

PROGRAM STRUCTURE AND SYLLABUS

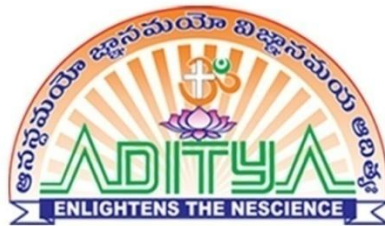
(I to VIII Semesters)

**ELECTRONICS AND
COMMUNICATION 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 become a center of excellence in the field of Electronics and Communication Engineering with technological capability, professional commitment and social responsibility.

MISSION

M1. Provide quality education, well-equipped laboratory facilities and industry collaboration.

M2. Promote cutting edge technologies to serve the needs of the society and industry through innovative research.

M3. Inculcate professional ethics and personality development skills.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)**Graduates of the Program will**

PEO 1	Adapt the learning culture needed for a successful professional career and pursue research.
PEO 2	Build modern electronic systems by considering technical, environmental and social contexts.
PEO 3	Communicate effectively and demonstrate leadership qualities with professional ethics.

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	Provide sustainable solutions in the field of Communication and Signal Processing.
PSO 2	Apply current technologies in the field of VLSI and embedded systems for professional growth.

Mission of the department – PEOs mapping

PEO's Statements	M1	M2	M3
PEO 1: Adapt the learning culture needed for a successful professional career and pursue research.	3	2	2
PEO 2: Build modern electronic systems by considering technical, environmental and social contexts.	2	3	2
PEO 3: Communicate effectively and demonstrate leadership qualities with professional ethics.	2	2	3

Mapping / Correlation levels
Slight (Low)
Moderate (Medium)
Substantial (High)

INDUCTION PROGRAMME

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

PROGRAM STRUCTURE**I Semester**

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

II Semester

S.No.	Course Code	Course Title	Course Component	L	T	P	C
1	231BS2T01	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	231EC2T01	Network Analysis	PCC	3	0	0	3
6	231BS2L01	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	231EC2L01	Network Analysis and Simulation Laboratory	PCC	0	0	3	1.5
10	231HS2L03	NSS/NCC/Scouts & Guides/Community Service	HSMC	0	0	1	0.5
11	231MC2T01	Constitution of India	MC	2	0	0	0
12	231MC2T02	Cognitive English for Engineers – I	MC	0	0	2	0
TOTAL							21

III Semester

S.No.	Course Code	Course Title	Course Component	L	T	P	C
1	231BS3T04	Probability theory and stochastic process	BSC	3	0	0	3
2	231HS3T01	Universal Human Values	HSMC	2	1	0	3
3	231EC3T03	Signals and Systems	PCC	3	0	0	3
4	231EC3T01	Electronic Devices and Circuits	PCC	3	0	0	3
5	231EC3T02	Switching Theory and Logic Design	PCC	3	0	0	3
6	231EC3L01	Electronic Devices and Circuits Lab	PCC	0	0	3	1.5
7	231EC3L02	Switching Theory and Logic Design Lab	PCC	0	0	3	1.5
8	231EC3S01	Data Structures using Python	SC	0	1	2	2
9	231EC3P01	Community Service Project	PROJ	0	0	4	0
10	231MC3T03	Cognitive English for Engineers - II	MC	0	0	2	0
TOTAL							20

IV Semester

S.No.	Course Code	Course Title	Course Component	L	T	P	C
1	231HS4T01	Managerial Economics and Financial Analysis	HSMC	2	0	0	2
2	231ES4T05	Control Systems Engineering	ESC	3	0	0	3
3	231EC4T01	Electromagnetic Waves and Transmission Lines	PCC	3	0	0	3
4	231EC4T02	Electronic Circuit Analysis	PCC	3	0	0	3
5	231EC4T03	Analog Communications	PCC	3	0	0	3
6	231EC4L01	Signals and Systems Lab	PCC	0	0	3	1.5
7	231EC4L02	Electronic Circuit Analysis 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	231MC4T02	Biology for Engineers	MC	2	0	0	0
TOTAL							21

V SEMESTER

S.No	Course Code	Course Name	Category	L	T	P	C
1	231EC5T01	Analog & Digital IC Applications	PCC	3	0	0	3
2	231EC5T02	Digital communications	PCC	3	0	0	3
3	231EC5T03	Antennas and Wave Propagation	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	231EC5L01	Analog & Digital IC Applications Lab	PCC	0	0	3	1.5
7	231EC5L02	Analog and digital communications Lab	PCC	0	0	3	1.5
8	231EC5S01	Applications of Lab view for Instrumentation & Communications	SEC	0	1	2	2
9	231EC5L03	Design of PCB/Antennas lab	PCC	0	0	2	1
10	231MC5T01	Professional Ethics and Human Values	MC	2	0	0	-
11	231EC5P01	Summer Internship-I	PROJ	-	-	-	2
Total				15	1	10	23

VI SEMESTER

S.No	Course Code	Course Name	Category	L	T	P	C
1	231EC6T01	VLSI Design	PCC	3	0	0	3
2	231EC6T02	Microprocessors & Microcontrollers	PCC	3	0	0	3
3	231EC6T03	Digital Signal Processing	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	231EC6L01	VLSI Design Lab	PCC	0	0	3	1.5
8	231EC6L02	Microprocessors & Microcontrollers Lab	PCC	0	0	3	1.5
9	231EC6S01	Machine Learning Lab	SEC	0	1	2	2
10	231MC6T01	Technical paper writing and IPR	MC	2	0	0	-
Total				20	1	08	23
Mandatory Industry Internship of 08 weeks duration during summer vacation							

VII SEMESTER

S.No	Course Code	Course Name	Category	L	T	P	C
1	231EC7T01	Cellular & Mobile Communications	PCC	3	0	0	3
2	231HS7T03	Management Science	HSMC	2	0	0	2
3		Professional Elective-IV	PEC - IV	3	0	0	3
4		Professional Elective-V	PEC - V	3	0	0	3
5		Open Elective – III	OEC - III	3	0	0	3
6		Open Elective-IV	OEC - IV	3	0	0	3
7	231EC7S01	Digital Signal and Image Processing Lab	SEC	0	0	4	2
8	231MC7T01	Research methodology	MC	2	0	0	-
9	231EC7P01	Summer Internship-II	PROJ	-	-	-	2
Total				19	0	04	21

VIII SEMESTER

S.No.	Course Code	Course Name	Category	L	T	P	C
1	231EC8P01	Project (Full Semester Internship)	PROJ	-	-	24	12

Professional Elective – I (V Semester)**Professional Elective – II (VI Semester)**

S.No	Course Code	Name of the Course	S.No	Course Code	Name of the Course
1	231EC5E01	Digital System Design through HDL	1	231EC6E01	Analog IC Design
2	231EC5E02	Artificial Intelligence	2	231EC6E02	Satellite Communication
3	231EC5E03	Electronic Measurements and Instrumentation	3	231EC6E03	Smart and Wireless Instrumentation
4	231EC5E04	Computer Organization and Architecture	4	231EC6E04	Machine Learning
5		MOOCS-NPTEL/SWAYAM	5		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	Name of the Course
1	231EC6E05	Bio Medical Instrumentation	1	231EC7E01	low power VLSI Design
2	231EC6E06	Microwave Engineering	2	231EC7E02	Coding Theory and Applications
3	231EC6E07	Embedded Systems	3	231EC7E03	DSP Processors and Architectures
4	231EC6E08	Optical Communications	4	231EC7E04	Soft Computing Techniques
5		MOOCS-NPTEL/SWAYAM	5		MOOCS-NPTEL/SWAYAM

Professional Elective – V (VII Semester)

S.No	Course Code	Name of the Course
1	231EC7E05	Design for Testability
2	231EC7E06	Radar Engineering
3	231EC7E07	Digital Image Processing
4	231EC7E08	Internet of Things
5		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.	231CE5001	Waste Water Management	CE
2.	231CE5002	Construction Technology & Management	CE
3.	231CE5003	Green Buildings	CE
4.	231EE5001	Renewable Energy Sources	EEE
5.	231EE5002	Concepts of Energy Auditing & Management	EEE
6.	231ME5001	Sustainable Energy Technologies	ME
7.	231ME5002	Applied Operations Research	ME
8.	231ME5003	Nano Technology	ME
9.	231ME5004	Thermal Management of Electronic systems	ME
10.	231ME5005	Entrepreneurship	ME
11.	231EC5001	Principles of Signals and Systems	ECE
12.	231EC5002	Introduction to Internet of Things	ECE
13.	231EC5003	Digital Electronics and Logic Design	ECE
14.	231CS5001	Database Management Systems	CSE
15.	231DS5001	Python Programming	DS
16.	231IT5001	Computer Organization	IT
17.	231AM5001	Object Oriented Programming Through Java	AIML
18.	231PT5001	Introduction to Petroleum Engineering	PT
19.	231PT5002	Introduction to Petroleum Geology	PT
20.	231PT5003	Introduction to Well Logging	PT
21.	231MI5001	Introduction to Underground Mining	Min.E
22.	231MI5002	Introduction to Surface Mining	Min.E
23.	231MI5003	Tunnelling and Underground Space Design	Min.E
24.	231MI5004	Introduction to Mine Environment	Min.E
25.	231AG5001	Basic Crop Production Practices	Ag.E
26.	231AG5002	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 Waste Water Management	CE
2.	231CE7O02	Basics of RS&GIS	CE
3.	231CE7O03	Safety Engineering	CE
4.	231EE7O01	Battery Management Systems and Charging Stations	EEE
5.	231EE7O02	Concepts of Smart Grid Technologies	EEE
6.	231ME7O01	Finite Element Methods	ME
7.	231ME7O02	Introduction to Mechatronics	ME
8.	231ME7O03	Product design and development	ME
9.	231ME7O04	Advanced Materials	ME
10.	231ME7O05	Smart Manufacturing	ME
11.	231EC7O01	Discrete Time Signal Processing	ECE
12.	231EC7O02	Linear and Digital IC Applications	ECE
13.	231EC7O03	Principles of Embedded Systems	ECE
14.	231CS7O01	Cyber Security	CSE
15.	231DS7O01	Bigdata Analytics	DS
16.	231IT7O01	Internet of things	IT
17.	231AM7O01	Computer Networks	AIML
18.	231PT7O01	Pipeline Engineering	PT
19.	231PT7O02	Introduction to Seismic methods	PT
20.	231PT7O03	Introduction to Artificial Lift Methods	PT
21.	231MI7O01	Mine Waste Management	Min.E
22.	231MI7O02	Sustainable 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
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management Courses
PCC-CS	Professional Core Courses
PEC-CS	Professional Elective Courses
OEC-CS	Open Elective Courses
MC	Mandatory Courses
SC	Skill oriented course
PROJ	Project

ENGINEERING PHYSICS

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

I Semester	L	T	P	C
Course Code: 231BS1T01	3	0	0	3

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

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

Mapping of Course Outcomes with Program Outcomes:

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	L	T	P	C
Course Code: 231BS1T02	3	0	0	3

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

- CO1:** Solve the system of Linear equations
- CO2:** Calculate Eigen values and Eigen vectors
- CO3:** Apply Mean value theorems for given functions
- CO4:** Calculate the Maximum value and Minimum value of a function of several variables
- CO5:** Compute areas and volumes using multiple integrals

Mapping of Course Outcomes with Program Outcomes:

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

Unit-I:

Matrices :

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

Unit-II:

Eigen values, Eigen vectors and Orthogonal Transformation :

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

Unit-III:

Calculus :

Mean Value Theorems: Rolle’s Theorem, Lagrange’s mean value theorem with their geometrical interpretation, Cauchy’s mean value theorem, Taylor’s and Maclaurin theorems

with remainders (without proof), Problems and applications on the above theorems.

