wang, Sanda S Katila, Cengage Learning

Weblinks:

- W1** <https://www.w3schools.com/> (html, css, js, xml, nodejs, angular, react, php)
- W2** <https://www.angular.io/docs>

INTRODUCTION TO DATA SCIENCE (Open Elective-II)

Semester: VI
Course Code: 231DS6001

L T P C
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 for 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, Data Frame, 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, 1st 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

Weblinks:

- W1** <https://www.geeksforgeeks.org/how-to-become-a-data-analyst-complete-roadmap/>
- W2** https://en.m.wikipedia.org/wiki/Data_Science_and_Predictive_Analytics

OPERATING SYSTEMS

(Open Elective-II)

Semester: VI**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
CO1:	2	-	-	-	-	-	-	-	-	-	-	-
CO2:	1	3	-	-	-	-	-	-	-	-	-	-
CO3:	1	2	-	-	-	-	-	-	-	-	-	-
CO4:	1	3	-	-	-	-	-	-	-	-	-	-
CO5:	2	2	-	-	-	-	-	-	1	1	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
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, 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:

T1 Operating System Concepts, Silberschatz A, GalvinPB, GagneG, 10th Edition, Wiley, 2018

T2 Modern Operating Systems, Tanenbaum AS, 4th Edition, Pearson, 2016

Reference Books:

R1 Operating Systems -Internals and Design Principles, Stallings W, 9th edition, Pearson, 2018

R2 Operating Systems: A Concept Based Approach, D. M Dhamdhare, 3rd Edition, McGraw- Hill, 2013

Weblinks:

W1 <https://archive.nptel.ac.in/courses/106/105/106105214/>

W2 <https://www.coursera.org/specializations/codio-introduction-operating-systems>

COMPUTER ORGANIZATION ARCHITECTURE

(Open Elective-II)

Semester: VI

Course Code: 231AM6O01

L	T	P	C
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	2	-	-	-	-	-	-	-
CO2	2	1	-	-	2	-	-	-	-	-	-	-
CO3	3	1	-	-	2	-	-	-	-	-	-	-
CO4	2	1	-	-	2	-	-	-	-	-	-	-
CO5	3	2	-	-	3	-	-	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

CO / PSO	PSO 1	PSO 2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

T1 Computer System Architecture, M. Morris Mano, Third Edition, Pearson, 2008.

T2 Computer Organization, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, 5/e, McGraw Hill

Reference Books:

R1 Computer Organization and Architecture, William Stallings, 6/e, Pearson, 2006.

R2 Structured Computer Organization, Andrew S. Tanenbaum, 4/e, Pearson, 2005.

Weblinks:

W1 <https://nptel.ac.in/courses/106/105/106105163/>

W2 <https://nptel.ac.in/courses/106/106/106106092/>

INTRODUCTION TO DRILLING TECHNOLOGY (OPEN ELECTIVE – II)

Semester: VI**Course Code: 231PT6O01**

L	T	P	C
3	0	0	3

Course Outcomes:

- 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.
 CO5: 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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

T1 Petroleum Engineering: Drilling and Well Completion, Carl Gatlin, Prentice-Hall, Inc., 1960.

T2 . Drilling Engineering, J.J. Azar and G.Robello Samuel, PennWell Books, 2007

Reference Books:

R1 Oil Well Drilling Engineering: Principles and Practice, H. Rabia, Graham & Trotman, 1985

R2 Drilling Engineering: A Complete Well Planning Approach, Neal Adams, Tommie Charrier Pennwell, 1985.

Weblinks:

W1 <https://nptel.ac.in/courses/106/105/106105163/>

W2 <https://nptel.ac.in/courses/106/106/106106092/>

INTRODUCTION TO WELL COMPLETIONS (OPEN ELECTIVE-II)

Semester: VI**Course Code: 231PT6O02**

L	T	P	C
3	0	0	3

Course Outcomes:**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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

T1 Well Completion and Servicing, D. Perrin, Micheal Caron, Georges Gaillot, Editions Technip, 1999.

T2 Primer of Well Service, Workover and Completion, Petroleum Extension Service (PETEX), University of Texas at Austin, 1997

Reference Books:

R1 Well Completion Design, Jonathan Bellarby, Elsevier, 2009.

R2 Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman, Inc., 1986

Weblinks:

W1 <https://nptel.ac.in/courses/106/105/106105163/>

W2 <https://nptel.ac.in/courses/106/105/106105146/>

INTRODUCTION TO PETROLEUM PRODUCTION ENGINEERING (OPEN ELECTIVE – II)

Semester: VI**Course Code: 231PT6O03****Course Outcomes:**

L	T	P	C
3	0	0	3

- 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
 CO5: 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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

- T1** Petroleum Production Engineering: A computer Assisted Approach, Boyun Guo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books, 2007. 2. Petroleum.
- T2** Production Systems, M. J. Economides, A. Daniel Hill & C. E. Economides, Prentice- Hall, N. J – 07488, 1994

Reference Books:

- R1** Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.
- R2** The Technology of Artificial Lift Method, Brown, K.E., Volume 1, PennWell Books, 1977.

Weblinks:

- W1** <https://nptel.ac.in/courses/106/105/106105163>
- W2** <https://nptel.ac.in/courses/106/105/106105263>

MINERAL ECONOMICS**(OPEN ELECTIVE – II)****Semester: VI****Course Code: 231MI6O01****L T P C****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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
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

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:

T1 Alwyn E. Annels, Mineral Deposit Evaluation: A Practical Approach, Chapman Hall, 1991

T2 1) Deshmukh R.T. Mine and Mineral Economics, Emdee Publishers, 1986.

Reference Books:

R1 Sloan, D.A., Mine Management, Chapman and Hall, London, 1983

R2 1) Chatterjee, K.K., Mineral economics, Wiley Eastern, 1992.

Weblinks:

W1 <https://pubs.usgs.gov/circ/1953/0231/report.pdf>

W2 <https://www.min.int/impact/whatis.shtml>

LANDSLIDES & SLOPE STABILITY ENGINEERING (OPEN ELECTIVE – II)

Semester: VI
Course Code: 231MI6O02

L T P C
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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
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

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:

T1 Hoek, E. and Bray, J.W; Rock Slope Engineering; John Wiley & Sons; New York; 1984

T2 Brawner, C.O; Stability in surface mining, SME of USA; New York, 1982.

Reference Books:

R1 Giani, F; Rock Slope Stability Analysis; Balkema; Rotterdam; 1992

R2 Fundamentals and applications of rock mechanics, Deb.D and Verma A.K, PHI Publications

Weblinks:

W1 <http://www.rocsience.com/learning/resource-library/books-by-r-e-goodman>

W2 <http://www.sciencedirect.com/topics/earth-and-planetary-sciences/rock-mechanics>

REMOTE SENSING AND GIS (OPEN ELECTIVE – II)

Semester: VI
Course Code: 231MI6O03

L T P C
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.

Text Books:

- T1** Remote Sensing and Image Interpretation, by Lillesand, T.M, R.W. Kiefer and J.W. Chipman, Wiley India Pvt. Ltd., (2015), 7th Edition
- T2** Remote Sensing - Models and Methods for Image Processing' by Robert A Schowenger, Elsevier publishers, (2009).

Reference Books:

- R1** Giani, F; Rock Slope Stability Analysis; Balkema; Rotterdam; 1992
- R2** Fundamentals and applications of rock mechanics, Deb.D and Verma A.K, PHI Publications

Weblinks:

- W1** <http://www.rocsience.com/learning/resource-library/books-by-r-e-goodman>
- W2** <http://www.sciencedirect.com/topics/earth-and-planetary-sciences/rock-mechanics>

GEOSTATISTICS (OPEN ELECTIVE – II)

Semester: VI
Course Code: 231MI6O04

L T P C
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
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

- T1** Sarma DD. Geo statistics with applications in earth sciences. Springer publications. 2009
- T2** Remote Sensing - Models and Methods for Image Processing' by Robert A Schowenger, Elsevier publishers, (2009).

Reference Books:

- R1** Journel AG and Huijbregts C J. Mining geo statistics. Academic press. 1981
- R2** Andereson F. Geo statistics by example approach using R. 2006

Weblinks:

- W1** <https://pdfcoffee.com/surpac-tutorialpdf-pdf-free.html>
- W2** <https://baixardoc.com/documents/surpac-introduction-tutorial-system%20software-technology-5dbde76f19168>

ENGINEERING PROPERTIES OF AGRICULTURAL PRODUCE**(Open Elective-II)**

Semester: VI
Course Code: 231AG6O01

L **T** **P** **C**
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:

- T1** Physical properties of plant and animal materials, Mohsenin N N, Gordon and Breach Science Publishers, New York, 2nd edition, 1986.
- T2** 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:

- R1** Food and Process Engineering Technology, Wilhelm LR, Suler W A and Brusewitz, G H, American Society of Agricultural Engineers (ASAE), St. Joseph, MI.
- R2** Engineering Properties of Biological Materials, O.P. Singhal and D.V.K. Samuel, Saroj Prakashan, Allahabad, 1st edition, 2003.

Weblinks:

- W1** http://ecourses.iasri.res.in/email_authentication.aspx?Degree_Id=04
- W2** <http://ecoursesonline.iasri.res.in/course/view.php?id=25>

PLASTIC APPLICATIONS IN AGRICULTURE**(Open Elective-II)****Semester: VI**
Course Code: 231AG6O02**L**
3 **T**
0 **P**
0 **C**
3**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	2	-
CO2	2	-
CO3	2	-
CO4	-	2
CO5	1	-

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:

- T1** 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
- T2** Charles A. Harper. 2006. Handbook of Plastics Technologies. The Complete Guide to Properties and Performance. McGraw-Hill, New Delhi

Reference Books:

- R1** Brahma Singh, Balraj Singh, Naved Sabir and Murtaza Hasan. 2014. Advances in Protected Cultivation. New India Publishing Agency, New Delhi.
- R2** Shankar, A.N. 2014. Integrated Horticulture Development in Eastern Himalayas, Plasticulture in Agri- Horticulture Systems, 241-247.

Weblinks:

- W1** <https://krishi.icar.gov.in/jspui/bitstream/123456789/42008/1/Article%201.pdf>
- W2** https://ec.europa.eu/eip/agriculture/sites/default/files/eipagri_fg_plastic_footprint_mini_paper_c_final.pdf

HEAT TRANSFER LAB**Semester: VI****Course Code: 231ME6L01**

L	T	P	C
0	0	3	1.5

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

- CO 1 :** Measure thermal conductivity of metals, insulating powders, and composite materials using steady-state and transient methods
- CO 2 :** Determine convective heat transfer coefficients for natural and forced convection systems through empirical data analysis
- CO 3 :** Compare heat transfer performance of parallel-flow and counter-flow heat exchangers by calculating effectiveness and LMTD
- CO 4 :** Analyze extended surface heat transfer by evaluating fin efficiency and effectiveness experimentally
- CO 5 :** Estimate emissivity of test surfaces and verify the Stefan-Boltzmann law through radiation experiments

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	2	1	1
CO2	3	3	-	1	-	-	-	-	2	2	1	1
CO3	3	3	-	1	-	-	-	-	2	2	1	1
CO4	3	3	-	1	-	-	-	-	2	2	1	1
CO5	3	3	-	1	-	-	-	-	2	2	1	1

Mapping of Course Outcomes with Program Specific Outcomes

CO / PSO	PSO 1	PSO 2
CO1	-	2
CO2	-	2
CO3	-	2
CO4	-	2
CO5	-	2

List of Experiments:**Week 1:**

Determination of thermal conductivity of a metal.

Week 2:

Determination of overall heat transfer co-efficient of a composite material.

Week 3:

Determination of heat transfer rate through a lagged pipe.

Week 4:

Determine the thermal conductivity of insulating powder.

Week 5:

Determination of efficiency of a pin-fin.

Week 6:

Determination of heat transfer coefficient in forced convection.

Week 7:

Determination of heat transfer coefficient in natural convection.

Week 8:

Determination of effectiveness of parallel and counter flow heat exchangers.

Week 9:

Determination of emissivity of a given surface.

Week 10:

Determination of Stefan- Boltzman constant.