Unit-IV:

Partial differentiation and Applications (Multi variable calculus) :

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

Unit-V:

Multiple Integrals (Multi variable Calculus) :

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

Text Books:

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

Reference Books:

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

Web Links:

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

BASIC CIVIL AND MECHANICAL ENGINEERING

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

I Semester	L T P C
Course Code: 231ES1T01	3 0 0 3

Course Outcomes:

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

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

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Outcomes

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

PART A: BASIC CIVIL ENGINEERING

UNIT I

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

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

UNIT II

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

UNIT III

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

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

Text Books:

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

Reference Books:

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

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_ce42/preview
2. https://www.youtube.com/watch?v=chhuq_t40rY&list=PL20A0651466E8A776
3. https://www.youtube.com/results?search_query=Transportation+engineering+NPTTEL
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 All branches of Engineering)

I Semester	L T P C
Course Code: 231ES1T02	1 0 4 3

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

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

Mapping of course outcomes with program outcomes:

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

UNIT I

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

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

UNIT II

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

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

UNIT III

Projections of Planes: Regular planes Perpendicular to both reference planes, parallel to one

reference plane and inclined to the other reference plane; plane inclined to both the reference planes.

UNIT IV

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

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

UNIT V

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

Text books:

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

Reference Books:

1. Engineering Drawing, K.L. Narayana and P. Kanniah, 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://freevidelectures.com/Course/3420/Engineering-Drawing>
3. <http://engineeringdrawing.org>
4. <http://inoxwap.com/video/category/engineering-drawing-for-first-year-engineering.html>

COMMUNICATIVE ENGLISH**(Common to all branches)**

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

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

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

Mapping of Course Outcomes with Program Outcomes:

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

UNIT I**Lesson: HUMAN VALUES: The Gift of The Magi by O. Henry (Short Story)****Listening:** Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions.**Speaking:** Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others.**Reading:** Skimming to get the main idea of a text; scanning to look for specific pieces of information.**Writing:** Mechanics of Writing-Capitalization, Spellings, Punctuation-Parts of Sentences.**Grammar:** Parts of Speech, Basic Sentence Structures-forming questions**Vocabulary:** Synonyms, Antonyms, Affixes (Prefixes/Suffixes), Root words.**UNIT II****Lesson: NATURE: The Brook by Alfred Tennyson (Poem)****Listening:** Answering a series of questions about main ideas and supporting ideas after listening to audio texts.**Speaking:** Discussion in pairs/small groups on specific topics followed by short structure

talks.

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

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

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

Vocabulary: Homonyms, Homophones, Homographs.

UNIT III

Lesson: BIOGRAPHY: Elon Musk

Listening: Listening for global comprehension and summarizing what is listened to.

Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed

Reading: Reading a text in detail by making basic inferences -recognizing and interpreting specific context clues; strategies to use text clues for comprehension.

Writing: Summarizing, Note-making, paraphrasing

Grammar: Verbs - tenses; subject-verb agreement; Compound words, Collocations

Vocabulary: Compound words, Collocations

UNIT IV

Lesson: INSPIRATION: The Toys of Peace by Saki

Listening: Making predictions while listening to conversations/ transactional dialogues without video; listening with video.

Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.

Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data.

Writing: Letter Writing: Official Letters, Resumes

Grammar: Reporting verbs, Direct & Indirect speech, Active & Passive Voice

Vocabulary: Words often confused, Jargons

UNIT V

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

Listening: Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension.

Speaking: Formal oral presentations on topics from academic contexts.

Reading: Reading comprehension.

Writing: Writing structured essays on specific topics.

Grammar: Editing short texts –identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)

Vocabulary: Technical Jargons

Text Books:

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

Reference Books:

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

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

Week 2: System Assembling and Disassembling

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

Week 3: Virtual Machine setup

- Setting up and configuring a new virtual machine.

Week 4: Installation of software

- Every student should individually install LINUX on the personal computer.
- 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

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

Week 6: Text Editors

- 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, IITL Education Solutions limited, Pearson Education, 2012, 2nd edition.
4. PC Hardware - A Handbook, Kate J. Chase, PHI (Microsoft).
5. LaTeX Companion, Leslie Lamport, PHI/Pearson.
6. Essential Computer and IT Fundamentals for Engineering and Science Students, Dr.N.B.Vekateswarlu, S.Chand.

Web Links:

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

COMMUNICATIVE ENGLISH LAB**(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)**

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

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

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

Mapping of Course Outcomes with Program Outcomes:

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

List of Topics:

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

Suggested Software:

- Walden Infotech
- Young India Films

- Cambridge Empower

Reference Books:

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

Web Links:**Spoken English:**

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

Voice & Accent:

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

HEALTH AND WELLNESS, YOGA AND SPORTS

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

I Semester

Course Code: 231HS1L02

L T P C

0 0 1 0.5

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

CO1: Explain the importance of yoga and sports for Physical fitness and sound health.

CO2: Demonstrate an understanding of health-related fitness components.

CO3: Compare and contrast various activities that help enhance their health.

CO4: Assess current personal fitness levels.

CO5: Develop Positive Personality

Mapping of Course Outcomes with Program Outcomes:

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

UNIT I

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

Activities:

- 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 as 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.

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

I Semester	L	T	P	C
Course Code: 231MC1T01	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

CHEMISTRY
(Common to EEE, ECE)

II Semester
Course Code: 231BS2T01

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

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

- CO1** Summarize the fundamentals of bonding models.
- CO2** Discuss the fundamentals and applications of polymers.
- CO3** Outline the difference between primary and secondary cells.
- CO4** Interpret the various modern engineering materials and their applications
- CO5** Illustrate about Spectroscopic Methods and Chromatographic Techniques.

Mapping of Course Outcomes with Program Outcomes:

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

Unit-I:

Structure and Bonding Models

Valence bond theory, Hybridisation - Types of hybridizations - Molecular orbital theory – bonding in homo- and heteronuclear diatomic molecules – energy level diagrams of H₂, B₂, N₂, O₂ and CO, NO. π -molecular orbitals of butadiene and benzene, calculation of bond order.

UNIT II:

Polymer Chemistry

Introduction to polymers, functionality of monomers, chain growth and step growth polymerization, coordination polymerization, with specific examples and methods of polymerization (Suspension polymerization and Emulsion Polymerization)

Plastics: Thermoplastics and Thermosetting polymers, Preparation, properties, and applications of PVC, Teflon, Bakelite, Nylon-6,6.

Elastomers–Buna-S, Buna-N–preparation, properties, and applications.

Conducting polymers: polyacetylene, polyaniline, – mechanism of conduction and applications.

Bio-Degradable polymers - Poly Glycolic Acid (PGA), Poly L-Lactic Acid (PLA).

UNIT III:**Electrochemistry and Applications**

Electrochemical cell, Nernst equation, cell potential calculations and numerical problems, potentiometry- potentiometric titrations (redox titrations), concept of conductivity, conductivity cell, conductometric titrations (acid-base titrations).

Electrochemical sensors – potentiometric sensors with examples, amperometric sensors with examples.

Primary cells – Zinc-air battery, Secondary cells –lithium-ion batteries- working of the batteries including cell reactions; Fuel cells, hydrogen-oxygen fuel cell– working of the cells. Polymer Electrolyte Membrane Fuel cells (PEMFC).

Unit-IV:**Modern Engineering materials**

Semiconductors, band diagram in solids, Semiconductor devices (p-n junction diode as rectifier and transistors)

Super conductors-Introduction, types, and applications.

Supercapacitors: Introduction, Basic Concept-Classification and applications.

Nano materials: Introduction, Preparation of nano materials by Sol-Gel method, Applications of Fullerenes, carbon nano tubes and Graphene nanoparticles.

Unit-V:**Instrumental Methods and Applications**

Electromagnetic spectrum. Absorption of radiation: Beer-Lambert's law. UV-Visible Spectroscopy, electronic transition, Instrumentation, IR spectroscopies, fundamental modes and selection rules, Instrumentation. Chromatography-Basic Principle, Classification-HPLC: Principle, Instrumentation and Applications.

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. Skoog and West, Principles of Instrumental Analysis, 6/e, Thomson, 2007.
2. Dr S.S.Dara, Dr S.S.Umare , A Textbook of Engineering Chemistry, S.Chand Publication, 2022 .

Web Links:

1. <https://archive.nptel.ac.in/courses/104/106/104106096/>
2. <https://archive.nptel.ac.in/courses/104/105/104105124/>
3. <https://archive.nptel.ac.in/courses/104/106/104106137/>
4. <https://nptel.ac.in/courses/118102003>
5. <https://archive.nptel.ac.in/courses/104/106/104106075/>

DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS
(Common to all branches)

II Semester	L	T	P	C
Course Code: 231BS2T03	3	0	0	3

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

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

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
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	L	T	P	C
Course Code: 231ES2T01	3	0	0	3

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

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

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

PART A: BASIC ELECTRICAL ENGINEERING

UNIT-1 DC & AC Circuits

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

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

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

UNIT-II Machines and Measuring Instruments

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

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

UNIT-III Energy Resources, Electricity Bill & Safety Measures

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

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

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

Text Books:

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

Reference Books:

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

Web Links:

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

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

PART B: BASIC ELECTRONICS ENGINEERING

UNIT I SEMICONDUCTOR DEVICES

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

UNIT II BASIC ELECTRONIC CIRCUITS AND INSTRUMENTATION

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

Electronic Instrumentation: Block diagram of an electronic instrumentation system.

UNIT III DIGITAL ELECTRONICS

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

Text books:

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

Reference Books:

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

Web Links:

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

INTRODUCTION TO PROGRAMMING

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

II Semester

Course Code: 231ES2T02

L T P C

3 0 0 3

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

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

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

CO3: Solve complex problems using Arrays and Strings.

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

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

Mapping of Course Outcomes with Program Outcomes:

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

UNIT I Introduction to Programming and Problem Solving

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

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

UNIT II Control Structures

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

UNIT III Arrays and Strings

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

UNIT IV Functions & Pointers

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

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

UNIT V User Defined Data types & File Handling

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

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

Text books:

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

Reference Books:

1. Computing fundamentals and C Programming, Balagurusamy, E., McGraw-Hill Education, 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.

NETWORK ANALYSIS

II Semester
Course Code: 231EC2T01

L	T	P	C
3	0	0	3

Course Outcomes:

At the end of this course, students will be able to

CO1: Apply mesh and nodal analysis to DC and AC circuits.

CO2: Analyze the circuit using network theorems.

CO3: Apply Transient response to first and second order systems.

CO4: Outline the characteristics of resonant and coupled circuits.

CO5: Compute the parameters of a two-port network.

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT I

Introduction: Types of circuit components, Types of Sources and Source Transformations, Mesh analysis and Nodal analysis, problem solving with resistances only including dependent sources also, principle of Duality with examples.

Steady State Analysis of A.C Circuits: Impedance concept, phase angle and phasor notation for series R-L, R-C, and R-L-C circuits, mesh and nodal analysis, Star-Delta conversion, problem solving.

UNIT II

Network Theorems: Thevenin's, Norton's, Reciprocity, Max Power Transfer, Tellegen's, problem solving using dependent sources also.

UNIT III

Transients: First order differential equations, Definition of time constants, R-L circuit, R-C circuit with DC excitation, evaluating initial conditions procedure, second order differential equations, homogeneous, non-homogenous, problem-solving using R-L-C elements with DC excitation and AC excitation.

UNIT IV

Resonance: Introduction, Definition of Q, Series resonance, Bandwidth of series resonance, Parallel resonance, general case-resistance present in both branches, anti-resonance at all frequencies.

Coupled Circuits: Self-inductance, Mutual inductance, Coefficient of coupling, analysis of coupled circuits.

UNIT V

Two-port Networks: Relationship of two port networks, Z-parameters, Y-parameters, Transmission line parameters, h- parameters, Relationships Between parameter Sets, cascading of two port networks, problem solving using dependent sources also. Image and iterative impedances.

Text books:

1. Joseph Edminister and Mahmood Nahvi, Electric Circuits, Schaum's Outline Series, 7th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2017
2. Engineering Circuit Analysis by William H. Hayt, Jack Kemmerly, Jamie Phillips, Steven M. Durbin, 9th Edition 2020.
3. Network lines and Fields by John. D. Ryder 2nd Edition, PHI

Reference Books:

1. Network Analysis – ME Van Valkenburg, Prentice Hall of India, revised 3rd Edition, 2019.
2. D. Roy Choudhury, Networks and Systems, New Age International Publications, 2013.
3. Fundamentals of Electric Circuits by Charles K. Alexander and Matthew N. O. Sadiku, McGraw-Hill Education.

Web Links:

1. <https://www.falstad.com>
2. <http://ocw.mit.edu>
3. www.allaboutcircuits.com
4. www.analyzethat.net

CHEMISTRY LAB**(Common to EEE, ECE)****II Semester****L T P C****Course Code: 231BS2L01****0 0 2 1****Course Outcomes:** At the end of the course, the students will be able to:

- CO1** Analyze and improve the experimental skills.
- CO2** Summarize parameters of water
- CO3** Analyze the strength of acids by instrumentation.
- CO4** Preparation of polymer and nano particles
- CO5** Analysing the samples by Spectroscopic and chromatographic techniques

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	2	-	-	-	-	-	-	-	2	-	-	-

List of Experiments (Any ten Experiments):

1. Determination of Hardness of a ground water sample
2. Determination of Chloride content in given water sample
3. Estimation of dissolved oxygen in given water sample
4. Estimation of Vitamin-C in ascorbic acid
5. Preparation of a polymer (Bakelite)
6. Conductometric titration of strong acid vs strong base
7. Potentiometry - determination of strong acid -strong base
8. Paper chromatography technique

9. Preparation of nano particles by Green synthesis
10. Determination of Strength of an acid in Pb-Acid battery

Augmented Experiments (Any One Experiment to be conducted):

11. Wavelength measurement of sample through UV-Visible Spectroscopy
12. Identification of simple organic compounds by IR

Reference Books:

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

ELECTRICAL AND ELECTRONICS ENGINEERING LAB**(Common to CE, EEE, ME, ECE, Min.E, PT & Ag.E)**

II Semester
 Course Code:231ES2L01

L	T	P	C
0	0	3	1.5

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

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

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

PART A: ELECTRICAL ENGINEERING LAB

List of experiments:

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

List of Augmented Experiments:

(Any one of the following experiment can be performed)

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

Reference Books:

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

Web Links:

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

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

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

List of Augmented Experiments:

(Any one of the following experiment can be performed)

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

References:

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

Web Links:

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

COMPUTER PROGRAMMING LAB

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

II Semester

L T P C

Course Code: 231ES2L02

0 0 3 1.5

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

CO1: Develop the basic C programs in different environments.

CO2: Utilize appropriate control structures, arrays and strings for problem solving.

CO3: Develop modular programming using functions.

CO4: Apply pointers for dynamic memory allocation and file operations for file handling.

CO5: Make use of structures and unions to handle heterogeneous data.

Mapping of Course Outcomes with Program Outcomes:

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

List of Experiments:

Develop the following programs using ‘C’

Week 1: Explore different platforms

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

Week 2: Basics and Operators

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

Objective: Learn how to work with bits (0,1) and bitwise operators.

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

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

Week 3: Operators and Expressions, Variables and Type conversions

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

Week 4: Conditional Statements

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

Week 5: Loops

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

Week 6: Arrays

- a. 1D Arrays in C
Objective: Print the sum and free the memory where the array is stored.
<https://www.hackerrank.com/challenges/1d-arrays-in-c/problem?isFullScreen=true>
- b. Array reversal

Objective: Working with indices in array

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

- c. Search an element in array (Linear Search)
- d. Find min and max elements in array
- e. Insert an element into array
- f. Eliminate duplicate elements from array
- g. Sorting of elements in an array using Bubble sort

Week 7: 2-D Arrays

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

Week 8: Strings

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

Week 9: Functions and Recursion

- a. Functions in C
Objective: Learn simple usage of functions.
<https://www.hackerrank.com/challenges/functions-in-c/problem?isFullScreen=true>
- b. Fibonacci Numbers
Objective: Complete the recursive function.
<https://www.hackerrank.com/challenges/ctci-fibonacci-numbers/problem>
- c. Factorial
Objective: N! (N factorial) using recursion.
<https://www.hackerrank.com/contests/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 upto single digit (Lucky Number)
33. Display the Fibonacci series [Hint: 0 1 1 2 3 5 ... (sum of the consecutive numbers)].
34. Display from 1 to 20 [Eg: 5 * 1 = 5 5 * 20 = 100].
35. Display following format

- 1 2
 1 2 3
 1 2 3 n
36. Display following format (Floyd's Triangle)
 1
 2 3
 4 5 6

37. Display following format
 1
 1 2
 1 2 3
n
 3 2 1
 2 1
 1
38. Generate pyramid structure format
 0
 1 0 1
 2 1 0 1 2
 3 2 1 0 1 2 3
39. Generate Pascal triangle format
 1
 1 1
 1 2 1
 1 3 3 1
 1 4 6 4 1
40. Find the value of ncr [Hint : $n!/r!(n-r)!$].
 41. Print the sum of the following series. $1 + x + x^2 + x^3 + \dots + x^n$
 42. Print the sum of the following series. $1 + x + x^2/2 + x^3/3 + \dots + x^n/n$
 43. Print the sum of the following series. $1 + x + x^2/2! + x^3/3! + \dots + x^n/n!$
 44. Print the sum of the following series. $X + x^3/3! + \dots + x^n/n!$
 45. Find LCM & GCD of given numbers.
 46. Convert decimal number to binary number and vice versa
 47. Convert Decimal number to Octal number and vice versa.
 48. Convert Decimal number to Hexa-Decimal number and vice versa.
 49. Read elements into array and display them.
 50. Accept 'n' cells into integer array
 i) copy into another array in reverse order.
 ii) accept a number to search and how many times that number is found and print the positions at which it is found.
 iii) accept the delete position and delete that position value from the array.
 iv) accept a value and a position to insert the accepted value into that position.
 v) accept delete value and delete that value from array.
 vi) and place the even numbers in one array and odd numbers in another array.
 vii) count number of even, odd values and display.