List of Augmented Experiments:

(Any two of the following experiments can be performed)

1. Determination of heat transfer rate in drop and film wise condensation.
2. Study of two-phase flow.
3. Demonstration of heat pipe.
4. Determination of critical heat flux.

References:

1. Heat and Mass Transfer, D.S.Kumar, S.K.Kataria & Sons Publications, 3rd edition.
2. Heat Transfer, P.K.Nag, TMH Publications, 3rd edition.
3. Heat and Mass transfer data book, C. P. Kothandaramam, New age publications, 10th Edition.

Weblinks:

1. <http://mech.gecgudlavalley.ac.in/pdf/manuals/HEAT%20TRANSFER%20LABS>
2. [http://www.cittumkur.org/manuals/mech/HMT_MANUAL_FINAL_10 MEL67](http://www.cittumkur.org/manuals/mech/HMT_MANUAL_FINAL_10_MEL67)

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING LAB**Semester: VI****Course Code: 231ME6L02**

L	T	P	C
0	0	3	1.5

Course Outcomes: At the end of the Course, Student will be able to:**CO1:** Explain the basic concepts of Data preprocessing**CO2:** Explain classification models and their accuracy**CO3:** Explain association rule mining in Artificial Intelligence**CO4:** Apply various machine learning techniques to solve real world problems**CO5:** Apply the machine learning analytics and deep learning techniques to solve real world problems**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	1	1	1	-	-	-	-	-	-	-	-
CO2	2	1	3	2	-	-	-	-	-	-	-	-
CO3	3	1	1	2	-	-	-	-	-	-	-	-
CO4	2	2	2	3	-	-	-	-	-	-	-	-
CO5	1	3	1	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

List of Experiments:**Week – 1**

Explore machine learning tool “WEKA”

Explore WEKA Data Mining/Machine Learning Toolkit.

Downloading and/or installation of WEKA data mining toolkit.

Understand the features of WEKA toolkit such as Explorer, Knowledge Flow interface, Experimenter, command-line interface.

Navigate the options available in the WEKA (ex. Select attributes panel, Preprocess panel, Classify panel, Cluster panel, Associate panel and Visualize panel)

Study the arff file format Explore the available data sets in WEKA. Load a data set (ex. Weather dataset, Iris dataset, etc.)

Load each dataset and observe the following:

1. List the attribute names and they types
2. Number of records in each dataset
3. Identify the class attribute (if any)
4. Plot Histogram
5. Determine the number of records for each class.
6. Visualize the data in various dimensions

Week – 2

Data Preprocessing with Weka or Python

Week - 3

Exploring machine learning models including classification and clustering using scikit-learn or Weka or Python

Week - 4

Building Decision Trees for Soybean classification model using Weka or Python

Week - 5

Write a program of Naive Bayesian classification using Python programming language

Week - 6

Generating association rules on Weather data using Weka or Python

Week - 7

Build Neural Network Classifier using Weka or Python

Week - 8

Write a program to calculate chi-square value using Python. Report your observation

Week – 9

Demonstrate performing clustering of data sets

Load each dataset into Weka and run simple k-means clustering algorithm with different values of k (number of desired clusters).

Study the clusters formed. Observe the sum of squared errors and centroids, and derive insights.

Explore other clustering techniques available in Weka.

Explore visualization features of Weka to visualize the clusters. Derive interesting insights and explain

Week – 10

Supervisedly - Perform Data Labeling for various images using object recognition

Week – 11

Image Classifier using Tensor Flow or OpenCV Automatic Facial recognition using Microsoft Azure or OpenCV

Week – 12

Implement a DB Scan algorithm

List of Augmented Experiments:

Write a program to cluster your choice of data using simple k-means algorithm using JDK

Write a program of cluster analysis using simple k-means algorithm Python programming language

Write a program to compute/display dissimilarity matrix (for your own dataset containing at least four instances with two attributes) using Python

Weblinks:

W1 Weka Documentation, <https://www.cs.waikato.ac.nz/ml/weka/documentation.html>

W2 Weka Knowledge Flow, https://www.cs.waikato.ac.nz/~eibe/WEKA_Ecosystem.pdf

Robotics and Drone Technologies Lab

Semester: VI

Course Code: 231ME6S01

L	T	P	C
0	0	4	2

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

CO1: Simulate robotic systems and perform forward/inverse dynamic analysis

CO2: Program and control basic mobile robots and robotic arms using microcontrollers

CO3: Design and build functional robotic systems using CAD tools and electronic sensors

CO4: Understand drone structure, navigation principles, and onboard sensors

CO5: Develop and demonstrate a drone for specific real-time 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
CO1	3	2	2	3	3	-	-	-	-	-	-	-
CO2	2	2	3	2	3	-	-	-	-	-	-	-
CO3	2	-	3	2	3	-	-	-	-	-	-	-
CO4	2	2	2	-	3	-	-	-	-	-	-	-
CO5	2	2	3	2	3	-	-	-	-	-	-	-

Mapping Course Outcomes with Program Specific Outcomes:

	PSO 1	PSO 2
CO1	3	2
CO2	3	3
CO3	3	3
CO4	2	2
CO5	3	3

List of Experiments:

Robotics:

1. Simulation of Mathematical Model of Robot.
2. Forward and Inverse Dynamic Analysis of a 2-DOF Robotic Manipulator using Software Tools.
3. Building and Programming a Simple Arduino-Based Robot for basic movement.
4. Build a robot that can navigate through a maze or an environment by using sensors to detect obstacles and avoid them.
5. Construct a robotic arm using servo motors or stepper motors and program the arm to perform various tasks, such as picking up objects, sorting the colour, or drawing shapes.
6. Build a robot that follows a black line on a contrasting surface using line-following sensors.
7. Designing a 3D Model of a Robotic Arm and Grippers Using Software
8. Implement a PID controller for a robotic arm or mobile robot and simulate its performance in tracking a desired trajectory.

Drone technologies:

- 1.Demonstration of parts and functions of a drone.
- 2.Demonstration of effects of forces, manoeuvres of a drone by roll, pitch and yaw.
- 3.Demonstration of various sensors and battery management used in drones.
- 4.Build a prototype drone to record videos and photos.
- 5.Make a drone for a certain payload.

Weblinks:

- W1** <https://aim.gov.in/pdf/equipment-manual-pdf.pdf>
- W2** <https://atl.aim.gov.in/ATL-Equipment-Manual/>
- W3** <https://aim.gov.in/pdf/Level-1.pdf>
- W4** <https://aim.gov.in/pdf/Level-2.pdf>
- W5** <https://aim.gov.in/pdf/Level-3.pdf>
- W6** https://aim.gov.in/pdf/ATL_Drone_Module.pdf
- W7** <https://aim.gov.in/pdf/equipment-manual-pdf.pdf>
- W8** <https://atl.aim.gov.in/ATL-Equipment-Manual/>
- W9** <https://aim.gov.in/pdf/Level-1.pdf>
- W10** <https://aim.gov.in/pdf/Level-2.pdf>
- W11** <https://aim.gov.in/pdf/Level-3.pdf>
- W12** <https://aim.gov.in/pdf/equipment-manual-pdf.pdf>

TECHNICAL PAPER WRITING AND IPR

Semester: VI**Course Code: 231MC6T01**

L	T	P	C
2	0	0	-

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	PO10	PO11	PO 12
CO1	-	-	-	-	-	2	2	2	2	2	2	1
CO2	-	-	-	-	-	2	2	2	2	2	2	1
CO3	-	-	-	-	-	2	2	2	2	2	2	1
CO4	-	-	-	-	-	2	2	2	2	2	2	1
CO5	-	-	-	-	-	2	2	2	2	2	2	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

- T1** Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press..
- T2** Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.

Reference Books:

- R1** Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
- R2** Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman’s book.
- R3** Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
- R4** Mayall, “Industrial Design”, McGraw Hill, 1992.

Weblinks:

- W1** <http://nptel.ac.in/courses/112102101>
- W2** <https://archive.nptel.ac.in/courses/112/102/112102102/>

CAD/CAM**Semester: VII****Course Code: 231ME7T01**

L	T	P	C
2	0	0	2

Course Outcomes: At the end of the Course, Student will be able to:**CO1:** Explain the basic concepts of CAD/CAM and geometric transformation techniques.**CO2:** Develop the mathematical models to represent curves and surfaces.**CO3:** Develop part programs for profiles using G Codes and M Codes.**CO4:** Apply Group technology and Computer Aided Process Planning for product development.**CO5:** Examine the elements of Computer Integrated Manufacturing Systems.**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	-	-	-		-	-	-	-	-	-	1
CO2:	2	2	-	-		-	-	-	-	-	-	1
CO3:	2	2	-	-	1	-	-	-	-	-	-	1
CO4:	2	2	-	-		-	-	-	-	-	-	1
CO5:	2	1	-	-	1	-	-	-	-	-	-	

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	1	-
CO2:	1	-
CO3:	1	-
CO4:	1	-
CO5:	1	-

Unit - I**Introduction:**

Computers in industrial manufacturing, product cycle, Applications of CAD, Industry 4.0 and AI in manufacturing, CAD / CAM Hardware, basic structure, CPU, Memory types, Input devices, Display devices, Hard copy devices, Storage devices.

Computer Graphics:

Raster scan graphics coordinate system, Database structure for graphics modeling, transformation of geometry, 3D transformations, Mathematics of projections, Clipping, Hidden surface removal.

Unit – II**Geometric Modeling:**

Requirements, geometric models, geometric construction models, curve representation methods, surface representation methods.

3D Modelling Features:

Shading and Rendering, Revolving, Lofting

Unit – III**Part Programming for NC Machines:**

NC, NC modes, NC elements, CNC machine tools, Structure of CNC machine tools, Features of Machining center, Turning center, CNC Part Programming: Fundamentals, Manual part programming methods, Computer Aided Part Programming, Direct Numerical Control, Adaptive Control.

Unit – IV**Group technology:**

Part family, coding and classification, production flow analysis, types and advantages, Computer aided processes planning – importance, types.

Flexible manufacturing system:

Introduction, Equipment, Tool management systems, Layouts, FMS Control, benefits of FMS.

Unit – V**Computer Aided Quality Control:**

Computers in Quality control, Inspection methods contact and noncontact types, Computer aided testing, Integration of CAQC with CAD/CAM.

Computer Integrated Manufacturing Systems:

Types of manufacturing systems, Machine tools and related equipment, Material handling systems- Introduction, Material requirement planning, Computer control systems, Human labor in manufacturing systems, CIMS benefits.

Text Books:

- T1** CAD / CAM - Computer Aided Design and Manufacturing, M. Groover and E. Zimmers, Pearson Education, 12th Edition.
- T2** Automation, Production systems & Computer integrated Manufacturing, Groover,P.E, 4th Edition,2015.

Reference Books:

- R1** CAD / CAM Theory and Practice, Ibrahim Zeid and Subramanian, TMH, 2009 Edition.
- R2** CAD/CAM Concepts and Applications, Chennakesava R. Alavala, PHI, 1st Edition.
- R3** Principles of Computer Aided Design and Manufacturing, Farid Amirouche, Pearson. 2nd Edition.
- R3** Introduction to Industrial Internet of Things and Industry 4.0, Sudip Misra, Chandana Roy, Anandarup MukherjeeCRC Press 2021.

Weblinks:

- W1** <http://nptel.ac.in/courses/112102101>
- W2** <https://archive.nptel.ac.in/courses/112/102/112102102/>

OPERATIONS RESEARCH**Semester: VII****Course Code: 231HS7T03**

L	T	P	C
2	0	0	2

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:**

CO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
CO1	2	1	1	-	-	2	-	-	-	-	1
CO2	1	1	1	-	-	1	-	-	-	-	1
CO3	3	2	1	-	-	1	-	-	-	-	1
CO4	2	1	1	-	-	2	-	-	-	-	1
CO5	2	1	1	-	-	2	-	-	-	-	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 –I**INTRODUCTION:**

Definitions – 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:

- T1** Operations Research-An Introduction/Hamdy A Taha/ Pearson publishers
- T2** Operations Research –Theory & publications / S.D.Sharma Kedarnath/McMillan publishers India Ltd.