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


```

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

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

NETWORK ANALYSIS AND SIMULATION LABORATORY

II Semester
Course Code: 231EC2L01

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

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

CO1: Examine electric circuits using mesh, nodal analysis and network theorems.

CO2: Measure time constants of RL & RC circuits.

CO3: Analyze behavior of RLC circuit for different cases.

CO4: Analyze the characteristics of resonant circuit.

CO5: Characterize and model the network in terms of all network parameters.

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

The following experiments need to be performed using Hardware or simulation Software.

1. Verification of mesh and nodal analysis for DC Circuits (T & Pi Networks).
2. Verification of Thevenin's & Norton's theorems.
3. Verification of maximum power transfer theorem.
4. Verification of Tellegen's theorem for two networks of the same topology.
5. Obtain the transient response of RL, RC, and RLC circuits with DC excitation.
6. Obtain frequency response of first-order RL & RC networks.
7. Obtain the transient and steady-state response of a second-order circuit.
8. Determine the Bandwidth and Q Factor of a Series and Parallel Resonance circuit.
9. Determination of open circuit (Z) and short circuit (Y) parameters

10. Determination of hybrid (H) and transmission (ABCD) parameters

List of Augmented Experiments

(Any one of the following experiment can be performed)

11. Determination of self, mutual inductances, and coefficient of coupling.
12. Verification of Reciprocity theorem.

Hardware Requirements:

Regulated Power supplies, Analog/Digital Function Generators, Digital Multimeters, Decade Resistance Boxes/Rheostats, Decade Capacitance Boxes, Ammeters (Analog or Digital), Voltmeters (Analog or Digital), Active and passive Electronic Components

Software requirements:

Multisim/ Pspice/Equivalent simulation software tool, Computer Systems with required specifications

References:

1. Joseph Edminister and Mahmood Nahvi, Electric Circuits, Schaum's Outline Series, 7th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2017
2. Engineering Circuit Analysis by William H. Hayt, Jack Kemmerly, Jamie Phillips, Steven M. Durbin, 9th Edition 2020.
3. Introduction to Pspice Using Orcad for Circuits and Electronics by Muhammad H. Rashid, 3rd Edition 2005.

Web Links:

1. <https://www.falstad.com>
2. <http://ocw.mit.edu>
3. www.allaboutcircuits.com
4. www.analyzethat.net

NSS/NCC/SCOUTS & GUIDES/COMMUNITY SERVICE

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

II Semester	L	T	P	C
Course Code:231HS2L03	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:

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

UNIT II Nature & Care

Activities:

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

UNIT III Community Service**Activities:**

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

Reference Books:

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

General Guidelines:

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

Evaluation Guidelines:

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

*** **

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. NewDelhi.
2. Subash Kashyap, Indian Constitution, National BookTrust.

Reference Books:

1. J.A. Siwach, Dynamics of Indian Government & Politics.
2. D.C. Gupta, Indian Government 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	L	T	P	C
Course Code: 231MC2T02	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. 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

PROBABILITY THEORY AND STOCHASTIC PROCESS

III Semester	L	T	P	C
Course Code: 231BS3T04	3	0	0	3

Course Outcomes:

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

- CO1:** Solve probabilistic problems using basic Probability concepts.
- CO2:** Summarize the properties of a random variable.
- CO3:** Infer the characteristics of single and multiple random variables
- CO4:** Interpret the characteristics of random process in time domain and frequency domain.
- CO5:** Summarize the functions of complex variable and complex integration.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Probability introduced through Sets and Relative Frequency: Experiments and Sample Spaces, Discrete and Continuous Sample Spaces, Events, Probability Definitions and Axioms.

Joint Probability, Conditional Probability, Total Probability, Bay's Theorem, Independent Events.

UNIT-II

Random Variable: Definition, Conditions for a Function to be a Random Variable, Discrete, Continuous and Mixed Random Variable, Distribution and Density functions, Properties.

Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, Methods of defining Conditioning Event, Conditional Distribution, Conditional Density and their Properties.

UNIT – III**Operations on Single & Multiple Random Variables–Expectations:**

Expected Value of a Random Variable, Function of a Random Variable, Moments about the Origin, Central Moments, Variance and Skew, Characteristic Function, Moment Generating Function, Joint Distribution Function and its Properties, Marginal Distribution Functions, Conditional Distribution and Density, Conditional Distribution and Density.

Sum of Two Random Variables, Sum of Several Random Variables, Central Limit Theorem, (Proof not expected). Unequal Distribution, Equal Distributions. Expected Value of a Function of Random Variables: Joint Moments about the Origin, Joint Central Moments, Joint Characteristic Functions, Jointly Gaussian Random Variables: Two Random Variables case, N Random Variable case, Properties.

UNIT – IV**Random Processes– Temporal & Spectral Characteristics:**

Temporal characteristics: The Random Process Concept, classification of Processes, Deterministic and Nondeterministic Processes, Distribution and Density Functions, concept of Stationarity and Statistical Independence. First-Order Stationary Processes, Second Order and Wide-Sense Stationarity, (N-Order) and Strict-Sense Stationarity, Time Averages and Ergodicity, Mean-Ergodic Processes, Covariance Functions, Random Signal Response of Linear Systems: System Response – Convolution, Mean and Mean-squared Value of System Response.

Spectral Characteristics: The Power Spectrum: Properties, Relationship between Power Spectrum and Autocorrelation Function, the Cross-Power Density Spectrum, Properties, Relationship between Cross-Power Spectrum and Cross-Correlation Function.

UNIT – V**Functions of a Complex variable and Complex integration:**

Functions of a Complex variable: 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

Text Books:

1. Probability, Random Variables & Random Signal Principles, Peyton Z. Peebles, TMH Publications, 4th Edition.
2. Probability-Random Variables and Stochastic Processes, Athanasios Papoulis and S. Unnikrishna, PHI Publications, 4th Edition.

Reference Books:

1. Probability Theory and Stochastic Processes, Y. Mallikarjuna Reddy, Universities Press (India) Pvt. Ltd., 4th Edition.
2. Probability and Random Processes with Applications to Signal Processing, Henry Stark and John W. Woods, Pearson Education, International Edition.
3. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers.

Web Links:

1. <http://nptel.ac.in/courses/117105085/> - by Prof.M.Chakraborty, IIT Khargpur
2. <https://ocw.mit.edu/courses/mathematics/18-445-introduction-to-stochastic-processes-spring-2015/> - Offered by MIT

UNIVERSAL HUMAN VALUES

III Semester	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	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	-	-	-
CO4	-	-	-	-	-	-	2	1	1	-	-	-
CO5	-	-	-	-	-	-	2	1	1	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

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

- Tutorial:** Practice Session 1. Sharing about Oneself
 2.Exploring Human Consciousness
 3.Exploring Natural Acceptance

UNIT-II

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

Tutorial: Practice Session 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 – III

Harmony in the Family and Society: Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, Practice Session PS7 Exploring the Feeling of Trust, 'Respect' – as the Right Evaluation, 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 – IV

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

Tutorial: Practice Session 1. Exploring the Four Orders of Nature,
 2. Exploring Co-existence in Existence.

UNIT – V

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

Reference Books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi.
3. E G Seebauer & Robert L. Berry, Fundamentals of Ethics for Scientists & Engineers, Oxford University Press

Web Links:

1. <https://www.youtube.com/playlist?list=PLWDeKF97v9SMRfe5PK1HPYnEcrJOL6K7>
2. <https://www.uhv.org.in/uhv-ii>
3. <http://www.uptu.ac.in/>
4. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

SIGNALS AND SYSTEMS

III Semester

Course Code:231EC3T03

Course Outcomes:

L	T	P	C
3	0	0	3

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

- CO1:** Apply the knowledge of linear algebra topics like vector space, dot product and orthogonal basis to signals.
- CO2:** Analyze the frequency domain representation of signals using Fourier concepts.
- CO3:** Analyze the response of continuous time LTI system.
- CO4:** Utilize the concept of correlation and sampling theorem in signal processing.
- CO5:** Apply Laplace and Z-transform techniques on signals.

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Signals: Definitions of a signal , Classification of signals, Elementary signals, Operations on signals: time-shifting, timescaling, amplitude-shifting, amplitude-scaling.Problems on classification and characteristics of Signals.

Signal Analysis: Analogy between vectors and signals, Orthogonal signal space, Signal approximation using orthogonal signals, Mean square error, Closed or complete set of orthogonal functions, Orthogonality in complex functions. Related problems.

Unit – II

Fourier Series: Representation of Fourier series for continuous time periodic signals, Trigonometric and Exponential Fourier series, Symmetry conditions , Dirichlet's conditions, Properties of Fourier series, Complex Fourier spectrum.

Fourier Transform: Deriving Fourier Transform from Fourier series, Fourier Transform of arbitrary signals, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms, Fourier transforms involving impulse function and Signum function, Introduction to Hilbert Transform, Properties of Hilbert Transform,Related problems.

Unit – III

Analysis of Linear Systems: Definitions of a system, Classification of Systems, Linear time invariant (LTI) system, Linear time variant(LTV)system, Transfer function of a LTI system, Impulse response and step response of LTI systems, Filter characteristics of linear systems, Distortion less transmission through a system, Ideal LPF, HPF,BPF and BSF characteristics, Signal bandwidth, System bandwidth, Causality and Poly-Wiener criterion for physical realization.relationship between bandwidth and rise time.Related problems.

Convolution: Convolution and it's properties, Graphical representation of convolution, Convolution of signals through transforms.

Unit – IV

Correlation: Auto-correlation and cross-correlation of functions, properties of correlation function, Energy density spectrum, Parseval's theorem, Power density spectrum, Relation between Convolution and correlation, Detection of periodic signals in the presence of noise by correlation, Extraction of signal from noise by filtering.

Sampling: Introduction to Sampling , Sampling theorem, Nyquist rate, Nyquist duration, Types of Sampling, Reconstruction of signal from its samples, Effect of under sampling- Aliasing, Introduction to Band Pass sampling.Related problems.

Unit – V

Laplace Transforms: Bilateral and unilateral Laplace Transforms, Region of convergence and its properties, Constraints on ROC for various classes of continuous time signals, Properties of Laplace Transform, Inverse Laplace Transform.Relation between L.T's, and F.T.

Z-Transforms: Concept of Z- Transform of a Discrete Sequence, Region of convergence in Z-Transform, Constraints on ROC for various classes of discrete time signals, Properties of Z-Transform, Inverse Z-Transform.Distinction between Laplace, Fourier and Z-transforms.

Text Books:

1. Signals & Systems - Simon Haykin and Van Veen, Wiley, 2nd Edition,2021.
2. Signals and Systems - A.V. Oppenheim, A.S. Willsky, and S.H. Nawab, PHI,2nd Edition.

Reference Books:

1. Signals and Systems – A. Anand Kumar, PHI, 3rd Edition, 2022.
2. Fundamentals of Signals and Systems- Michel J. Robert, MGH International Edition.
3. Signals, Systems & Communications - B.P. Lathi, BS Publications.

Web Links:

1. [https://nptel.ac.in/courses/108/104/108104100/by Prof. Aditya K.Jagannatham, Department of Electrical Engineering, IIT Kanpur.](https://nptel.ac.in/courses/108/104/108104100/by Prof. Aditya K.Jagannatham, Department of Electrical Engineering, IIT Kanpur)
2. <https://www.udemy.com/course/signals-and-systems-from-basics-to-advance>
3. <https://www.edx.org/learn/engineering/iitbombay-signals-and-systems-part-1>
4. <https://freevideolectures.com/course/3540/signals-and-systems-i>
5. <https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011>

ELECTRONIC DEVICES AND CIRCUITS

III Semester	L	T	P	C
Course Code: 231EC3T01	3	0	0	3

Course Outcomes:

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

- CO1:** Interpret the basic concepts of semiconductor physics
- CO2:** Infer the applications of semiconductor diodes.
- CO3:** Explain the characteristics of BJT along with biasing methods
- CO4:** Construct a small signal low frequency equivalent model of BJT
- CO5:** Illustrate the characteristics and operation of different FETs.

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I

Review of Semiconductor Physics: Mobility and Conductivity, Intrinsic and Extrinsic semiconductors, Hall effect, law of junction, Fermi Dirac function, Fermi level in intrinsic and extrinsic Semiconductors.

Junction Diode Characteristics: Energy band diagram of PN junction Diode, Open circuited p-n junction, Biased p-n junction, p-n junction diode, Current components in p-n junction Diode, Diode equation, V-I Characteristics, Temperature dependence on V-I characteristics, Diode resistance, Diode capacitance.

Unit – II

Special Semiconductor Devices: Zener Diode, Breakdown mechanisms, Zener diode applications, Varactor Diode, LED, Photodiode, Tunnel Diode, UJT.

Diode Circuits: Clipping (limiting) circuits, Clamping circuits, Basic Rectifier setup, half wave rectifier, full wave rectifier, bridge rectifier, derivations of characteristics of rectifiers, Filters, Inductor filter, Capacitor filter, π -section Filter, comparison of various filter circuits in terms of ripple factors.

Unit – III

Transistor Characteristics: Junction transistor, Transistor current components, Transistor equation in CB configuration, Transistor as an amplifier, characteristics of transistor in Common Base, Common Emitter and Common Collector configurations, Punch through/reach through, Photo transistor, Typical transistor junction voltage values.

Transistor Biasing and Thermal Stabilization: Need for biasing, Operating point, Load line analysis, BJT biasing- methods, basic stability, Fixed bias, Collector to base bias, Self-bias, Stabilization against variations in V_{BE} , I_c , and β , Stability factors, (S, S', S''), Bias compensation, Thermal runaway, Thermal stability.

Unit – IV**Small Signal Low Frequency Transistor Amplifier Models**

BJT: Two port network, Transistor hybrid model, Determination of h-parameters, Conversion of h-parameters, Generalized analysis of transistor amplifier model using h-parameters, Analysis of CB, CE and CC amplifiers using exact and approximate analysis, Comparison of transistor amplifiers.

Unit – V

FET: FET types, JFET operation, characteristics, small signal model of JFET. Common Source, Common Gate, Source Follower, Comparison of FET amplifiers.

MOSFET: MOSFET Structure, Operation of MOSFET: operation in triode region, operation in saturation region, MOSFET as a variable resistor, derivation of V-I characteristics of MOSFET, Comparison of Bipolar and MOS devices.

Text Books:

1. Electronic Devices and Circuits- J. Millman, C. C. Halkias and Satyabrata Jit, McGraw Hill Education, 4th edition.
2. Integrated Electronics-J. Millman, C. Halkias, and Ch. D. Parikh, McGraw Hill Education, 2nd Edition.

Reference Books:

1. Basic Electronics- Principles and Applications, Chinmoy Saha, Arindam Halder, Debarati Ganguly, Cambridge University Press.
2. Electronics devices & circuit theory- Robert L. Boylestad and Loui Nashelsky, Pearson, 11th edition.
3. Electronic Devices and Circuits - David A. Bell, Oxford University Press, 5th edition.

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/117103063/11byDr.ChitralekhaMahanta,IITGuwahati>
4. <https://nptel.ac.in/courses/122106025/ by Prof. T. S. Natarajan, IIT Madras.>
5. <https://www.circuitlab.com/editor/#?id=6syafk>
6. <https://www.falstad.com/circuit/circuitjs.html>

SWITCHING THEORY AND LOGIC DESIGN

III Semester

L T P C

Course Code: 231EC3T02

3 0 0 3

Course Outcomes:

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

- CO 1:** Interpret numeric information in different code formats.
- CO 2:** Realize logic minimization using suitable techniques.
- CO 3:** Develop various combinational logic circuits for required specifications.
- CO 4:** Develop different sequential logic circuits for required specifications.
- CO 5:** Analyze different Finite State Machines (FSMs).

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

Mapping of course outcomes with program Specific Outcomes:

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

UNIT-I

Number Systems: Representation of numbers of different radix, conversion from one radix to another radix, $r-1$'s complements and r 's complements of signed numbers, problem solving.

Binary Codes: 4bit codes, BCD, Excess-3, 2421, 84-2-1, 9's complement code etc. Error detection & correction codes, Gray code, error detection, error correction codes (parity checking, even parity, odd parity, Hamming code)

Boolean Theorems and Logic operations: Boolean theorems, principle of complementation & duality, De-Morgan theorems, Basic logic operations: NOT, OR, AND, Universal logic operations, EX-OR, EX-NOR operations, standard SOP and POS forms,

NAND-NAND and NOR-NOR realizations, Realization of three level logic circuits.

UNIT-II

MINIMIZATION TECHNIQUES: Minimization and realization of switching functions using Boolean theorems, K-Map (up to 6 variables) and tabular method (Quine-mccluskey method) with only four variables and single function.

COMBINATIONAL LOGIC CIRCUITS DESIGN: Design of Half adder, full adder, half subtractor, full subtractor, applications of full adders; 4- bit adder-subtractor circuit, BCD adder circuit, Excess 3 adder circuit and carry look-a- head adder circuit, Design code converts using Karnaugh method and draw the complete circuit diagrams.

UNIT-III

COMBINATIONAL LOGIC CIRCUITS DESIGN USING MSI & LSI: Design of encoder, decoder, multiplexer and de-multiplexers, Implementation of higher order circuits using lower order circuits. Realization of Boolean functions using decoders and multiplexers. Design of Priority encoder, 4-bit digital comparator and seven segment decoder.

INTRODUCTION OF PLD's: PROM, PAL, PLA -Basics structures, realization of Boolean functions, Programming table.

UNIT-IV

Sequential Circuits-I: Classification of sequential circuits (synchronous and asynchronous), operation of NAND & NOR latches and flip-flops; truth tables and excitation tables of 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. Design of ripple counters, design of synchronous counters, Johnson counter, ring counter. Design of registers - Buffer register, control buffer register, shift register, bidirectional shift register, universal shift, register. Study the following relevant ICs and their relevant functions 7474,7475,7476,7490,7493,74121.

UNIT-V

Sequential Circuits –II:

Finite state machine: state diagrams, state tables, reduction of state tables. Analysis of clocked sequential circuits Mealy to Moore conversion and vice-versa. Realization of sequence generator, Design of Clocked Sequential Circuit to detect the given sequence (with overlapping or without overlapping)

Text Books:

1. Switching and finite automata theory Zvi.KOHAVI, Niraj.K.Jha 3rd Edition, Cambridge University Press.
2. Digital Design by M.Morris Mano, Michael D Ciletti,4th edition PHI publication.

Reference Books:

1. Modern Digital Electronics, RP Jain, Tata Mc Graw Hill, 4th Edition.
2. Introduction to Switching Theory and Logic Design, Fredriac J. Hill, Gerald R. Peterson, 3rd Edition, John Wiley & Sons Inc.
3. Fundamentals of Logic Design, Charles H. Roth Jr., Jaico Publishers.

Web Links:

1. <http://nptel.ac.in/courses/117/106/117106086/> (By Prof. Goutam Saha, Electronics & Electrical Communication Engineering Dept, IIT Kharagpur).
2. www.nptelvideos.in/2012/12/digital-circuits-and-systems.html(By Prof. Santanu Chattopadhyay, Electronics & Electrical Communication Engineering Dept, IIT Kharagpur).
3. <https://www.smartzworld.com/notes/switching-theory-and-logic-design-stld/>.

ELECTRONIC DEVICES AND CIRCUITS LAB

III Semester	L	T	P	C
Course Code: 231EC3L01	0	0	3	1.5

Course Outcomes:

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

- CO1:** Contrast the functional characteristics of semiconductor devices.
- CO2:** Examine the characteristics of negative resistance devices.
- CO3:** Infer the characteristics of bipolar junction transistor in different configurations.
- CO4:** Distinguish the frequency response of small signal low frequency amplifiers.
- CO5:** Interpret the characteristics of field effect transistor in CS configuration.

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Lab Experiments:

1. Oscilloscope Operation and its Measurements.
2. Calculate Static and Dynamic resistance of P-N junction diode from V-I characteristics.
3. Design and analysis of transfer characteristics for Clipper circuit.
4. Design and analysis of transfer characteristics for Clamper circuit.
5. UJT Characteristics.
6. Determine h-parameters of CB Configuration from Input and Output Characteristics.
7. BJT-CE Amplifier.
8. Emitter Follower-CC Amplifier.
9. FET Characteristics (CS Configuration)
Part A: Drain Characteristics Part B: Transfer Characteristics.
10. FET-CS Amplifier.

List of Augmented Experiments:**(Any two of the following experiments can be performed)**

1. V-I characteristics of LED.
2. Non-Linear wave shaping – Shunt Clippers with reference voltage.
3. Transistor as a switch.
4. Transistor biasing- Design of self-bias circuit.

Reference Books:

1. Electronic Devices and Circuits- J. Millman, C. C. Halkias and Satyabrata Jit, Mc-Graw Hill Education, 4th edition.
2. Integrated Electronics-J. Millman, C. Halkias, and Ch. D. Parikh, Mc-Graw Hill Education, 2nd Edition.
3. Electronics devices & circuit theory- Robert L. Boylestad and Loui Nashelsky, Pearson, 11th edition.

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/117103063/11byDr.ChitralkhaMahanta,IITGuwahati>
4. <https://nptel.ac.in/courses/122106025/ by Prof. T. S. Natarajan, IIT Madras.>
5. <https://www.circuitlab.com/editor/#?id=6syafk>
6. <https://www.falstad.com/circuit/circuitjs.html>

SWITCHING THEORY AND LOGIC DESIGN LAB**III Semester****L T P C****Course Code: 231EC3L02****0 0 3 1.5****Course Outcomes:**

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

- CO1:** Choose an appropriate logic gate for the design of digital circuits.
- CO2:** Construct logic circuit to verify Boolean expression.
- CO3:** Construct combinational logic circuits.
- CO4:** Interpret the behavior of flip-flops for different combination of inputs.
- CO5:** Build registers and counters using flip flops.

Mapping of course outcomes with program outcomes:

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

Mapping of course outcomes with program Specific Outcomes:

CO/PSO	PSO 1	PSO 2
CO1	-	3
CO2	-	3
CO3	-	3
CO4	-	3
CO5	-	3

List of Experiments:

1. Verification of truth tables of the following Logic gates Two input (i) OR (ii) AND (iii) NOR (iv) NAND (v) Exclusive-OR (vi) Exclusive-NOR
2. Design a simple combinational circuit with four variables and obtain minimal SOP expression and verify the truth table using Digital Trainer Kit.
3. Verification of functional table of 3 to 8-line Decoder /De-multiplexer

4. 4 variable logic function verification using 8 to 1 multiplexer.
5. Design full adder circuit and verify its functional table.
6. Verification of functional tables of (i) JK Edge triggered Flip-Flop (ii) JK Master Slave Flip-Flop (iii) D Flip-Flop
7. Design a four-bit ring counter using D Flip-Flops/JK Flip Flop and verify output.
8. F Design a four-bit Johnson's counter using D Flip-Flops/JK Flip Flops and verify output
9. Verify the operation of 4-bit Universal Shift Register for different Modes of operation.
10. Draw the circuit diagram of MOD-8 ripple counter and construct a circuit using T-FlipFlops and Test It with a low frequency clock and sketch the output waveforms.
11. Design MOD-8 synchronous counter using T Flip-Flop and verify the result and sketch the output waveforms.
12. (a) Draw the circuit diagram of a single bit comparator and test the output
(b) Construct 7 Segment Display Circuit Using Decoder and 7 Segment LED and test it.

List of Augmented Experiments:

(Any One of the following experiments can be performed)

1. Design BCD Adder Circuit and Test the Same using Relevant IC
2. Design Excess-3 to 9- Complement convertor using only four Full Adders and test the Circuit.
3. Design an Experimental model to demonstrate the operation of 74154 De-Multiplexer using LEDs for outputs.
4. Design of any combinational circuit using Hardware Description Language
5. Design of any sequential circuit using Hardware Description Language

Equipment Required:

1. Bread board Trainer Kits.
2. Digital ICs.
3. Patch Cords

Reference Books:

1. Switching Theory and Logic Design, A. Anand Kumar, Pearson, 3rd Edition.
2. Digital Design Principles and Practices, John F Wakerly, 3rd Edition, Pearson Education.
3. Switching and Finite Automata Theory, ZviKohavi & Niraj K.Jha, 3rd Edition.

Web Links:

1. <https://www.falstad.com/circuit/>
2. <http://vlabs.iitkgp.ernet.in/dec/#>
3. <http://www.nptelvideos.in/2012/12/digital-circuits-and-systems.html>
4. <http://nptel.ac.in/courses/117/106/117106086/> (By Prof. Goutam Saha, Electronics & Electrical Communication Engineering Dept, IIT Kharagpur)

DATA STRUCTURES USING PYTHON

III Semester

L T P C

Course Code: 231EC3S01

0 1 2 2

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

- CO1:** Apply OOPs concepts for Problem Solving
CO2: Develop applications using built in data structures and functions.
CO3: Implement Searching and Sorting techniques using Python
CO4: Implement linear data structures using Python
CO5: Perform Binary Search Tree Operations using Python

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	2	2	-	2
CO2	2	2	-	-	2	-	-	-	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:

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

List of Experiments:

1. Write a Python program for class, Flower, that has three instance variables of type str, int, and float that respectively represent the name of the flower, its number of petals, and its price. Your class must include a constructor method that initializes each variable to an appropriate value, and your class should include methods for setting the value of each type, and retrieving the value of each type.
2. Develop an inheritance hierarchy based upon a Polygon class that has abstract methods area() and perimeter(). Implement classes Triangle, Quadrilateral, Pentagon, that extend this base class, with the obvious meanings for the area() and perimeter() methods. Write a simple program that allows users to create polygons of the various types and input their geometric dimensions, and the program then outputs their area and perimeter
3. Write a python program to implement Method Overloading and Method Overriding.
4. Write a Python program to illustrate the following comprehensions: a) List Comprehensions b) Dictionary Comprehensions c) Set Comprehensions d) Generator Comprehensions
5. Write a Python program to generate the combinations of n distinct objects taken from the elements of a given list. Example: Original list: [1, 2, 3, 4, 5, 6, 7, 8, 9] Combinations

- of 2 distinct objects: [1, 2] [1, 3] [1, 4] [1, 5] [7, 8] [7, 9] [8, 9].
6. Write a program for Linear Search and Binary search.
 7. Write a program to implement Bubble Sort and Selection Sort.
 8. Write a program to implement Merge sort and Quick sort.
 9. Write a program to implement Stacks and Queues.
 10. Write a program to implement Singly Linked List.
 11. Write a program to implement Doubly Linked list.
 12. Write a program to implement Binary Search Tree.

List of Augmented Experiments:

1. Write a program to create tuples (name, age, address, college) for at least two members and concatenate the tuples and print the concatenated tuples.
2. Write a program to implement Heap Sort
3. Write a program to implement Circular Linked list.

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.
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>
3. https://onlinecourses.nptel.ac.in/noc20_cs70/preview

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

III Semester	L	T	P	C
Course Code:231MC3T03	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:

1. Cambridge Empower – Second Edition B2 Level

Reference Books:

1. Raman Meenakshi, Sangeeta-Sharma. Technical Communication. Oxford University Press. 2018.
2. Taylor Grant: English Conversation Practice, Tata McGraw-Hill Education India.
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.

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

MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS

IV Semester	L	T	P	C
Course Code: 231HS4T01	2	0	0	2

Course Outcomes:

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

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

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I**Managerial Economics:**

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

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

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

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

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

Unit – IV**Capital Budgeting:**

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

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

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

Text Books:

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

Reference Books:

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

Web Links:

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

CONTROL SYSTEMS ENGINEERING

IV Semester	L	T	P	C
Course Code: 231ES4T05	3	0	0	3

Course Outcomes:

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

- CO1:** Develop the overall transfer function using block diagram algebra and signal flow graphs.
- CO2:** Identify time response specifications, error constants of second order systems.
- CO3:** Analyze absolute and relative stability of LTI systems using Routh's stability criterion and the root locus method.
- CO4:** Analyze the stability of LTI systems using frequency response methods.
- CO5:** Develop state models for physical 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	3	-	-	-	-	-	-	-	-	1
CO2	2	3	1	-	-	-	-	-	-	-	-	1
CO3	2	3	2	-	-	-	-	-	-	-	-	1
CO4	2	3	2	-	-	-	-	-	-	-	-	1
CO5	2	2	3	-	-	-	-	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Mathematical Modeling of Control Systems: Classification of control systems, Open Loop and closed loop control systems and their differences, Feed-Back Characteristics, transfer function of linear system, Differential equations of electrical networks, Translational and Rotational mechanical systems, Block diagram algebra – Representation by Signal flow graph - Reduction using Mason's gain formula. Transfer Function of DC Servo motor.

UNIT – II

Time Response Analysis: Standard test signals, Time response of first and second order systems, Time domain specifications, Steady state errors and error constants, Effects of proportional derivative, proportional integral systems.

UNIT – III

Stability and Root locus Technique: The concept of stability, Routh's stability criterion, limitations of Routh's stability, Root locus concept, construction of root loci.

UNIT – IV

Frequency Response Analysis: Introduction to Frequency domain specifications-Bode diagrams-transfer function from the Bode Diagram-Phase margin and Gain margin stability Analysis from Bode Plots, Polar Plots,Nyquist Stability criterion, Lag, Lead, Lag-Lead compensators.

UNIT – V

State Variable Analysis and Concepts of State Variables: Concepts of state, state variables and state model, state space representation of transfer function, Diagonalization- Solving the time invariant state equations- State Transition Matrix and its Properties – Concepts of Controllability and Observability, Pole-placement by state feedback, Discrete-time systems, Difference Equations, State-space models of linear discrete-time systems, Stability of linear discrete-time systems.

Text Books:

1. Control Systems principles and design, M.Gopal, Tata McGraw Hill education Pvt Ltd., 4th Edition.
2. Automatic control systems, Benjamin C.Kuo, Prentice Hall of India, 7th Edition.

Reference Books:

1. Control Systems Engineering, I.J.Nagarath and M.Gopal, Newage International Publications, 7th Edition, 2021.
2. Control Systems, Manik Dhanesh N, Cengage publications, 4th Edition.
3. Modern Control Engineering, Kotsuhiko Ogata, Prentice Hall of India, 5th Edition.

Web Links:

1. <https://www.electrical4u.com/state-space-analysis-of-control-system>
2. <https://nptel.ac.in/courses/107/106/107106081> by Dr.Ramkrishna Pasumarthy

ELECTROMAGNETIC WAVES AND TRANSMISSION LINES

IV Semester	L	T	P	C
Course Code: 231EC4T01	3	0	0	3

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

- CO1:** Interpret the properties of electric fields and magnetic fields.
- CO2:** Infer the Maxwell's equations for electric fields and magnetic fields.
- CO3:** Analyze the characteristics of uniform plane waves.
- CO4:** Interpret the fundamentals of transmission lines.
- CO5:** Apply impedance matching techniques for the transmission lines.

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	3	2	2	-	-	-	-	-	-	-	-	-
CO4	3	1	1	-	-	-	-	-	-	-	-	-
CO5	2	2	1	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Review on Co-ordinate Systems, Vector Calculus.

Electrostatics: Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss Law and Applications, Electric Potential, Maxwell's Two Equations for Electrostatic Fields, Energy Density, Illustrative Problems. Convection and Conduction Currents, Dielectric Constant, Poisson's and Laplace's Equations; Capacitance - Parallel Plate, Coaxial Capacitors.

UNIT – II

Magnetostatics: Biot-Savart Law, Ampere's Circuital Law and Applications, Magnetic Flux Density, Maxwell's Two Equations for Magnetostatic Fields, Magnetic Scalar and Vector Potentials, Forces due to Magnetic Fields, Ampere's Force Law, Inductances and Magnetic Energy.

Maxwell's Equations (Time Varying Fields): Faraday's Law and Transformer EMF, Inconsistency of Ampere's Law and Displacement Current Density, Maxwell's Equations in Different Final Forms and Word Statements, Conditions at a Boundary Surface.

UNIT – III

EM Wave Characteristics : Wave Equations for Conducting and Perfect Dielectric Media, Uniform Plane Waves – Definition, All Relations Between E & H, Sinusoidal Variations, Wave Propagation in Lossy dielectrics, lossless dielectrics, free space, wave propagation in good conductors, skin depth, Polarization & Types.

Reflection and Refraction of Plane Waves – Normal and Oblique Incidences, for both Perfect Conductor and Perfect Dielectrics, Brewster Angle, Critical Angle and Total Internal Reflection, Surface Impedance, Poynting Vector and Poynting Theorem.

UNIT – IV

Transmission lines-I: Types, Parameters, T & π Equivalent Circuits, Transmission Line Equations, Primary & Secondary Constants, Expressions for Characteristic Impedance, Propagation Constant, Phase and Group Velocities, Infinite Line, Lossless lines, distortion less lines.

UNIT – V

Transmission lines-II: Input Impedance Relations, Reflection Coefficient, VSWR, Average Power, Shorted Lines, Open Circuited Lines, and Matched Lines, Low loss radio frequency and UHF Transmission lines, UHF Lines as Circuit Elements, Smith Chart – Construction and Applications, Quarter wave transformer, Single Stub Matching.

Text Books:

1. Principles of Electromagnetics, Matthew N.O. Sadiku, and S.V. Kulkarni, Oxford University Press, 6th Edition.
2. Electromagnetic Waves and Radiating Systems, E.C. Jordan and K.G. Balmain, PHI, 2nd Edition.

Reference Books:

1. Engineering Electromagnetics, William H. Hayt, John A. Buck, Jaleel M. Akhtar, TMH, 9th edition, 2020.
2. Transmission Lines and Networks, UmeshSinha and Satya Prakashan, Technical India Publications, 2nd Edition.
3. Electromagnetic Waves and Transmission Lines, Y Mallikarjuna Reddy, Universities Press, 1st Edition.

Web Links:

1. <https://nptel.ac.in/courses/108106157> NPTEL Course on “Transmission lines and Electromagnetic Waves”, IIT Madras, Dr. Ananth Krishnan.
2. <https://www.damtp.cam.ac.uk/user/tong/em.html> Lectures on “Electromagnetism”, by David Tong, University of Cambridge, London.
3. <https://nptel.ac.in/courses/117103065> NPTEL Course on “Electromagnetic fields” , IIT Guwahati, Dr. Ratnajit Bhattacharjee.

ELECTRONIC CIRCUIT ANALYSIS

IV Semester
Course Code: 231EC4T02

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Build the high frequency transistor amplifier circuits.
- CO2:** Analyze the frequency response of multi stage circuits
- CO3:** Summarize the performance metrics of feedback amplifiers.
- CO4:** Construct low and high frequency oscillators for given specifications.
- CO5:** Analyze the efficiency performance of power and tuned amplifiers.

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Small Signal High Frequency Transistor Amplifier Models:

BJT: Transistor at high frequencies, Hybrid- π common emitter transistor model, Hybrid π conductance, Hybrid π capacitances, validity of hybrid π model, determination of high frequency parameters in terms of low-frequency parameters, CE short circuit current gain, current gain with resistive load, cut-off frequencies, frequency response and gain bandwidth product.

FET: Analysis of common Source and common drain Amplifier circuits at high frequencies.

Unit – II

Multistage Amplifiers: Classification of amplifiers, methods of coupling, cascaded transistor amplifier and its analysis, analysis of two stage RC coupled amplifier, high input resistance transistor amplifier circuits and their analysis-Darlington pair amplifier, Cascode amplifier, Boot-strap emitter follower, Differential amplifier using BJT.

Unit – III

Feedback Amplifiers: Feedback principle and concept, types of feedback, classification of amplifiers, feedback topologies, Characteristics of negative feedback amplifiers, Generalized analysis of feedback amplifiers, Performance comparison of feedback amplifiers, Method of analysis of feedback amplifiers.

Unit-IV

Oscillators: Oscillator principle, condition for oscillations, types of oscillators, RC phase shift and Wien bridge oscillators with BJT and FET and their analysis, Generalized analysis of LC Oscillators, Hartley and Colpitt's oscillators using BJT, Frequency and amplitude stability of oscillators.

Unit –V

Power Amplifiers: Classification of amplifiers, Class A power Amplifiers, Class B Push-pull amplifiers, Complementary symmetry push pull amplifier, Class AB power amplifier, Class-C power amplifier, Thermal stability and Heat sinks.

Tuned Amplifiers: Introduction, Q-Factor, small signal tuned amplifier, capacitance single tuned amplifier, double tuned amplifiers, staggered tuned amplifiers

Text Books:

1. Integrated Electronics- J. Millman and C. C. Halkias, Tata McGraw-Hill.
2. Electronic Devices and Circuits Theory –Robert L. Boylestad and Louis Nashelsky, Pearson/Prentice Hall, Tenth Edition.

Reference Books:

1. Electronic Circuit Analysis and Design –Donald A. Neaman, McGrawHill.
2. Micro electronic Circuits-Sedra A.S. and K.C. Smith, Oxford University Press, Sixth Edition.
3. Electronic Circuit Analysis-B.V.Rao, K.R.Rajeswari, P.C.R.Pantulu, K.B.R.Murthy, Pearson Publications.

Weblinks:

1. https://onlinecourses.nptel.ac.in/noc21_ee89/preview by Prof. Shouribrata Chatterjee, IIT, Delhi.
2. <https://nptel.ac.in/courses/108/102/108102095> by Prof. S.C.Dutta Roy, IIT, Delhi.
3. <http://www.iitg.ac.in/apvajpeyi/ph218.html>
4. <https://nptel.ac.in/courses/108/102/108102095> by Prof. S.C.Dutta Roy, IIT, Delhi

ANALOG COMMUNICATIONS