Reference Books:

- R1** Introduction to O.R/Hiller & Libermann/TMH.
- R2** Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education

Weblinks:

- W1** <https://nptel.ac.in/courses/110106062>
- W2** <https://www.coursera.org/learn/operations-research-algorithms>

INDUSTRY INTERNSHIP -II**Semester: VII****Course Code: 231ME7P01**

L	T	P	C
0	0	0	2

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

CO1: Execute Advanced Industry-Relevant Tasks – Students will independently apply technical and managerial skills to contribute meaningfully to real-world projects, demonstrating proficiency in their field.

CO2: Analyze and Improve Industry Processes – Students will critically evaluate workplace systems, identify inefficiencies, and propose data-driven solutions or innovations.

CO3: Demonstrate Professional Leadership & Adaptability – Students will exhibit initiative, problem-solving, and adaptability in dynamic work environments while adhering to industry standards and ethics.

CO4: Document & Present Industry Learning Effectively – Students will synthesize their internship experiences through structured reports, presentations, or portfolios, highlighting key insights and skill development.

CO5: Build Professional Networks & Career Pathways – Students will engage with mentors, explore career opportunities, and reflect on long-term professional goals based on industry exposure

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	3	-	-	-	-	1	1	-	-	-	-	1
CO3	3	-	-	-	-	-	-	-	-	1	1	1
CO4	1	1	3	2	-	-	-	-	-	-	-	-
CO5	-	-	-	-	3	-	-	2	1	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	2
CO2	2	2
CO3	2	2
CO4	2	2
CO5	2	2

Guidelines:

1. The Internship is a team activity of 3 to 4 students.
2. The students can undergo Industrial Training / Internship at Govt. Organizations, software MNCs or do Research projects in National Laboratories/Academic Institutions like IITs, NITs etc. during summer breaks after completion of VI Semester.
3. INDUSTRY INTERNSHIP Project is an alternative to the Summer Internship, whenever there is an exigency and students cannot pursue their Summer Internship. A group of students or even a single student can take up the Community Service Project during summer breaks. However, a student can opt for this only once. The students have to identify social problems existing in any geographical area/village and try to solve them technically or suggest people to the necessary solutions for solving these problems.
4. Prior letter and approval from the Head of the Department must be taken before applying to any organization for the course.
5. Every student should put in a minimum of 180 hours for the INDUSTRY INTERNSHIP Project during the summer vacation.
6. Each class/section should be assigned with a Project Coordinator.

MECHATRONICS
(Professional Elective – IV)

Semester: VII**Course Code: 231ME7E01**

L	T	P	C
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
CO1	2	-	-	-	1	-	-	-	-	-	-	-
CO2	2	-	-	-	1	-	-	-	-	-	-	-
CO3	2	-	-	-	1	-	-	-	-	-	-	-
CO4	2	-	1	-	2	-	-	-	-	-	-	-
CO5	2	-		-	2	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	2	-
CO2	1	-
CO3	1	-
CO4	2	-
CO5	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.

Textbooks:

- T1** Mechatronics Integrated Mechanical Electronics Systems/KP Ramachandran & G K Vijaya Raghavan/WILEY India Edition/2008.
- T2** Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.

Reference Books:

- R1** Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
- R2** Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
- R3** Mechatronics System Design / Devdas Shetty/Richard/Thomson.
- R4** Mechatronics/M. D. Singh/J. G. Joshi/PHI.

Weblinks:

- W1** <https://www.electronicshub.org/different-types-sensors/>
- W2** https://en.wikipedia.org/wiki/Solid-state_electronics
- W3** <http://www.htl-worldwide.com/the-difference-between-pneumatic-hydraulic-and-electrical-actuators/>
- W4** <https://www.worldscientific.com/worldscibooks/10.1142/10193>

COMPUTATIONAL FLUID DYNAMICS

(Professional Elective – IV)

Semester: VII

Course Code: 231ME7E02

L	T	P	C
3	0	0	3

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

- CO1** Explain the classification of PDEs and differential solutions and methods for elliptical, parabolic and hyperbolic equations.
- CO2** Explain basic principles and derive governing equations of CFD.
- CO3** Apply the finite difference method for incompressible viscous flow problems and compressible flow problems.
- CO4** Apply finite volume formulations for two-dimensional and three-dimensional problems.
- CO5** Apply finite element methods for steady-state and transient fluid flow problems.

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	3	-	-	-	-	-	-	-	-	-
CO4	2	2	3	-	-	-	-	-	-	-	-	-
CO5	2	2	3	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	2
CO2	-	2
CO3	-	2
CO4	-	2
CO5	-	2

UNIT- I:

INTRODUCTION:

Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations.

SOLUTION METHODS:

Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination.

UNIT- II:

PARABOLIC EQUATIONS:

Explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direct implicit schemes, approximate factorization, fractional step methods.

HYPERBOLIC EQUATIONS:

Explicit schemes and Von Neumann stability analysis, implicit schemes, multi-step methods, nonlinear problems.

BURGER'S EQUATIONS:

Explicit and implicit schemes, Runge-Kutta method.

UNIT- III:**FORMULATIONS OF INCOMPRESSIBLE VISCOUS FLOWS:**

Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, and vortex methods.

FORMULATIONS OF COMPRESSIBLE FLOWS:

Potential equation, Euler equations, central schemes, Navier-Stokes system of equations, boundary conditions, and example problems.

UNIT- IV:**FINITE VOLUME METHOD:**

Finite volume method via finite difference method, formulations for two and three-dimensional problems.

UNIT- V:**FINITE ELEMENT METHODS:**

Introduction to Finite Element Methods, Finite Element Interpolation Functions, Linear Problems-Steady-State Problems – Standard Galerkin's Methods, Transient Problems – Generalized Galerkin's Methods, Example Problems.

Text Books:

- T1** Patankar, S. V., 2017, Numerical Heat Transfer and Fluid Flow, Special Indian ed., CRC Press.
- T2** Introduction to Computational Fluid Dynamics Development, Application and Analysis, Atul Sharma, Wiley Publication.

Reference Books:

- R1** Muralidhar K., and Sundararajan T. (Editors), 2017, Computational Fluid Flow and Heat Transfer, 2nd ed. tenth reprint, Narosa.
- R2** Donea, J., and Huerta, A., 2003, Finite Element Methods for Flow Problems, John Wiley & Sons, Ltd.
- R3** Introduction to Computational Fluid Dynamics, an: The Finite Volume Method, H. Versteeg, W. Malalasekera, Pearson Education Limited, 2nd Edition.
- R4** Computational fluid dynamics, T. J. Chung, Cambridge University press, 2002.

Web links:

- W1** <https://nptel.ac.in/courses/112105045>
- W2** <https://archive.nptel.ac.in/courses/112/105/112105254/>

ADVANCED MATERIAL SCIENCE**(Professional Elective – IV)****Semester: VII****Course Code: 231ME7E03**

L	T	P	C
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 to understand the structure-property correlations in materials.
- CO2** Apply the concept of strengthening mechanisms to assess the advanced metallic materials and alloys.
- CO3** Assess the recyclability aspects of polymers and composite materials.
- CO4** Analyze the role of functional & smart materials in the contemporary applications.
- CO5** Explain advances in nanomaterials applications and future trends in materials science.

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	3	2	-	-	-	-		-	-	-	-	-
CO2	3	2	-	-	-	-		-	-	-	-	-
CO3	3	2	-	-	-	-	3	-	-	-	-	-
CO4	3	2	-	-	-	-		-	-	-	-	-
CO5	3	2	-	-	-	-	3	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	2	-
CO2	2	-
CO3	2	-
CO4	2	-
CO5	2	-

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**Advanced 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:

- T1** R. Balasubramaniam, "Callister's Materials Science and Engineering," 2nd Edition, Wiley, 2009.
T2 G. E. Dieter, "Mechanical Behavior of Materials," 3rd Edition, McGraw-Hill, 1986.

Reference Books:

- R1** L. M. Nieckele, "Advanced Materials: Properties, Processing, and Applications," CRC Press, 2019.
R2 R. W. Cahn and P. Haasen (Eds.), "Physical Metallurgy," 4th Edition, Elsevier, 1996.
R3 S. C. Sharma, "Advanced Materials and Their Applications," Dhanpat Rai Publishing Company, 2018.
R4 V. Raghavan, "Materials Science and Engineering," PHI Learning, 2014.

Weblinks:

- W1** <https://ocw.mit.edu/courses/3-051j-materials-for-biomedical-applications-spring-2006/>
W2 https://www.youtube.com/playlist?list=PLbRMhDVUMngdzwQyMgoUgdaGBqi_p4nVM

**EMBEDDED SYSTEMS AND PROGRAMMING
(Professional Elective-IV)**

Semester: VII**Course Code: 231ME7E04**

L	T	P	C
3	0	0	3

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:

T1 Embedded Systems, Shibu.K. V, Tata McGraw Hill Education Private Limited, 2013.

T2 Embedded Systems-Architectures, Programming and Design, Raj Kamal, Tata McGraw Hill Publications

Reference Books:

R1 Embedded System Design, Frank Vahid and Tony Givargis, John Wiley Publications, 2013.

R2 Hardware Software Co-Design Principles and Practice, J. Staunstrup, Springer Publications

Weblinks:

W1 <https://www.iitk.ac.in/tkic/workshop/sensors-and-actuators/ppt/sandeep.pdf>

W2 http://www.artistembedded.org/docs/Events/2006/ChinaSchool/1_ESIntroduction.pdf

HYDROGEN AND FUEL CELL TECHNOLOGY**(Professional Elective – V)****Semester: VII****Course Code: 231ME7E05**

L	T	P	C
3	0	0	3

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

- CO1** To identify the potential of H₂ as renewable and green fuel, and also to suitable production systems.
- CO2** To analyze various storage methods available for hydrogen fuel to act as feedstock for energy conversion.
- CO3** To understand the thermodynamics and working principles of fuel cell.
- CO4** To understand the various fuel cell designs and its losses involved in the operation.
- CO5** To describe the application of fuel cells in industrial and commercial areas.

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	3	3	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	
CO3	3	3	-	-	-	-	-	-	-	-	-	
CO4	3	2	-	-	-	-	-	-	-	-	-	1
CO5	3	2	-	-	-	-	-	-	-	-	-	

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	3
CO2	-	3
CO3	-	3
CO4	-	3
CO5	-	3

Unit - I**Hydrogen energy:**

Hydrogen as a fuel, application. Hydrogen production methods – production of hydrogen from fossil fuels, electrolysis, thermal decompositions, photochemical and photocatalytic methods

Unit -II**Hydrogen Storage:**

Hydrogen storage methods – metal hydrides, metallic alloy hydrides, carbon nano-tubes, sea as source of deuterium.

Unit – III**Fuel Cell Basic:**

Fuel cell definition, difference between batteries and fuel cells, fuel cell history, components of fuel cells, principles of working and performance characteristics of fuel cells, efficiency of fuel cells, fuel cell electrochemistry.

Unit – IV**Overview of fuel cells:**

Fuel cell types – classification by operating temperature/electrolyte type, fuel cell performance, activation, ohmic and concentration over potential fuel cell design and components – cell components, stack components, system components.

Unit – V**Types of fuel cells:**

solid oxide fuel cells, molten carbonate fuel cells, phosphoric acid fuel cells, polymer electrolyte membrane fuel cells – heat and mass transfer, water management, current issues, direct methanol fuel cells.

Text Books:

T1 Principles of Fuel Cells', by Xianguo Li, Taylor & Francis, 2006.

T2 Hydrogen and Fuel Cells: Emerging Technologies and Applications', Bent Sørensen, Academic press, 2012.

Reference Books:

R1 Fuel Cells, Principles and Applications', Viswanathan, B. and Scibioh, Aulice M, Universities Press, 2006.

R2 O'Hayre R. P., S. Cha., W. Colella., F. B. Prinz., Fuel Cell Fundamentals, Wiley, NY, 3rd edition, 2016.

Weblinks:

W1 <https://archive.nptel.ac.in/courses/103/102/103102015/>

W2 https://onlinecourses.nptel.ac.in/noc22_ch66/preview

Smart Manufacturing

(Professional Elective – V)

Semester: VII

Course Code: 231ME7E06

L	T	P	C
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	PO10	PO11	PO12
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	-
CO2	2	-
CO3	2	-
CO4	2	-
CO5	2	-

UNIT –I

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 –II

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 –III

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 – IV

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

.