IV Semester

Course Code: 231EC4T03

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Interpret the Modulation and Demodulation techniques of standard AM.
- CO2:** Compare different types of Amplitude Modulation and Demodulation techniques.
- CO3:** Analyze the generation and detection of Angle Modulation.
- CO4:** Outline the Radio Transmitter and Receiver sections.
- CO5:** Illustrate the noise performance of analog communication systems and pulse modulation 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	1	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-
CO3	2	3	1	-	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-
CO5	3	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

Amplitude Modulation: Introduction to Fourier transform, Introduction to communication system, Need for modulation, Amplitude Modulation, Time domain and Frequency domain description, Single tone modulation, Power relations in AM waves, Generation of AM waves, Detection of AM Waves, Related problems.

Unit – II

DSB & SSB Modulation: Double sideband suppressed carrier modulator: Time domain and frequency domain description, Generation of DSBSC Waves, Detection of DSBSC Waves.

Single sideband suppressed carrier: Time domain and Frequency domain description, Generation of SSBSC Waves, Demodulation of SSB Waves.

Vestigial sideband modulation: Time domain description, Frequency domain description, Generation of VSB Modulated wave, Envelope detection of a VSB Wave pulse Carrier.

Comparison of AM Techniques, Applications of different AM Systems, Related problems.

Unit – III

Angle Modulation: Introduction, Basic concept of phase modulation, Frequency Modulation: Single tone frequency modulation, Spectrum Analysis of Sinusoidal FM Wave, Narrow band FM, Wide band FM, Constant Average Power, Transmission bandwidth of FM Wave, Generation of FM Waves, Detection of FM Waves,–Phase locked loop, Comparison of FM & AM, Related problems.

Unit – IV

Radio Transmitters: Classification of Transmitters, AM Transmitter, Effect of feedback on performance of AM Transmitter, FM Transmitter: Variable reactance type and Phase modulated FM Transmitter, Frequency stability in FM Transmitter.

Radio Receivers: Receiver Types: Tuned radio frequency receiver, Super heterodyne receiver, RF section and Characteristics, Frequency changing and tracking, Intermediate frequency, AGC, FM Receiver, Amplitude limiting, Comparison of FM & AM Receivers, Communication Receivers, Extension of super heterodyne principle and additional circuits.

Unit – V

Noise: Review of noise and noise sources, Noise figure, Noise in Analog communication Systems: Noise in DSB & SSB Systems, Noise in AM System and Noise in Angle Modulation Systems, Threshold effect in Angle Modulation System, Pre-emphasis & De-emphasis.

Pulse Analog Modulation: Types of Pulse modulation, PAM (Single polarity, double polarity), PWM: Generation & Detection of PWM, PPM: Generation and Detection of PPM, Time Division Multiplexing, TDM Vs FDM.

Text Books:

1. Communication Systems, Simon Haykin, Michael Moher, Wiley, 5th Edition.
2. Modern Digital and Analog Communication Systems, B.P.Lathi, Zhi Ding, Hari Mohan Gupta, Oxford University Press, 4th Edition.

Reference Books:

1. Electronics & Communication Systems, George Kennedy, Bernard Davis, S R M Prasanna, TMH, 6th Edition.
2. Principles of Communication Systems, HTaub, DLSchilling, Gautam Sahe, TMH, 4th Edition.
3. Communication Systems, R P Singh, S D Sapre, TMH, 3rd Edition.

Web Links:

1. <http://nptel.ac.in/courses/117102059/> Prof. Surendra Prasad.
2. <https://ict.iitk.ac.in/wp-content/uploads/EE320A-Principles-Of-Communication-CommunicationSystems-4ed-Haykin.pdf>.
3. <https://www.scribd.com/document/266137872/sanjay-sharma-pdf>.
4. <http://bayanbox.ir/view/914409083519889086/Book-Modern-Digital-And-AnalogCommunication-Systems-4th-edition-by-Lathi.pdf>.
5. <https://soaneemrana.org/onewebmedia/ELECTRONICS%20COMMUNICATION%20SYSTEM%20BY%20GEORGE%20KENNEDY.pdf>
6. <https://eem.eskisehir.edu.tr/Ders.aspx?dersId=95>, Prof. Dr. Nuray AT.

SIGNALS AND SYSTEMS LAB

IV Semester

Course Code: 231EC4L01

L	T	P	C
0	0	3	1.5

Course Outcomes:

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

CO1: Generate elementary signals.

CO2: Apply basic operations on signals

CO3: Analyze spectral characteristics of signal using transform techniques.

CO4: Examine LTI properties of a given system.

CO5: Utilize the concept of convolution and sampling theorem in 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	1	-	1	2	-	-	-	1	1	-	1
CO2	2	3	-	1	2	-	-	-	1	1	-	1
CO3	2	2	-	1	2	-	-	-	1	1	-	1
CO4	2	3	-	1	2	-	-	-	1	1	-	1
CO5	2	2	-	2	2	-	-	-	1	1	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

List of Experiments:

1. Generation of various signals such as unit impulse, unit step, ramp, exponential and sinewave.
2. Perform Operations on signals such as Addition, Multiplication, Scaling, Shifting, and Folding.
3. Calculate Power and Energy of a given signal.
4. Finding the even and odd parts, real and imaginary parts of signal.
5. Calculate the Fourier Transform and Inverse Fourier Transform of a given continuous time signal.
6. Obtain Laplace Transform and inverse Laplace Transform of a given continuous time signal.
7. Calculate the Z-Transform and Inverse Z-Transform of a given discrete time signal.

8. Obtain Impulse and step response of given LTI system.
9. Perform convolution of given continuous time signals.
10. Obtain Power spectral density of a given signal.

List of Augmented Experiments:

(Any two of the following experiments can be performed)

1. Perform Fourier synthesis of square wave.
2. Analyze the effect of increasing the number of terms in the Fourier series on the Gibbs phenomenon.
3. Verification of linearity and time invariance properties of a given system.
4. Calculate the Hilbert Transform of a given signal.

Tools Required:

MATLAB / Python.

Reference Books:

1. Fundamentals of Signals and Systems- Michel J. Robert, MGH International Edition, Reprint.
2. Signals, Systems & Communications - B.P. Lathi, BS Publications.

Web Links:

1. <https://www.mathworks.com/support/learn-with-matlab-tutorials.html>
2. <https://www.edx.org/learn/engineering/iitbombay-signals-and-systems-part-1>
3. <https://freevidelectures.com/course/3540/signals-and-systems-i>

ELECTRONIC CIRCUIT ANALYSIS LAB

IV Semester
Course Code: 231EC4L02

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

Course Outcomes:

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

- CO1:** Examine the frequency response of multi stage amplifiers
CO2: Construct feedback amplifiers for given specifications.
CO3: Design RC phase shift oscillator for given specifications
CO4: Analyze the efficiency of class A power amplifier for given specifications.
CO5: Examine the frequency response of single tuned amplifier for given specifications.
CO6: Analyze LC oscillator for given specifications

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	2	2	-	-	-	1	1	-	1
CO2	2	2	1	2	2	-	-	-	1	1	-	1
CO3	2	2	3	2	2	-	-	-	1	1	-	1
CO4	2	3	1	2	2	-	-	-	1	1	-	1
CO5	2	3	1	2	2	-	-	-	1	1	-	1
CO6	2	2	3	2	2	-	-	-	1	1	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

List of Experiments has to be performed using software:

1. Design a two stage RC coupled amplifier to obtain frequency response, voltage gain and Bandwidth.
2. Design voltage series feedback amplifier to obtain frequency response, voltage gain and Bandwidth.
3. Design a RC phase shift oscillator using BJT to generate a sinusoidal signal.
4. Design and compare class-A and class-B complementary symmetry power amplifier to obtain power efficiency.
5. Design a single tuned amplifier to obtain frequency response, voltage gain and Bandwidth.

List of Experiments has to be performed using discrete components:

6. Design a two stage RC coupled amplifier to obtain frequency response, voltage gain and Bandwidth.
7. Design voltage series feedback amplifier to obtain frequency response, voltage gain and Bandwidth.
8. Design a RC phase shift oscillator using BJT to generate a sinusoidal signal.
9. Design a class-A power amplifier and draw the input & output waveforms. Find its efficiency.
10. Design a single tuned amplifier and determine the Q of its tuned circuit practically.

List of Augmented Experiments:

1. Construct three stage RC coupled amplifier and compare with two stage RC coupled amplifiers.
2. Construct Darlington pair amplifier to obtain frequency response, voltage gain and Bandwidth.
3. Construct a Colpitt's oscillator using BJT to generate a sinusoidal signal.
4. Construct a Bootstrapped emitter follower.

Software Equipment Required:

1. OrCAD family release 9.2

Hardware Equipment Required:

1. Regulated Power supplies.
2. Analog/Digital Storage Oscilloscopes.
3. Analog/Digital Function Generators.
4. Digital Multimeters.
5. Decade Résistance Boxes/Rheostats.
6. Decade Capacitance Boxes.
7. Ammeters (Analog or Digital).
8. Voltmeters (Analog or Digital).
9. Active & Passive Electronic Components.

Reference Books:

1. Integrated Electronics, J. Millman and C.C.Halkias, Tata Mc Graw-Hill.
2. Circuit Analysis PSpice- Nassir H., CRC press Taylor & Fransis Group.

Weblinks:

1. <https://www.circuitlab.com>
2. www.dcaclab.com
3. <https://www.vlab.co.in>

SOFT SKILLS**IV Semester****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	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

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

DESIGN THINKING & INNOVATION

IV Semester

Course Code: 231ES4T04

L	T	P	C
1	0	2	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	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

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

BIOLOGY FOR ENGINEERS

IV Semester	L	T	P	C
Course Code: 231MC4T02	2	0	0	0

Course Outcomes:

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

- CO1:** Apply biological engineering principles, procedures needed to solve real-world problems.
- CO2:** Demonstrate the fundamentals of living things, their classification, cell structure and biochemical constituents.
- CO3:** Apply the concept of plant, animal and microbial systems and growth in real life Situations.
- CO4:** Explain genetics and the immune system to know the cause, symptoms, diagnosis and treatment of common diseases.
- CO5:** Demonstrate basic knowledge of the applications of biological systems in relevant industries.
- CO6:** Apply the basic knowledge of transgenic plants and animals for the benefit of society.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I

Introduction to life:

Characteristics of living organisms-Basic classification-cell theory-structure of prokaryotic and eukaryotic cell- Introduction to biomolecules: definition-general classification and important functions of carbohydrates-lipids- proteins-nucleic acids vitamins and enzymes-genes and chromosome.

Unit – II

Biodiversity Plant System: basic concepts of plant growth-nutrition-photosynthesis and nitrogen fixation- **Animal System:** elementary study of digestive-respiratory-circulatory-excretory systems and their functions **Microbial System:** history-types of microbes-economic importance and control of microbes.

Unit – III

Genetics and immune system: Evolution: theories of evolution-Mendel's cell division-mitosis and meiosis-evidence of e laws of inheritance-variation and speciation- nucleic acids as a genetic material-central dogma
immunity antigens-antibody-immune response

Unit – IV

Human diseases: Definition- causes, symptoms, diagnosis, treatment and prevention of diabetes, cancer,hypertension, influenza, AIDS and Hepatitis.

Unit – V

Biology and its industrial applications: Transgenic plants and animal , stem cell and tissue engineering, bio-reactors, bio-pharming, recombinant vaccines, cloning-drug discovery, biological neural networks, bio- remediation, bio-fertilizer, bio-control, bio-filters, bio-sensors, bio-polymers, bio-energy, bio-materials, bio-chips, basic biomedical instrumentation

Text Books:

1. A Text book of Biotechnology, R.C.Dubey, S. Chand Higher Academic Publication.
2. Diseases of the Human Body, Carol D. Tamparo and Marcia A. Lewis, F.A. Davis Company.

Reference Books:

1. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis.
2. Cell Biology and Genetics (Biology: The unity and diversity of life Volume I), Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, Cengage Learning.
3. Biotechnology Expanding horizon, B.D. Singh, Kalyani Publishers.

Web Links:

1. <https://www.biology-online.org/>
2. <http://www.biologyreference.com/>
3. <http://www.allexperts.com/browse.cgi?catLvl=2&catID=229>
4. <https://www.library.qmul.ac.uk/subject-guides/biological-sciences>

ANALOG & DIGITAL IC APPLICATIONS

V Semester	L	T	P	C
Course Code: 231EC5T01	3	0	0	3

Course Outcomes:

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

CO1: Illustrate the parameters related to measurement of Op-Amp characteristics

CO2: Analyze the Op-Amp-based active filters and waveform generators.

CO3: Build the data conversion circuits using Op-Amp.

CO4: Analyze the characteristics digital logic families.

CO5: Develop sequential logic circuits using digital ICs.

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

Operational Amplifier:

Ideal and Practical Op-Amp, Op-Amp Characteristics, DC and AC Characteristics, features of 741 Op-Amp, Modes of Operation-Inverting, Non-Inverting, Differential, Instrumentation Amplifier, AC Amplifier, Differentiators and Integrators, Comparators, Schmitt Trigger

Unit – II

Op-Amp, IC-555 & IC565 Applications: Introduction to Active Filters, Characteristics of Band pass, Band reject and All Pass Filters, Analysis of 1st order LPF & HPF Butterworth Filters, Waveform Generators – Triangular, Sawtooth, Square Wave, IC555 Timer-Functional Diagram, Monostable and Astable Operations, Applications, IC565 PLL-Block Schematic, principle and Applications.