UNIT –V

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

Text Books:

- T1** Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
- T2** S. Kaushik, Artificial Intelligence, Cengage Learning India, ISBN 9788131510995, 2011.

Reference Books:

- R1** Tom M. Mitchell, Machine Learning, McGraw Hill, 2013
- R2** Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012.
- R3** M.C. Trivedi, A Classical Approach to Artificial Intelligence, Khanna Publishing House, New Delhi, 2018.
- R4** 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.

Web links:

- W1** https://onlinecourses.nptel.ac.in/noc25_cs91/preview
- W2** https://onlinecourses.nptel.ac.in/noc25_cs147/preview
- W3** https://onlinecourses.nptel.ac.in/noc25_cs146/preview

CRYOGENICS**(Professional Elective – V)****Semester: VII****Course Code: 231ME7E07**

L	T	P	C
3	0	0	3

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

- CO1** Illustrate the principles of cryogenic systems.
- CO2** Describe the air and helium liquefaction processes.
- CO3** Explain about rectification and cryogenic storage.
- CO4** Explain Cryogenic Refrigeration System.
- CO5** Demonstrate vacuum technology in cryogenics.

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	3	1	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-
CO4	3	1	-	-	-	-	-	-	-	-	-	-
CO5	3	1	-	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	2
CO2	-	2
CO3	-	2
CO4	-	2
CO5	-	2

UNIT-I:

Introduction: Historical background, Insight on Cryogenics, Definition and Engineering applications of Cryogenics, Properties of solids for cryogenic systems, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures, Mechanical properties, Thermal properties, Electrical and Magnetic Properties, Present area involving cryogenics.

UNIT-II:

Gas-Liquefaction System: Carnot liquefaction cycle, F.O.M, and Yield of liquefaction Cycles, Joule-Thomson effect, Adiabatic expansion, Simple Linde-Hampson system, Precooled Linde-Hampson system, Linde dual-pressure system, Cascade system, Claude system, Kapitza system, Collins helium liquefaction system, Ortho-Para hydrogen conversion, Critical components in liquefaction systems.

UNIT-III:

Binary Mixtures, T-C and H-C Diagrams, Principle of Rectification, Rectification Column Analysis - McCabe Thiele Method, Adsorption Systems for purification.
Cryogenic Storage and transfer Systems: Cryogenic fluid storage vessels, insulations, cryogenic transfer systems.

UNIT-IV:

Cryogenic Refrigeration System: Philips refrigerator, Importance of regenerator effectiveness for Philips refrigerator, Gifford-McMohan refrigerator, J. T. Cryocoolers, Stirling Cycle Refrigerators, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators.

UNIT -V:

Vacuum Technology: Introduction and importance of vacuum technology in cryogenics, Flow regimes in vacuum systems, Conductance in vacuum systems, Operation of vacuum pumps, Calculation of pump-down time for a vacuum systems, Components of a vacuum systems, Mechanical vacuum pumps, Diffusion pumps, Ion pumps, Cryopumping. Vacuum gauges and valves.

Text Books:

- T1** Fundamentals of Cryogenic Engineering, Mamata Mukhopadhyay, PHI Learning, 2010.
T2 Cryogenic Engineering, Thomas Flynn, CRC Press, 2nd edition, 2020.

Reference Books:

- R1** Cryogenic Technology and Applications, A. R. Jha, Butterworth-Heinemann, 1st edition, 2011.
R2 Cryogenic Mixed Refrigerant Processes, Gadhiraju Venkatarathnam, Springer-Verlag New York Inc., 2008th edition.
R3 Cryogenic Engineering: Fifty Years of Progress, Timmerhaus et. al., Springer, 2020.

Weblinks:

- W1** <https://nptel.ac.in/courses/112101004>.
W2 <https://trc.nist.gov/cryogenics/>.

ELECTRICAL DRIVES AND ACTUATORS**(Professional Elective – V)****Semester: VII****Course Code: 231ME7E08**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:**CO1** To understand the various power semiconductor devices used in electrical drives.**CO2** Analyze motor load dynamics and interpret drive characteristics in different operating modes.**CO3** Illustrate the principles, characteristics, and control of DC motors and drives.**CO4** Explain speed control methods used in AC motor drives.**CO5** Demonstrate the operation and drive logic of stepper and servo motors.**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	3	-	-		-	-	-	-	-	-	-	-
CO2	3	2	2	2	-	-	-	-	-	-	-	-
CO3	3	2	1	-	2	-	-	-	-	-	-	-
CO4	3	2	1	-		-	-	-	-	-	-	-
CO5	3	1	1	-	2	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	1	-
CO2	1	-
CO3	1	-
CO4	1	-
CO5	1	-

Unit I: Relay And Power Semi-Conductor Devices

Study of Switching Devices – Relay and Types, Switching characteristics -BJT, SCR, TRIAC, GTO, MOSFET, IGBT, and IGCT-: SCR, MOSFET, and IGBT – Triggering and commutation circuit Introduction to Driver and snubber circuits.

Unit II: Drive Characteristics

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, torque, and Direction starting & stopping – Selection of motor.

Unit III: Dc Motors and Drives

DC Servomotor – Types of PMDC & BLDC motors – principle of operation- EMF and torque equations – characteristics and control – Drives- H bridge – Single and Three Phases – 4 quadrant operation – Applications.

Unit IV: Ac Motors and Drives

Introduction – Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control – Static rotor resistance control – Slip power recovery control.

Unit V: Stepper And Servo Motor

Stepper Motor: Classifications- Construction and Principle of Operation – Modes of Excitation- Drive System-Logic Sequencer – Applications. Servo Mechanism – DC Servo motor-AC Servo motor – Applications.

Textbooks:

- T1** Bimbhra B.S., “Power Electronics”, 5th Edition, Kanna Publishers, New Delhi, 2012.
T2 Mehta V.K. & Rohit Mehta, “Principles of Electrical Machines”, 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2016.

Reference Books:

- R1** Gopal K. Dubey, “Fundamentals of Electrical Drives”, 2nd Edition, Narosal Publishing House, New Delhi, 2001.
R2 Theraja B.L. & Theraja A.K., “A Text Book of Electrical Technology”, 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2012.
R3 Singh M.D. & Kanchandhani K.B., “Power Electronics”, McGraw Hill, New Delhi, 2007.

Weblinks:

- W1** nptel.ac.in/courses/108108147
W2 nptel.ac.in/courses/108104140
W3 nptel.ac.in/courses/108104011

INDUSTRIAL WASTE WATER MANAGEMENT (Open Elective-III)

Semester: VII
Course Code: 231CE7O01

L T P C
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
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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

- T1** Wastewater Treatment by M.N. Rao and A.K. Dutta, Oxford & IBH, New Delhi, 2016
- T2** Industrial Wastewater Treatment by KVSG Murali Krishna.

Reference Books:

- R1** Industrial Water Pollution Control by W. Wesley Eckenfelder, Mc- GrawHill, Third Edition, 2015
- R2** Wastewater Treatment- Concepts and Design Approach by G.L. Karia & R.A. Christian, Prentice Hall of India

Weblinks:

- W1** <https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce32/>
- W2** <https://www.un-ihe.org/online-course-industrial-effluent-treatment>

**BASICS OF RS&GIS
(Open Elective-III)**

Semester: VII
Course Code:231CE7O02

L T P C
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
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:

- T1** Textbook of Remote Sensing and Geographical Information Systems, by Anji M. Reddy · 2018, BS Publications
- T2** Remote Sensing and GIS, Basudev Bhatta, Oxford Publishers 2015

Reference Books:

- R1** Basics of Remote sensing & GIS by S. Kumar, Laxmi Publications
- R2** Introduction to Geographic Information System, Kang-Tsung Chang, McGraw- Hill 2015.

Weblinks:

- W1** http://geology.wlu.edu/harbor/geol260/lecture_notes/notes.html
- W2** <https://lecturenotes.in/subject/572/remote-sensing-and-gis-rsg>

SAFETY ENGINEERING (Open Elective-III)

Semester: VII**Course Code: 231CE7O03**

L	T	P	C
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 safeguard 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
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**Accident 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:

- T1** Safety in the Build Environment' by Jnathea D.Sime, London, 2010
- T2** Reliability Maintenance and Safety Engineering, by Gupta A K, Laxmi Publications, New Delhi.

Reference Books:

- R1** Construction hazard and Safety Hand book' by Hudson, R., Butter Worth's, 1985
- R2** Construction Safety Hand Book'by V.J.Davies and K.Thomasin,Thomas Telford Ltd., London, 1990.

Weblinks:

- W1** nptel.ac.in/courses/105103093/
- W2** nptel.ac.in/courses/105103093/22

BATTERY MANAGEMENT SYSTEMS AND CHARGING STATIONS (OPEN ELECTIVE-III)

Semester: VII**Course Code:231EE7001**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, students 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	PO10	PO11	PO12
CO1	2	3	2	-	-	1	-	-	-	-	-	1
CO2	2	3	2	-	-	1	-	-	-	-	-	1
CO3	2	2	3	-	-	1	-	-	-	-	-	1
CO4	2	2	3	-	-	1	-	-	-	-	-	1
CO5	2	2	3	-	-	1	-	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

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:

- T1** Electric and hybrid vehicles: design fundamentals, 2nd edition, husain iqbal, crc press
- T2** Battery Management Systems Vol. – II Equivalent Circuits and Methods, by Gregory L.Plett, Artech House publisher, First edition 2016

Reference Books:

- R1** Lithium-Ion Batteries: Fundamentals and Applications (Electrochemical Energy Storage and Conversion) 1st Edition by Yuping Wu
- R2** Energy Systems for Electric and Hybrid Vehicles by K.T. Chau, IET Publications, First edition, 2016.

Weblinks:

- W1** <https://www.hydroquebec.com/data/electrification-transport/pdf/technical-guide.pdf>
- W2** <https://www.youtube.com/watch?v=eQX-iobIYmw>

CONCEPT OF SMART GRID TECHNOLOGY (OPEN ELECTIVE-III)

Semester: VII**Course Code:231EE7002**

L	T	P	C
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** Analyse 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
CO1	2	3	1	-	-	-	-	-	-	-	-
CO2	2	3	1	-	-	-	-	-	-	-	-
CO3	2	2	1	-	-	-	-	-	-	-	-
CO4	2	3	1	-	-	-	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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) - HomeArea Network (HAN) - Neighborhood Area Network (NAN) - Wide Area Network (WAN).

Text Books:

- T1** Integration of Green and Renewable Energy in Electric Power Systems - by Ali Keyhani – Mohammad N. Marwali - Min Dai Wiley - 2009.
- T2** The Smart Grid: Enabling Energy Efficiency and Demand Response - by Clark W. Gellings – Fairmont Press - 2009.

Reference Books:

- R1** The Advanced Smart Grid: Edge Power Driving Sustainability:1 by Andre Carvallo - John Cooper -Artech House Publishers July 2011
- R2** Smart Grid: Technology and Applications - by Janaka B. Ekanayake - Nick Jenkins -Kithsiri Liyanage - Jianzhong Wu - Akihiko Yokoyama - Wiley publishers - 2012.

Weblinks:

- W1** <https://nptel.ac.in/downloads/108101040/>
- W2** <https://nptel.ac.in/courses/108101040/>

FINITE ELEMENT METHODS**(OPEN ELECTIVE-III)****Semester: VII****Course Code: 231ME7001**

L	T	P	C
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
CO1	3	2	2	1	-	-	-	-	-	-	-	-
CO2	3	2	2	1	-	-	-	-	-	-	-	-
CO3	3	2	2	1	-	-	-	-	-	-	-	-
CO4	3	2	2	1	-	-	-	-	-	-	-	-
CO5	3	2	2	1	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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.

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:

- T1** Introduction to Finite Elements in Engineering, T.R. Chandrupatla and A.D. Belegundu, PHI publications, 4th Edition, 2011.
- T2** A First Course in the Finite Element Method, Daryl L. Logan, Cengage Learning India Private Limited, 6th edition, 2017.

Reference Books:

- R1** An Introduction to the Finite Element Method, J.N. Reddy, McGraw Hill Education, 4th Edition, 2020.
- R2** Concepts and Applications of Finite Element Analysis, Cook et al, Wiley Publications, 4th edition, 2007.
- R3** Engineering Thermodynamics, P. Chattopadhyay, Oxford University Press, 1st edition, 2011.
- R4** Refrigeration and Air-conditioning, CP Arora, , McGraw Hill, 4th edition 2021.

Weblinks:

- W1** <https://nptel.ac.in/courses/112/104/112104193/>
- W2** <https://nptel.ac.in/courses/112/104/112104205/>

INTRODUCTION TO MECHATRONICS**(OPEN ELECTIVE-III)****Semester: VII****Course Code: 231ME7O02**

L	T	P	C
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
CO1:	2	-		-	1	-	-	-	-	-	-	-
CO2:	2	-		-	1	-	-	-	-	-	-	-
CO3:	2	-		-	1	-	-	-	-	-	-	-
CO4:	2	-	1	-	2	-	-	-	-	-	-	-
CO5:	2	-		-	2	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

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:

- T1** Mechatronics Integrated Mechanical Electronics Systems/KP Ramachandran & G K Vijaya Raghavan/WILEY India Edition/2008
- T2** Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005

Reference Books:

- R1** Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
- R2** Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
- R3** Mechatronics System Design / Devdas Shetty/Richard/Thomson.
- R4** Mechatronics/M. D. Singh/J. G. Joshi/PHI.

Weblinks:

- W1** <https://www.electronicshub.org/different-types-sensors/>
- W2** https://en.wikipedia.org/wiki/Solid-state_electronics
- W3** <http://www.htl-worldwide.com/the-difference-between-pneumatic-hydraulic-and-electrical-actuators/>
- W4** <https://www.worldscientific.com/worldscibooks/10.1142/10193>

PRODUCT DESIGN AND DEVELOPMENT**(OPEN ELECTIVE-III)****Semester: VII****Course Code: 231ME7003**

L	T	P	C
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
CO1:	3	1	-	-	-	-	-	-	-	-	-	1
CO2:	3	-	1	-	2	-	-	-	-	-	2	1
CO3:	3	3	-	1	-	-	-	-	-	-	-	1
CO4:	3	2	-	2	-	-	2	-	-	-	-	1
CO5:	3	-	3	-	-	-	-	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

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 plan process, Levels of strategic planning, Wedge analysis, Opportunity search, Product life cycle Life cycle theory and 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:

T1 Engineering Design, George E. Dieter, McGraw-Hill

T2 Product Integrity and Reliability in Design, John W. Evans and Jillian Y. Evans, Springer Verlag.

Reference Books:

R1 The Product Management Handbook, Richard S. Handscombe, McGraw-Hill

R2 New Product Design, Ulrich Eppinger

R3 Product Design, Kevin Otto.

Weblinks:

W1 https://onlinecourses.nptel.ac.in/noc21_me83/preview

W2 <https://www.youtube.com/watch?v=HN9GtL21rb4&t=6s>

ADVANCED MATERIALS**(OPEN ELECTIVE-III)****Semester: VII****Course Code: 231ME7004**

L	T	P	C
2	0	0	2

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	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO1:	3	2	-	-	-	-		-	-	-	-	-
CO2:	3	2	-	-	-	-		-	-	-	-	-
CO3:	3	2	-	-	-	-	3	-	-	-	-	-
CO4:	3	2	-	-	-	-		-	-	-	-	-
CO5:	3	2	-	-	-	-	3	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

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:

- T1** R. Balasubramaniam, "Callister's Materials Science and Engineering," 2nd Edition, Wiley, 2009.
- T2** G. E. Dieter, "Mechanical Behavior of Materials," 3rd Edition, McGraw-Hill, 1986.

Reference Books:

- R1** L. M. Nieckele, "Advanced Materials: Properties, Processing, and Applications," CRC Press, 2019.
- R2** R. W. Cahn and P. Haasen (Eds.), "Physical Metallurgy," 4th Edition, Elsevier, 1996.
- R3** S. C. Sharma, "Advanced Materials and Their Applications," Dhanpat Rai Publishing Company, 2018.
- R4** V. Raghavan, "Materials Science and Engineering," PHI Learning, 2014.

Weblinks:

- W1** <https://ocw.mit.edu/courses/3-051j-materials-for-biomedical-applications-spring-2006/>
- W2** https://www.youtube.com/playlist?list=PLbRMhDVUMngdzwQyMgoUgdaGBqi_p4nVM
- W3** <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:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

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:

- T1** Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008
- T2** Tom M. Mitchell, Machine Learning, McGraw Hill, 2013
- T3** Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.
- T4** 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
- T5** S. Kaushik, Artificial Intelligence, Cengage Learning India,

Reference Books:

- R1** Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
- R2** Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012.
- R3** M.C. Trivedi, A Classical Approach to Artificial Intelligence, Khanna Publishing House, New Delhi, 2018.
- R4** Artificial Intelligence and Machine Learning, Principles and applications by Vinod Chandra S.S., Anand Hareendran S., PHI 2011.

Web links:

- W1** https://onlinecourses.nptel.ac.in/noc25_cs91/preview
- W2** https://onlinecourses.nptel.ac.in/noc25_cs147/preview
- W3** https://onlinecourses.nptel.ac.in/noc25_cs146/preview

DISCRETE TIME SIGNAL PROCESSING (Open Elective-III)

Semester: VII**Course Code: 231EC7001****L
3****T
0****P
0****C
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:

- T1** Digital Signal Processing, Principles, Algorithms and Applications: John G. Proakis, Dimitris G. Manolakis, Pearson Education/PHI, 2007
- T2** Discrete Time Signal Processing, A. V. Oppenheim and R. W. Schaffer, PHI, 2010

Reference Books:

- R1** Fundamentals of Digital Signal Processing using MATLAB, Robert J. Schilling, Sandra L. Harris, Thomson, 2007.
- R2** Digital Signal Processing, P. Ramesh Babu, SciTech Publications, 6th Edition, 2014.

Weblinks:

- W1** https://www.tutorialspoint.com/digital_signal_processing/index.htm
- W2** <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
Course Code: 231EC7002

L T P C
3 0 0 3

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 and non-linear applications using Op-Amp.
- CO4** Construct the circuits for different Data conversion and Filtering applications using Op-Amp.
- CO5** 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	3	2	2	-	-	-	-	-	-	-	-	2

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 741 IC, 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, 4th Edition, PHI, Pearson Education, 2015.
2. Linear Integrated Circuits– D. Roy Choudhry, Shail Jain, New Age International(p)Ltd, 5th Edition, 2018.
3. Digital Design Principles & Practices – John F. Wakerly, PHI/ Pearson Education Asia, 4th Edition, 2008.

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, 2010.
3. Operational Amplifiers & Linear Integrated Circuits–R.F.Coughlin & Fredrick Driscoll, PHI, 6th Edition, 2001.
4. Fundamentals of Digital Logic with VHDL Design- Stephen Brown, Zvonko Vranesic, McGrawHill, 3rd Edition, 2017.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc24_ee73/preview
2. <https://ocw.mit.edu/courses/6-01sc-introduction-to-electrical-engineering-and-computer-science-i-spring-2011/pages/unit-3-circuits/op-amps/>

PRINCIPLES OF EMBEDDED SYSTEMS
(Open Elective-III)

VII Semester
Course Code: 231EC7O03

L	T	P	C
3	0	0	3

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 and 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	-	-	-	-	-	-	-	-	-

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. Introduction to Embedded Systems, Shibu. K. V, Tata McGraw Hill Education Private Limited, 2nd Edition, 2016.
2. Embedded Systems – SoC, IoT, AI and Real-Time Systems, Raj Kamal, McGraw Hill Education India 4th Edition, 2020

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, 2013
3. Embedded Systems Architecture, Tammy Noergaard, Elsevier Publications, 3rd Edition, 2013.

Web Links:

1. <https://www.coursera.org/learn/introduction-embedded-systems>
2. <https://www.linkedin.com/learning/introduction-to-embedded-systems-with-rust>
3. <https://www.udemy.com/course/embedded-systems-and-microcontrollers/>

CYBER SECURITY (Open Elective-III)

Semester: VII**Course Code: 231CS7O01**

L	T	P	C
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	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

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:

T1 Pfleeger, C.P., Security in Computing, Prentice Hall, 5th edition.

T2 Schneier, Bruce. Applied Cryptography, Second Edition, John Wiley & Sons.

Reference Books:

R1 Rhodes-Ousley, Mark. Information Security: Complete Reference, Second

R2 Edition, Information Security Management: Concepts and Practice, McGrawHill.

Weblinks:

W1 <https://www.edx.org/micromasters/ritx-cybersecurity>.

W2 <https://www.coursera.org/specializations/cyber-security>.

BIG DATA ANALYTICS (OPEN ELECTIVE-III)

Semester: VII**Course Code: 231DS7001**

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	-	-

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:

T1 Hadoop: The Definitive Guide, Tom White, 4th Edition, O’reilly, 2012.

T2 Hadoop for Dummies, Dirkde Roos, PaulC.Zikopoulos, RomanB.Melnyk, Bruce Brown, Rafael Coss, John Wiley& Sons, 2014.

Reference Books:

R1 Bill Franks,“Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics”, John Wiley& sons,2012.

R2 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.

Weblinks:

W1 Hadoop:<http://hadoop.apache.org/>

W2 Hive:<https://cwiki.apache.org/confluence/display/Hive/Home>

INTERNET OF THINGS (Open Elective-III)

Semester: VII**Course Code: 231IT7001**

L	T	P	C
3	0	0	3

Course Outcomes (COs): At the end of the course, students 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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

- T1** Internet of Things: Architecture, Design Principles And Applications, Rajkamal, McGraw Hill Higher Education.
- T2** Vijay Madisetti, Arshdeep Bahga, Internet of Things A Hands-On- Approach, 2014

Reference Books:

- R1** 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.
- R2** 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.

Weblinks:

- W1** https://onlinecourses.nptel.ac.in/noc21_cs17/preview
- W2** <https://arduino makerspace.com/iot-projects-using-arduino/>

COMPUTER NETWORKS (OPEN ELECTIVE-III)

Semester: VII**Course Code: 231AM7O01**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, students 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-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:

- T1** Andrew S. Tanenbaum, Computer Networks, 5th Edition, Pearson Education, 2016.
- T2** Behrouz A Forouzan, Data Communications and Networking, 4th Edition, McGraw-Hill- 2006

Reference Books:

- R1** S Keshav, An Engineering approach to computer Networking, 2nd Edition, Pearson Education
- R2** J.F.Kurose, K.W.Ross, Computer Networking a Top-Down approach featuring the internet, 2nd Edition, Pearson Education.

Weblinks:

- W1** <https://nptel.ac.in/courses/106105081>
- W2** <https://www.coursera.org/learn/fundamentals-network-communications>

PIPELINE ENGINEERING (OPEN ELECTIVE-III)

Semester: VII

Course Code: 231PT7001

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, students 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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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 Books:

T1 GPSA Engineering Data Book, Volume 2, 12 Edition, 2003.

T2 Ludwig's Applied Process Design for Chemical and Petrochemical Plants, Volume 1, 4th Edition, A. Kayode Coker, Elsevier, 2007

Reference Books:

R1 Liquid pipeline hydraulics; E. Sashi Menon; Marcel Dekker Inc.; 2004.

R2 Gas-pipe hydraulics; E. Sashi Menon; CRC Press-Taylor & Francis Publications; 2005

Weblinks:

W1 <https://nptel.ac.in/courses/106105081>

W2 <https://www.coursera.org/learn/fundamentals-network-communicationsnptel.ac.in/courses/106/106/106106091/>

INTRODUCTION TO SEISMIC METHODS (OPEN ELECTIVE-III)

Semester: VII**Course Code: 231PT7O02**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, students 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
 CO5: 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	-	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	-	-
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:

- T1** Introduction to Geophysical Prospecting, Milton B. Dobrin, and Carl H. Savit, 4th Edition, McGraw Hill, 1988.
- T2** Outlines of Geophysical Prospecting: A Manual for Geologists, M.B. Ramachandra Rao, EBD Educational Pvt Ltd., 1993.

Reference Books:

- R1** Elements of Geology: Oil and Gas Exploration Techniques, J. Guillemot, Technip 1991.
- R2** Fundamentals of Geophysics, Lowri, W., Cambridge University Press. (1997).

Weblinks:

- W1** <https://nptel.ac.in/courses/106105081>
- W2** <https://www.coursera.org/learn/fundamentals-network-communications>

INTRODUCTION TO ARTIFICIAL LIFT METHODS (OPEN ELECTIVE-III)

Semester: VII**Course Code:231PT7O03**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, students 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
- CO5: 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	-	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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

- T1** Petroleum Production engineering: A computer assisted approach, Boyun GUO, William C. Lyons, Ali Ghalambor, Elsevier Science and Technology books 2007.
- T2** Petroleum Engineering Handbook-Production Operations Engineering, Volume 4, Joe Dunn Clegg and Larry W. Lake, SPE, 2014.

Reference Books:

- R1** Petroleum production systems, M.J. Economides, A. Daniel Hill & C. E. Economides, Prentice-Hall, N.J-07488, 1994.
- R2** The Technology of Artificial Lift Method, Brown, K.E, Volume 1-4, Penn Well Books, Tulsa, Oklahoma, 1977.

Weblinks:

- W1** <https://nptel.ac.in/courses/106105081>
- W2** <https://www.coursera.org/learn/fundamentals-network-communications>

MINE WASTE MANAGEMENT

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: Identify and classify different types of mining wastes and develop appropriate waste management plans.
- CO2: Apply efficient methods for handling and transporting waste rock dumps in mining operations.
- CO3: Design and evaluate tailings storage facilities complying with safety standards and environmental regulations.
- CO4: Conduct site investigations, stability assessments, and implement monitoring systems for waste structures.
- CO5: Implement waste reuse, reclamation, and closure strategies for sustainable mine waste 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	PO 12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-

UNIT – I

Introduction: Basic introduction to Terminologies, Sources, Nature and Characteristics of different types of waste generated during mining.

Types of waste dumps: Based on i) material types, ii) construction method iii) overall configuration and topographic constraints iv) Location (Internal/External) v) Geo-chemical properties. Method of design & construction. Introduction to Life of mine (LoM) mine waste management plans and handling strategy.

UNIT – II

Mine Waste Rock Dumps (WRDs): Nature and Type of coarse waste generated from surface mines. Methods and Practices of overburden waste handling, management and storage in open cast and open pit mines. Waste sources and management in underground mines Handling and Transportation of waste rocks: Methods, Techniques (dumper/draglines), Cost-benefit analysis, Dumping methods (top-down/bottom-up).

UNIT – III

Tailing Storage Facilities (TSFs): Key Terminologies, Sources of mine tailings, Physical & Chemical properties. Mode of tailings material handling (slurry transportation)

Type of TSFs: Upstream/Downstream/Centreline/Modified centreline

Washery rejects: Types, Nature and Characteristics of washery rejects, fly ash/bottom ash Basic design principle of Tailing dams and ash pond/dykes, Governing standards and Indian Regulations

UNIT – IV

Site selection & Material characterization for waste dumps and tailing dams: factor affecting site selection, site investigation and material testing (physical, geotechnical, geochemical) in WRDs & TSFs, sample collection, testing and analysis

Stability assessment in mine waste & tailing dams: Different modes of failures in waste dumps and tailing dams, Risk assessment and hazard classification

Stability analysis: Acceptance criteria, Stability requirement and risk involved. Numerical

techniques and methods for stability assessment, Basics of Dam Run-out/Breach modelling Instrumentation and monitoring in WRDs & TSFs structures: Requirements, Types, Advantages and Limitations, Introduction to state-of-the-art monitoring practices.

UNIT – V

Re-use and utilization of mine waste: Possible re-use of mine waste for civil, domestic purpose, notable examples of waste to wealth (India & Abroad). Introduction to Tailings re-mining practices.

Closure of WRDs and TSFs: Closure requirements (technical/environmental), Reclamation at waste dumps, Short-to-long-term environmental challenges and mitigation

Text Books:

1. P. Mark Hawley, John Cuning, Guidelines for Mine Waste Dump and Stockpile Design, CRC Press , ISBN 9781138197312
2. Vick, Steven G, Planning, Design, and Analysis of Tailings Dams, BiTech Publisher , ISBN 0-921095-12-0

Reference Books:

1. Lottermoser, Bernd, Mine Wastes-Characterization, Treatment and Environmental Impacts, Springer , ISBN 978-3-642-12418-1
2. Geoffrey E. Blight, Geotechnical Engineering for Mine Waste Storage Facilities, CRC Press , ISBN 9780367577216
3. Environmental Geology, Ghosh R. & Chatterjee D. S., Capital Publishing Co. New Delhi.
4. Water Resources Engineering Larry W. M., Publisher John Wiley and Sons
5. Water Resources Engineering - Ray K. L., Franzini J.B., Freyberg D.L., George Tchobanoglous G. & Hill M.G., 4th Ed.
6. Hydrology and Water Resources Engineering, Garg S.K., Khanna Publishers
7. Hydrology- Das M.M. & Saikia M.D., PHI Learning Pvt. Ltd., New Delhi.
8. SME Mining Reference Handbook, Lowrie R., SME Publication 2002.
9. Mining engineers Handbook, Peele R.

Web Links:

1. <https://www.slideshare.net/slideshow/mine-waste-management-243991332/243991332>
2. <https://www.unep.org/resources/report/mine-tailings-storage-safety-guidelines>
3. https://www.researchgate.net/publication/319944560_Mine_Waste_Management_Practices

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
3. <https://www.unep.org/resources/report/green-mining-sustainable-mining-practices>

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. Wohlbier
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>

IMPACTS OF MINING ON ENVIRONMENT

Open Elective -III

VII Semester	L	T	P	C
Course Code: 231MI7O04	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 – Sitting 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 regularity 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
2. 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

WATER HARVESTING AND SOIL CONSERVATION STRUCTURES

(Open Elective-III)

Semester: VII

Course Code: 231AG7O01

L	T	P	C
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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

- T1** Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
- T2** 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.

Reference Books:

- R1** Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
- R2** 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

Weblinks:

- W1** <https://nptel.ac.in/courses/126/105/126105012/>
- W2** <https://www.fao.org/land-water/water/water-management/water-storage/en/>

BASICS OF SOIL MECHANICS (Open Elective-IV)

Semester: VII
Course Code:231CE7004

L T P C
3 0 0 3

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

- CO1:** Explain the 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
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:

- T1** Arora, K.R. (2019), “Soil Mechanics and Foundation Engineering”, Standard Publishers, Delhi
- T2** Gopal Ranjan and Rao, A.S.R., “Basic and Applied Soil Mechanics”, New Age Ltd. International Publisher New Delhi (India) 2016

Reference Books:

- R1** Craig, R.F. (2019), “Soil Mechanics”, McGraw hill, New Delhi
- R2** Narasinga Rao, B.N.D. (2015), Soil Mechanics and Foundation Engineering, Wiley Publishers

Weblinks:

- W1** <http://nptel.ac.in/courses/105103099/>
- W2** <http://nptel.ac.in/courses/105103097/>

CONSTRUCTION MATERIALS AND EQUIPMENTS (Open Elective-IV)

Semester: VII
Course Code:231CE7005

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
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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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–ManufacturingProcess–Batchingplants–RMC–Propertiesoffresh 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–Clayproducts– 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:

T1 Varghese.P.C, "Building Materials", PHI Learning Pvt. Ltd, New Delhi, 2018.

T2 Rajput.R.K., "Engineering Materials", S.ChandandCompanyLtd., 2018.

Reference Books:

R1 Jagadish.K.S, "AlternativeBuildingMaterialsTechnology", NewAgeInternational, 2017.

R2 Gambhir.M.L., & NehaJamwal., "BuildingMaterials, products, propertiesandsystems", TataMcGrawHillEducationsPvt.Ltd, NewDelhi, 2019.

Weblinks:

W1 <https://nptel.ac.in/courses/105/102/105102012/>

W2 <https://nptel.ac.in/courses/105/106/105106176/>

NATURAL DISASTER MANAGEMENT & MITIGATION (Open Elective-IV)

Semester: VII
Course Code: 231CE7006

L	T	P	C
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
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:

- T1** Disaster Management, RB Singh (Ed), Rawat Publications, 2000
- T2** Disaster Management Future Challenges and Opportunities, Jagbir Singh, I.K International publishing house

Reference Books:

- R1** Natural Hazards in the Urban habitat by Iyengar, CBRI, Tata McGraw Hill
- R2** Natural Disaster management, Jon Ingleton (Ed), Tulor Rose, 1999

Weblinks:

- W1** <https://www.youtube.com/watch?v=2v7N5a3tLgE>
- W2** <https://www.youtube.com/watch?v=5KtVocJfVGw>

CONCEPTS OF POWER QUALITY (OPEN ELECTIVE-IV)

Semester: VII**Course Code: 231EE7O03**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, students 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
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:

- T1** Electrical Power Systems Quality - Dugan R C - McGranaghan M F – Santoso S - and Beaty H W - Second Edition - McGraw–Hill - 2012 - 3rd edition
- T2** Electric power quality problems – M.H.J.Bollen IEEE series-Wiley india publications – 2011

Reference Books:

- R1** Understanding Power Quality Problems: Voltage Sags and Interruptions - Bollen M HJ - First Edition - IEEE Press; 2000.
- R2** 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.

Weblinks:

- W1** <https://nptel.ac.in/courses/108107157>
- W2** https://onlinecourses.nptel.ac.in/noc21_ee103/preview

QUANTUM SCIENCE AND TECHNOLOGY

Open Elective-IV

VII Semester	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:** 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.
- 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	3	2	2	-	-	-	-	-	-	-	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-
CO5	3	2	2	-	-	-	-	-	-	-	-	-

UNIT – I

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 – II

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 – III

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, phaseflip, and Shor's 9-qubit code; Introduction to quantum programming: Qiskit, Cirq, IBM Quantum Experience (overview).

UNIT – IV

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 – V

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, DWave, 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

Reference Books:

1. Vedran Dunjko, Jacob M. Taylor and Hans J. Briegel, "*Quantum-Enhanced Machine Learning*", Physical Review Letters 117 (13).
2. Maria Schuld and Nathan Killoran, *Quantum machine learning in feature Hilbert spaces*, Phys. Rev. Lett. 122

Web Links:

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****Course Code: 231ME7006**

L	T	P	C
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
CO1:	3	2	2	-	1	-	-	-	-	-	-	-
CO2:	3	3	2	-	1	-	-	-	-	-	-	-
CO3:	3	2	2	-	-	-	-	-	-	-	-	-
CO4:	3	2	2	-	-	-	1	-	-	-	-	-
CO5:	2	1	2	-	1	-	1	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	1
CO2:	-	1
CO3:	-	1
CO4:	-	1
CO5:	-	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:

- T1** Engineering Optimization by S.S.Rao, 3rd edition, New Age Publishers,2013, ISBN13 978-8122427233
- T2** Reliability Engineering by L.S.Srinath, East west publishers,2005, ISBN13 978-8176710480

Reference Books:

- R1** Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
- R2** Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers
- R3** Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers
- R4** An Introduction to Reliability and Maintainability Engineering by CE Ebeling, Waveland Printers Inc., 2009

Weblinks:

- W1** https://onlinecourses.nptel.ac.in/noc21_me10/preview
- W2** <https://www.coursera.org/learn/operations-research-modeling>

**ADVANCED MANUFACTURING PROCESSES
(OPEN ELECTIVE-IV)**

Semester: VII**Course Code: 231ME7007**

L	T	P	C
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: Describe 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
CO1	3	-	-	-	1	2	-	-	-	-	-	1
CO2	3	-	-	-	1	2	-	-	-	-	-	1
CO3	3	-	-	-	1	2	-	-	-	-	-	1
CO4	3	-	-	-		2	-	-	-	-	-	1
CO5	3	-	-	-	1	2	-	-	-	-	-	1

Mapping Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

- T1** Manufacturing Engineering and Technology, Serope Kalpakjian and Steven R. Schmid, Pearson Education, 8th Edition, 2023.
- T2** Process and Materials of Manufacturing, R. A. Lindburg, Prentice Hall India Learning Private Limited, 4th Edition, 1990.

Reference Books:

- R1** Advanced Machining Processes, V. K. Jain, Allied Publications, 2002.
- R2** Introduction to Nanoscience and Nano Technology, K. K. Chattopadhyay & A. N. Banerjee, PHI Learning, 2009.
- R3** MEMS & Micro Systems Design and Manufacture, Tai Run Hsu, McGraw Hill Education, 1st edition, 2017.
- R4** Introduction to Manufacturing Processes, John A Schey, McGraw-Hill Education, 3rd edition, 1999.

Weblinks:

- W1** <https://archive.nptel.ac.in/courses/112/107/112107077/> .
- W2** <https://archive.nptel.ac.in/courses/112/103/112103306/>
- W3** <https://archive.nptel.ac.in/courses/112/105/112105053/>
- W4** <https://home.iitk.ac.in/~mohite/ae681.html>
- W5** <https://archive.nptel.ac.in/courses/113/104/113104102/>
- W6** <https://archive.nptel.ac.in/courses/103/106/103106075/>

TOTAL QUALITY MANAGEMENT**(OPEN ELECTIVE-IV)****Semester: VII****Course Code: 231ME7008**

L	T	P	C
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
CO1:	3	1	-	-	-	-	-	-	-	-	1	1
CO2:	3	2	-	-	-	-	-	-	-	-	1	1
CO3:	2	1	1	-	-	-	-	-	-	-	1	1
CO4:	2	2	1	1	1	-	-	-	-	1	1	1
CO5:	2	1	1	1	1	-	-	-	1	1	1	1

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	3
CO2:	-	3
CO3:	-	2
CO4:	-	2
CO5:	-	3

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:

- T1** Total Quality Management, Dale HB ester field, Pearson,4th Edition 2015
- T2** Total Quality Management,K.C.Arora,S.K.Kataria&sons,NewDelhi,2016
- T3** Total Quality Management, Subburaj Ramaswamy, TataMcgraw HillPublishing Company Ltd., 2005

Reference Books:

- R1** Management Quality-Concepts and Tasks, Narayana V and Sreenivasan N.S.,New age publishers;1st edition(1January2005).
- R2** Statistical Quality Control, SeventhEdition, RichardS.Leavenworth & Eugene LodewickGrant,7th Edition,TataMcgrawHill,2015
- R3** Total QualityManagement, Subburaj Ramasamy, TataMcGrawHill Publishing CompanyLtd., NewDelhi, 2005.

Web links:

- W1** <https://nptel.ac.in/courses/110/105/110105039/>
- W2** <https://nptel.ac.in/courses/110/104/110104085/>
- W3** <https://nptel.ac.in/courses/110/104/110104080/#>

OPERATIONS MANAGEMENT (OPEN ELECTIVE-IV)

Semester: VII

Course Code: 231ME8009

L	T	P	C
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/PS O	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	1	1	-	-	2	-	-	-	-	1	-
CO2	1	1	1	-	-	1	-	-	-	-	1	-
CO3	3	2	1	-	-	1	-	-	-	-	1	-
CO4	2	1	1	-	-	2	-	-	-	-	1	-
CO5	2	1	1	-	-	2	-	-	-	-	1	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO 2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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 x 2 games – dominance principle – m x 2 & 2 x 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:

- T1 Operations Research-An Introduction/Hamdy A Taha/Pearson publishers
- T2 Operations Research –Theory & publications / S.D.Sharma Kedarnath/McMillan publishers India Ltd

Reference Books:

- R1 Introduction to O.R/Hiller & Libermann/TMH
- R2 Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.

Weblinks:

- W1 <https://nptel.ac.in/courses/110/106/110106062/>
- W2 <https://ocw.mit.edu/courses/sloan-school-of-management/15-760a-operations-management-summer-2002/>

ENERGY AUDITING (OPEN ELECTIVE-IV)

Semester: VII**Course Code: 231ME7010**

L	T	P	C
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
CO1:	1	-	-	-	-	-	-	-	-	-	2	1
CO2:	2	-	-	-	-	-	-	-	-	-	3	1
CO3:	2	1	1	-	-	-	-	-	-	-	2	1
CO4:	1	2	1	1	-	-	-	-	-	1	1	1
CO5:	2	1	1	1	-	-	-	-	1	1	1	1

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

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:

- T1** General Aspects of Energy Management & Energy Audit,, National Certificate Examination for Energy Managers and Energy Auditors, National Productivity Council of India
- T2** Energy Performance Assessment for Equipment and Utility systems, National Certificate Examination for Energy Managers and Energy Auditors, National Productivity Council of India

Reference Books:

- R1** Murphy, W.R. , Mckay, G. (1982) 'Energy Management ', London: Butterworth-Heinemann
- R2** K. Smith, C.B. (Ed. 4) (1981). 'Energy Management Principles : applications, benefits, savings', Amsterdam : Pergamon Press
- R3** Witte, L. C. (1988), ' Industrial energy management and utilization ', Washington: Hemisphere Pub. Corp

Web links:

- W1** <https://sustainabilityeducationacademy.com/free-online-energy-audit-course/>
- W2** <https://coursevania.com/courses/introduction-to-energy-auditing/>
- W3** <https://www.cdgtraining.com/courses/Certified-Energy-Auditor-CEA-Course-66f78d2e6560e62a1e6ef941>

FUNDAMENTALS OF IMAGE PROCESSING (Open Elective-IV)

VII Semester
Course Code: 231EC7004

L T P C
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 and restoration techniques.
- CO3** Infer the color image processing methods.
- CO4** Make use of compression methods for image processing.
- CO5** 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	1	-	-	-	-	-	-	-	-	-	-
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

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

Image compression: Fundamentals, Basic compression methods: Huffman coding, Golomb coding, Arithmetic coding, LZW coding, Run-Length coding, Symbol-Based coding, Bit-Plane coding, Block Transform coding, Predictive coding.

Unit – V

Image segmentation: Fundamentals, point, line, edge detection, thresholding, and region – based segmentation, Image segmentation based on color.

Text Books:

1. Digital Image Processing, R. C. Gonzalez and R. E. Woods, Prentice Hall, 4th edition, 2018.
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/>(Digital Image Processing, IIT Kharagpur Prof. P.K. Biswas)
3. <https://sisu.ut.ee/imageprocessing/avaleht>
4. <https://www.coursera.org/learn/digital#ratings>

ELECTRONIC MEASUREMENT TECHNIQUES (Open Elective-IV)

VII Semester
Course Code: 231EC7005

L T P C
3 0 0 3

Course Outcomes:

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

- CO1** Outline the performance characteristics of measuring Instruments.
- CO2** Make use of transducers for physical parameter measurement.
- CO3** Select signal generators and wave analyzers for the given application.
- CO4** Interpret the working principle of oscilloscopes.
- CO5** Choose a suitable bridge for 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	2	3	1	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-
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

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

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

Unit – III**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 – IV**Oscilloscopes:**

digital storage oscilloscope, Lissajous method of frequency measurement, standard specifications of Oscilloscope, probes for Oscilloscope, active and passive, attenuator type.

Unit – V**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.

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, David A. 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>

SENSORS AND ACTUATORS (Open Elective-IV)

VII Semester
Course Code: 231EC7006

L T P C
3 0 0 3

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

- CO1** Identify basic principles of mechanical, electrical, and electromechanical sensors.
- CO2** Evaluate thermal and magnetic sensors for temperature, position, and flow measurement.
- CO3** Apply radiation and electrochemical sensors in optical, nuclear, gas, and chemical systems.
- CO4** Describe smart sensors, signal conditioning, and communication in automation systems.
- CO5** Identify pneumatic, hydraulic, mechanical, and electrical actuators in control 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	1	1	-	-	-	-	-	-	-	-	-
CO2	2	3	2	1	-	-	-	-	-	-	-	-
CO3	2	3	2	2	-	-	-	-	-	-	-	-
CO4	2	3	2	2	-	-	-	-	-	-	-	-
CO5	2	3	2	2	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO 1	PSO 2
CO1		
CO2		
CO3		
CO4		
CO5		

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>

INTRODUCTION TO MACHINE LEARNING (Open Elective-IV)

Semester: VII**Course Code: 231CS7O02**

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 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 Classification SVM 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:

- T1** Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Publications, 2019
- T2** Data Science and Machine Learning Mathematical and Statistical Methods, Dirk P. Kroese, Zdravko I. Botev, Thomas Taimre, Radislav Vaisman, 25th November 2020.

Reference Books:

- R1** Machine Learning Probabilistic Approach, Kevin P. Murphy, MIT Press, 2012.
- R2** Stephen Marsland, "Machine Learning -An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

Weblinks:

- W1** <https://www.deeplearning.ai/machine-learningyearning/>
- W2** <https://www.cse.huji.ac.il/~shais/UnderstandingMachineLearning/index.html>

DATA VISUALIZATION (OPEN ELECTIVE-IV)

Semester: VII**Course Code: 231DS7O02**

L	T	P	C
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:

- T1** Ward, Grinstein, Keim, Interactive Data Visualization: Foundations, Techniques, and Applications. Natick, 2nd edition, AK Peters, Ltd 2015
- T2** Tamara Munzner, Visualization Analysis & Design, 1st edition, AK Peters Visualization Series 2016

Reference Books:

- R1** Scott Murray, Interactive Data Visualization for the Web, 2nd Edition, 2017
- R2** Tamara Munzner, Visualization Analysis & Design, 1st edition, AK Peters Visualization Series 2014

Weblinks:

- W1** https://onlinecourses.nptel.ac.in/noc22_mg67/preview
- W2** https://onlinecourses.nptel.ac.in/noc22_mg67/preview

CLOUD COMPUTING (Open Elective-IV)

Semester: VII**Course Code: 231IT7002**L
3

T	P	C
0	0	3

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

- CO 1:** Explain cloud computing concepts, service models (IaaS, PaaS, SaaS), and deployment models (public, private, hybrid).
- CO 2:** Analyze cloud-enabling technologies including distributed computing, virtualization, and SOA.
- CO 3:** Evaluate virtualization technologies and container platforms such as Docker and Kubernetes.
- CO 4:** Assess the major challenges in cloud computing, including security, interoperability, and fault tolerance.
- CO 5:** 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	-	-	-	-	-	-	-	-	-	2
CO2	2	3	2	-	-	-	-	-	-	-	-	2
CO3	2	2	3	2	2	-	-	-	-	-	-	
CO4	2	3		3	2	1	1	-	-	-	-	2
CO5	3	2	2	2	2	-	-	-	-	1	1	2

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:

- T1** Distributed and Cloud Computing, Kai Hwang, Geoffery C. Fox, Jack J. Dongarra, Elsevier, 2012.
- T2** Mastering Cloud Computing, 2nd edition, Rajkumar Buyya, Christian Vecchiola, Thamarai Selvi, Shivananda Poojara, Satish N. Srirama, Mc Graw Hill, 2024.

Reference Books:

- R1** Essentials of cloud Computing, K. Chandrasekhran, CRC press, 2014
- R2** Cloud Computing, Theory and Practice, Dan C Marinescu, 2nd edition, MK Elsevier, 2018.

Weblinks:

- W1** <https://nptel.ac.in/courses/106105167>
- W2** <https://docs.aws.amazon.com>

SOFTWARE ENGINEERING (OPEN ELECTIVE-IV)

Semester: VII**L T P C****Course Code: 231AM7O02****3 0 0 3****Course Outcomes: At the end of the course, students 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
CO1	3	2	-	-	-	-	-	1	-	-	-	1
CO2	2	1	3	2	-	-	-	-	-	-	2	2
CO3	2	2	3	-	3	-	-	2	-	-	-	-
CO4	2	2	-	3	2	1	-	-	-	-	-	-
CO5	2	2	-	-	3	-	-	1	1	-	2	2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	2
CO2	-	1
CO3	-	2
CO4	-	1
CO5	-	2

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:

- T1** Fundamentals of Software Engineering, Rajib Mall, 5th Edition, PHI
- T2** Software Engineering A Practitioner's Approach, Roger S. Pressman, 9th Edition, McGraw Hill International Edition

Reference Books:

- R1** Software Engineering, Ian Sommerville, 10th Edition, Pearson
- R2** Software Engineering, Principles and Practices, Deepak Jain, Oxford University Press.

Weblinks:

- W1** <https://nptel.ac.in/courses/106101061>
- W2** <https://nptel.ac.in/courses/106105087>

DEEPWATER TECHNOLOGY (OPEN ELECTIVE-IV)

Semester: VII**Course Code: 231PT7O4**

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, students 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
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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

- T1** Subsea Engineering Handbook, Yong bai and Qiangbai, Gulf Professional Publishing, 2010.
- T2** Offshore Petroleum Drilling and Production, By Sukumar Laik, 1st Edition, Published June 30, 2020 by CRC Press.

Reference Books:

- R1** Floating Drilling: Equipment and Its Use, by Riley Sheffield Volume 2 of Floating Drilling and Volume 2 of Practical drilling technology-1980
- R2** Handbook On Non-destructive Testing of Concrete By V.M. Malhotra And N.J. Carino, Second Edition Crc Press-2004

Weblinks:

- W1** <https://nptel.ac.in/courses/106105087>
- W2** <https://nptel.ac.in/courses/106101061>

INTRODUCTION TO ACIDIZING AND HYDRO-FRACTURING (OPEN ELECTIVE-IV)

Semester: VII

Course Code: 231PT7O05

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the course, students 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.
- CO 5:** 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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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 Books:

- T1** Reservoir Stimulation, Michael. J. Economides, Kenneth G. Nolte, 2nd Edition, Prentice Hall, 1989.

Reference Books:

- R1** Oil Well Stimulation, Robert S. Schechter, Prentice Hall, 1992
- R2** Modern Fracturing Enhancing Natural Gas Production, Michael J. Economides, Tony Martin, ET Publishing, 2007

Weblinks:

- W1** <https://nptel.ac.in/courses/106105087>
- W2** <https://nptel.ac.in/courses/106101061>

INTRODUCTION TO RESERVOIR ENGINEERING (OPEN ELECTIVE-IV)

Semester: VII

Course Code: 231PT7O06

L	T	P	C
3	0	0	3

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

- CO1:** Apply the basic concepts in reservoir engineering.
CO2: Perform basic PVT analysis of various types of fluids for wells.
CO3: Carry out the calculations in material balance and estimate the reserves of various sands of the reservoir from well data.
CO4: Apply the Darcy's Law and derive deliverability equations for various types of reservoirs.
CO5: 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	-	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	-	-
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:

- T1** Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science, 1978 (17th Impression 1998).
- T2** Reservoir Engineering Handbook, Tarek Ahmed, 3rd Edition, Gulf Professional Publishing, 2006

Reference Books:

- R1** Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman Inc. 1986
- R2** Reservoir Engineering Handbook, Tarek Ahmed, 3rd Edition, Gulf Professional Publishing, 2006.

Weblinks:

- W1** <https://nptel.ac.in/courses/106105087>
- W2** <https://nptel.ac.in/courses/106104087>

PRINCIPLES OF MINERAL ENGINEERING

Open Elective-IV

VII Semester

L T P C

Course Code: 231MI7O05

3 0 0 3

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

CO1: Describe the fundamentals and limitations of mineral dressing and microscopic analysis.

CO2: Apply crushing and grinding methods for effective mineral liberation.

CO3: Perform sizing and classification to analyze particle size distribution.

CO4: Select appropriate gravity concentration and flotation methods for mineral processing.

CO5: Develop beneficiation flow sheets and apply sampling and coal washing 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	1	1	-
CO2	3	2	-	-	-	-	-	-	1	1	1	-
CO3	3	2	-	-	-	-	-	-	1	1	1	-
CO4	3	2	-	-	-	-	-	-	1	1	1	-
CO5	3	2	-	-	-	-	-	-	1	1	1	-

UNIT – I

Scope, objectives and limitations of Mineral Dressing; Role of microscopic study.

Comminution and Liberation: Theory and practice of crushing & grinding; Conventional units used-their fields of application and limitation

UNIT – II

Sizing and Classification: Laws of settling of solids in fluid; Laboratory methods of sizing and interpretation of sizing data; Industrial sizing by screens; Types of classifiers; Classification as means of sizing by screens

UNIT – III

Gravity concentration Methods- Jigging, Flowing film concentration like spirals and shaking table, Heavy Media separation; Theory, applications and limitations of each method; Introductory Froth Flotation, physico-chemical, principles underlying flotation-reagents, flotation machines; Flotation of sulphides, oxides and non-metals..

UNIT – IV

Electrical Methods of Concentration: Electrostatic and magnetic methods, their principles of operation, fields of application and limitations.

Dewatering and drying: Thickening, filtration and drying

UNIT – V

Coal washing: Coal washability, crushing, sizing and cleaning of coal.

Sampling: Importance and methods used in ore-dressing.

Beneficiation and flow sheet of common minerals like copper, lead, zinc, gold, chromium, Aluminium etc.

Text Books:

1. Gaudin, A. M. (1939). Principles of mineral dressing. McGraw-Hill Book Company.
2. H.G. Vijendra, Handbook on Mineral Dressing. Pub: Vikas Publishing house New-Delhi

Reference Books:

1. Jain, S. K. (2018). Mineral processing (2nd ed.). CBS Publishers & Distributors.
2. Rao, G. S. R. (2017). Mineral processing: Including mineral dressing, experiments and numerical problems. I.K. International Publishing House Pvt. Ltd.

Web Links:

1. <https://www.nptel.ac.in/courses/105/105/105105171/>
2. https://miningandblasting.files.wordpress.com/2009/09/mineral_processing_notes.pdf
3. <https://www.slideshare.net/slideshow/mineral-processing-ore-dressing/24049712>

MINING INSTRUMENTATION

Open Elective-IV

VII Semester

L T P C

Course Code: 231MI7O06

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, Inclometers.

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 – Nuclear 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 – O₂, NO_x – H₂S analyzer – CO and CO₂ 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, Print ice-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

MINE SAFETY & ERGONOMICS

Open Elective-IV

VII Semester

L T P C

Course Code: 231MI7O07

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 Approving, 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
2. 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>

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
3. <https://www.slideshare.net/slideshow/geochemical-exploration/23792569>

AGRICULTURAL STRUCTURES AND PROTECTED CULTIVATION**(Open Elective-IV)****Semester: VII****Course Code: 231AG7O02**

L	T	P	C
3	0	0	3

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 greenhouse.

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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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:

- T1** Pandey, P.H. Principles and practices of Agricultural Structures and Environmental Control, Kalyani Publishers, Ludhiana
- T2** Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag, New Delhi.

Reference Books:

- R1** Venugopal Rao, P. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi
- R2** Sahay, K.M. and Singh, K.K. Unit Operations of Agricultural Processing, Vikas publishing pvt. Ltd, Noida.

Weblinks:

- W1** <https://nptel.ac.in/courses/104103020/3>
- W2** <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=618>

CAD/CAM LAB**Semester: VII****Course Code: 231ME7L01**

L	T	P	C
0	0	2	1

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

- CO1:** Apply the basic features of CATIA software to create 2D sketches using sketcher tools and geometric constraints.
- CO2:** Create 3D models and complex surfaces using part design.
- CO3:** Generate 2D engineering drawings from 3D models using drafting tools and apply dimensioning and annotation techniques.
- CO4:** Develop a CNC part program for cylindrical components.
- CO5:** Develop CNC part program for milling operations.

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	-	-	-	-	1	3	1	-	-
CO2:	-	-	2	-	-	-	-	1	3	1	-	-
CO3:	-	-	2	-	-	-	-	1	3	1	-	-
CO4:	-	-	2	-	-	-	-	1	3	1	-	-
CO5:	-	-	2	-	-	-	-	1	3	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	-
CO2:	2	-
CO3:	2	-
CO4:	2	-
CO5:	2	-

List of Experiments:**Section A: CAD LAB**

1. Introduction to CATIA, Applications & Scope, Workbenches, Extensive Capabilities, Creating Axis System.
2. Work Bench – sketcher, Sketcher Menu Bar & Sketcher Toolbar, Tools, sketcher, constraints, Profiles & Operations.
3. Work Bench - Part Design, Sketch Based Features, Dress up Features, transformation Features, Reference Elements, Boolean operations, sketcher toolbar.
4. Work Bench – GSD, Menu Bar, Wireframe Toolbar, Surfaces Toolbar, Operations, Toolbar, Tools Toolbar, Generic Tools Toolbars, Replication Toolbar, Advanced surfaces toolbar.
5. Work Bench – Drafting, Generative Drafting, Views Toolbar Automat Dimension creation.

Section A: CAM LAB

6. Practice on CNC Sinutrain Turning.
7. Practice on CNC Sinutrain Milling
8. CNC programming for turned components using FANUC Controller
9. CNC programming for milled components using FANUC Controller
10. Automated CNC Tool path & G-Code generation using Pro/E/Master CAM

List of Augmented Experiments:

1. Work Bench Assembly Design, Product Structure Tools, Move Toolbar, Constraints toolbar.
2. Study of various post processors used in NC Machines.

Software Used:

1. CATIA
2. AUTOCAD 2024
3. FANUC CNC Controllers

Text Books/ Reference Books:

- T1** Automation, Production systems & Computer integrated Manufacturing, M.P. Groover, Pearson publications Education.
- T2** Computer Control of Manufacturing systems, Yoram Korem, Indian Edition, Mc Graw Hill Education.

Weblinks:

- W1** <https://www.tinkercad.com/learn>
- W2** <https://3dp-dei.vlabs.ac.in/>

MECHATRONICS LAB**Semester: VII****Course Code: 231ME7S01**

L	T	P	C
0	0	4	2

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

- CO1** Conduct experiments to understand the working and characteristics of LVDT, Strain Gauge, Summing Amplifier, and Reflective Opto-Transducer.
- CO2** Develop and simulate ladder programs for different applications.
- CO3** Demonstrate the design and simulation of basic hydraulic circuits using Automation Studio software for industrial control 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
CO1	2	-	-	-	-	-	-	-	1		-	1
CO2	1	-	-	-	3	-	-	-	1	1	-	-
CO3	3	-	3	-	1	-	1	-	1	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1	3	-
CO2	3	-
CO3	3	-

List of Experiments

1. Characteristics of LVDT
2. Principle & Characteristics of Strain Gauge
3. Characteristics of Summing Amplifier
4. Characteristics of Reflective Opto Transducer
5. Ladder programming on Logic gates, Timers & counters
6. Ladder programming & Simulations of Traffic Light control
7. Ladder programming & Simulations of Water level control
8. Introduction to Automation studio & its control.
9. Draw & Simulate Hydraulic circuits for series & parallel cylinders connection by using Automation studio software
10. Design & Simulate Meter-in, Meter-out by using Automation studio software

List of Augmented Experiments:

1. Ladder programming & Simulations of Lift control
2. Ladder programming & Simulations of Conveyor Belt

Text Books:

- T1** Mechatronics Integrated Mechanical Electronics Systems/KP Ramachandran & G K Vijaya Raghavan/WILEY India Edition/2008
- T2** Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.

Reference Books:

- R1** Mechatronics, Smaili A, MradF, Oxford Higher Education, Oxford University Press.
- R2** Mechatronics Source Book, Newton C Braga, Thomson Publications, Chennai.
- R3** Mechatronics, N. Shanmugam, Anuradha Agencies Publishers

Weblinks:

- W1** <http://www.htl-worldwide.com/the-difference-between-pneumatic-hydraulic-and-electrical-actuators/>
- W2** <https://www.worldscientific.com/worldscibooks/10.1142/10193>

RESEARCH METHODOLOGY (Audit Course)

Semester: VII**Course Code: 231MC7T01**

L	T	P	C
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:

- R1 Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd., 1997.
- R2 Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi, 2011

Weblinks:

- W1 <https://nptel.ac.in/courses/127106227>
- W2 https://www.youtube.com/watch?v=IZLn9_PA_4s

PROJECT (FULL SEMESTER INTERNSHIP)**Semester: VIII****L T P C****Course Code: 231ME8P01****0 0 24 12****Guidelines for Project:**

The objective of this project work is to enable the student to take up investigative study in the field of Mechanical 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.