Unit – III

Data Converters: Introduction, Basic DAC techniques, Different types of DACs-Weighted resistor DAC, R-2R ladder DAC, Inverted R-2R DAC, Different Types of ADCs – Parallel Comparator Type ADC, Counter Type ADC, Successive Approximation ADC and Dual Slope ADC, DAC and ADC Specifications.

Unit – IV

Combinational Logic ICs: Specifications and Applications of TTL-74XX & CMOS 40XX Series ICs - Code Converters, Decoders, LED & LCD Decoders with Drivers, Encoders, Priority Encoders, Multiplexers, De-multiplexers, Priority Generators/Checkers, Parallel Binary Adder/Subtractor, Magnitude Comparators.

Unit – V

Sequential Logic IC's and Memories: Familiarity with commonly available 74XX & CMOS40XX Series ICs - All Types of Flip-flops, Synchronous Counters, Decade Counters, Shift Registers. Memories - ROM Architecture, Types of ROMS & Applications, RAM Architecture, Static & Dynamic RAMs.

Text Books:

1. Op-Amps & Linear ICs – Ramakanth A.Gayakwad, PHI, 4th Edition 2015.
2. Digital Fundamentals – Floyd and Jain, Pearson Education, 8th Edition 2005.

Reference Books:

1. Integrated Circuits- D.Roy Chowdhury, 4th Edition 2017.
2. Digital Design Principles and Practices-John.F.Wakerly, 3th Edition 2009.
3. Linear Integrated Circuits and Applications - Salivahana, TMH, 2nd Edition 2008.

Web Links:

1. <https://www.udemy.com/course/linear-integrated-circuits-and-applications-for-all-levels/>
2. https://www.tutorialspoint.com/linear_integrated_circuits_applications/index.htm
3. <https://www.udemy.com/course/cmos-digital-integrated-circuit-design/?srsltid=AfmBOorkoMSskwpqWh39eal7aAL6IICtEOu45IRxxaJMili8Zz1qbE6K&couponCode=NVDIN35>
4. <https://www.tutorialspoint.com/digital-integrated-circuits>

DIGITAL COMMUNICATIONS

V Semester

Course Code: 231EC5T02

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Inspect the characteristics of pulse digital modulation techniques.
- CO2:** Summarize the shift keying techniques.
- CO3:** Illustrate the concepts of information.
- CO4:** Examine source coding techniques.
- CO5:** Analyze block and convolution coding 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
CO2	3	2	-	-	-	-	-	-	-	-	-	1
CO3	2	1	-	-	-	-	-	-	-	-	-	1
CO4	2	2	1	-	-	-	-	-	-	-	-	1
CO5	2	3	1	-	-	-	-	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Pulse Digital Modulation: Elements of digital communication systems, Advantages of digital communication systems, Elements of Pulse Code Modulation (PCM): Sampling, Quantization & Coding, Quantization error, Noise in PCM system, Need of Companding in PCM systems. Differential PCM system (DPCM), Delta Modulation (DM) and its draw backs, Noise in DM system, Adaptive Delta Modulation (ADM), Comparison of PCM and DM systems.

Unit – II

Digital Modulation Techniques: Introduction, Generation and Detection of ASK, FSK, PSK, DPSK, DEPSK, QPSK, M-ary PSK, (Qualitative Analysis with error probability calculations using optimum filter receiver)

Unit – III

Information Theory: Introduction, Concept of information and its properties. Entropy and its properties, Information rate, Mutual Information and its properties. Related Problems

Unit – IV

Source Coding: Introduction, Shannon's theorem, Shannon-Fano coding, Huffman coding, efficiency calculations, Capacity of a Gaussian channel, Capacity of discrete channels, Related Problems.

Unit – V

Linear Block Codes: Introduction, Matrix description of Linear Block codes, Error detection and error correction capabilities of Linear block codes, Hamming codes, Binary cyclic codes, Algebraic structure, encoding, syndrome calculation, BCH codes

Convolution Codes: Introduction, encoding of convolution codes, time domain approach, transform domain approach. Graphical approach: state, tree and trellis diagram, decoding using Viterbi algorithm.

Text Books:

1. Digital communications, Simon Haykin, John Wiley, 2nd Edition, 2014.
2. Principles of Communication Systems, Herbert Taub, Donald L. Schilling, Goutam Saha, McGraw Hill, 4th Edition, 2013.

Reference Books:

1. Digital and Analog Communication Systems, Sam Shanmugam, John Wiley Student Edition, 2005.
2. Digital Communications, John G. Proakis and Masoud Salehi, TMH, 5th Edition, 2008
3. Modern Digital and Analog Communication Systems, B.P.Lathi, Zhi Ding, Hari Mohan Gupta, 4th Edition, Oxford University Press, 2017.

Web Links:

1. <http://nptel.ac.in/courses/117101051/> (Prof. Bikash. Kumar. Dey, Electrical Engineering Dept., IITB).
2. <https://ocw.mit.edu/courses/electrical.../6...digital-communications.../lecture-notes>
3. <https://everythingvtu.wordpress.com/>
4. https://www.tutorialspoint.com/digital_communication
5. <https://www.smartzworld.com/notes/digital-communication-dc/>

ANTENNAS AND WAVE PROPAGATION

V Semester	L	T	P	C
Course Code: 231EC5T03	3	0	0	3

Course Outcomes:

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

- CO1:** Identify basic antenna parameters.
- CO2:** Quantify the fields radiated by various types of antennas
- CO3:** Design and analyze antenna arrays
- CO4:** Design and analyze wire antennas, loop antennas, reflector antennas, lens antennas, horn antennas and micro-strip antennas
- CO5:** Analyze antenna measurements to assess antenna's performance & inspect the characteristics of wave propagation

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	1	1	1	-	-	-	-	-	-	-	1
CO2	2	3	1	1	-	-	-	-	-	-	-	1
CO3	2	2	3	1	-	-	-	-	-	-	-	1
CO4	2	3	1	1	-	-	-	-	-	-	-	1
CO5	2	2	3	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

ANTENNA FUNDAMENTALS: Introduction, Radiation Mechanism – Single Wire, 2-Wire, dipoles, Current Distribution on a thin wire antenna. Antenna Parameters - Radiation Patterns, Patterns in Principal Planes, Field Regions, Main Lobe and Side Lobes, Beam width, Radiation Intensity, Directivity, Antenna Efficiency, Gain, Beam Efficiency, Polarization, Beam Area, Antenna Apertures, Aperture Efficiency, illustrated Problems.

Unit – II

THIN LINEAR WIRE ANTENNAS: Radiation from Small Electric Dipole, Quarter wave Monopole and Half wave Dipole – Current Distributions, Evaluation of Field Components, Power Radiated, Radiation Resistance, Directivity, Antenna Theorems – Applicability and Proofs for equivalence of directional characteristics, Loop Antennas: Small Loops - Field Components, Comparison of far fields of small loop and short dipole, Concept of short magnetic dipole, D and R_r relations for small loops.

Unit – III

ANTENNA ARRAYS : 2 element arrays – different cases, Principle of Pattern Multiplication, N element Uniform Linear Arrays – Broadside, End-fire Arrays, EFA with Increased Directivity (No derivations), Concept of Scanning Arrays. Directivity Relations (no derivations), Related Problems. Binomial Arrays, Effects of Uniform and Non-uniform Amplitude Distributions, Design Relations Arrays with Parasitic Elements, Yagi-Uda Arrays, Folded Dipoles and their characteristics.

Unit – IV

BROADBAND ANTENNAS: Helical Antennas – Significance, Geometry, basic properties; Design considerations for helical antennas in Axial Mode and Normal Modes.

UHF AND MICROWAVE ANTENNAS:

Horn Antennas – Types, Optimum Horns, Design Characteristics of Pyramidal Horns; **Paraboloidal Reflectors**: – Geometry, characteristics, types of feeds, F/D Ratio, Spill Over, Back Lobes, Aperture Blocking, Off-set Feeds, Case grain Feeds.

Microstrip Antennas-Introduction, Features, Advantages and Limitations, Rectangular Patch Antennas –Geometry and Parameters, Impact of different parameters on characteristics.

Unit – V

ANTENNA MEASUREMENTS: Friis Transmission Equation, Patterns Required, Set Up, Distance Criterion, Directivity and Gain Measurements (Comparison, Absolute and 3-Antenna Methods).

WAVE PROPAGATION: Types of propagations. Sky Wave Propagation – Formation of Ionospheric Layers and their Characteristics, Mechanism of Reflection and Refraction, Critical Frequency, MUF and Skip Distance; Space Wave Propagation – Mechanism, LOS and Radio Horizon, Field strength equation, illustrated Problems.

Text Books:

1. Antenna Theory: Analysis And Design- Constantine A. Balanis, 3rd Edition, A John Wiley & Sons, Inc., Publication
2. Antennas for All Applications – John D. Kraus and Ronald J. Marhefka, 3rd Edition, TMH, 2003.

Reference Books:

1. Antennas and Wave Propagation-G.S.N. Raju
2. Transmission and Propagation – E.V.D. Glazier and H.R.L. Lamont
3. Antennas – John D. Kraus

Web Links:

1. <http://nptel.ac.in/courses/117104127/2>
2. <http://www.amanogawa.com/antenna.html>
3. <http://www.radio-electronics.com/info/antennas/>
4. <http://nptel.ac.in/courses/117107035/> by Dr. Amalendu Patnaik
5. <http://www.radartutorial.eu/index.en.html>

DIGITAL SYSTEM DESIGN THROUGH HDL
(Professional elective-I)

V Semester	L	T	P	C
Course Code: 231EC5E01	3	0	0	3

Course Outcomes:

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

- CO1:** Interpret Verilog HDL modelling concepts and gate primitives.
- CO2:** Construct Combinational and sequential circuits using Verilog HDL concepts with Behavioral Modelling
- CO3:** Develop Verilog models for digital circuits at dataflow and switch level abstraction.
- CO4:** Construct synchronous sequential circuits using finite state machines.
- CO5:** Contrast the synthesis of combinational and sequential logic

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	2	3	-	-	-	-	-	-	-	-	1
CO3	2	2	3	-	-	-	-	-	-	-	-	1
CO4	2	2	3	-	-	-	-	-	-	-	-	1
CO5	2	3	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**Introduction to Verilog HDL and Gate Level Modelling:**

Verilog as HDL, Levels of Design Description, Basic Concepts of Verilog, Data Types, System Task, modules and ports.

Gate level Modelling: AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples, Tri-State Gates, Array of Instances of Primitives, Additional Examples, Design of Adders and subtractors with Gate Primitives, User-Defined Primitives (UDP): Introduction, Function, Tasks, Delays.

Unit – II**Behavioral Modelling:**

Introduction, Procedural assignments, timing controls, conditional statements, multi-way branching, loops, sequential and parallel blocks, generate blocks, Design of Decoders, encoders, Multiplexers, Flip-flops, Registers & Counters in Behavioral model.

Unit – III**Data flow Level Modelling:**

Introduction, Continuous Assignment Structures, Delays and Continuous Assignments, Assignment to Vectors, Operators, Design of Decoders, Multiplexers, Flip-flops, Registers & Counters in dataflow model,

Switch Level Modelling: Introduction, Basic Transistor Switches, CMOS Switch, Bi-directional Gates, Time Delays with Switch Primitive delays.

Unit – IV

FSM Design:

Basic design steps: State diagram, state table, state assignment, choice of flip flops and derivation of next state and output expressions, timing diagram, Mealy and Moore type FSM for serial adder, Verilog HDL code for the serial adder.

Unit – V

Synthesis of Combinational and Sequential logic:

Introduction to Synthesis, Synthesis of combinational logic, Synthesis of sequential logic with latches and flip-flops, Synthesis of Explicit and Implicit State Machines

Text Books:

1. Design through Verilog HDL by T. R. Padmanabhan, B. Bala Tripura Sundari, A JOHN WILEY & SONS, INC., PUBLICATION, 2008
2. Michael D. Ciletti, “Advanced digital design with the Verilog HDL”, Eastern economy edition, PHI, 2011.

Reference Books:

1. Samir Palnitkar, “Verilog HDL A Guide to Digital and Synthesis”, 2nd Edition, Pearson Education, 2006.
2. A Verilog HDL primer by J. Bhaskar, Star galaxy publishing, 3rd edition, 2018.
3. Fundamentals of Digital Logic with Verilog Design- Stephen Brown, Zvonko Vranesic, McGrawHill, 3rd Edition, 2013.

Web Links:

1. <http://nptel.ac.in/courses/117105080/> by Prof. D. Roy Chaudhry, IIT Kharagpur
2. <http://nptel.ac.in/courses/117106086/1> by Prof. S. Srinivasan, IIT Madras
3. https://onlinecourses-archive.nptel.ac.in/noc17_cs21/course by Prof. Indranil Sen Gupta, IIT Kharagpur

ARTIFICIAL INTELLIGENCE (Professional elective-I)

V Semester

Course Code: 231EC5E02

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Understand AI search strategies like state-space, heuristic search, and problem-solving techniques.
- CO2:** Represent knowledge using predicate logic and rule-based systems effectively.
- CO3:** Utilize probabilistic and non-monotonic reasoning to handle uncertainty in AI.
- CO4:** Model knowledge using fuzzy logic, semantic nets, frames, and scripts.
- CO5:** Implement AI techniques in game playing, planning, NLP, and neural networks.

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

What is AI (Artificial Intelligence)?: The AI Problems, the underlying assumption, what are AI Techniques, The level of the model, Criteria for success.

State space and Heuristic search techniques: Defining the problems as a state space search, Production systems, Problem characteristics, Production system characteristics and issues in the design of search programs. Generate-and-test, Hill Climbing, Best-first search, Problem reduction.

Unit – II

Knowledge Representation Issues: Representations and Mappings, Approaches to Knowledge Representation.

Using Predicate Logic: Representing Simple Facts in Logic, Representing Instance and ISA Relationships, Computable Functions and Predicates, Resolution.

Representing Knowledge Using Rules: Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning.

Unit – III

Symbolic Reasoning Under Uncertainty: Introduction to Nonmonotonic Reasoning, Logics for Non-monotonic Reasoning.

Statistical Reasoning: Probability And Bays' Theorem, Factors and Rule-Base Systems, Bayesian Networks, Dempster Shafer Theory.

Unit – IV

Weak Slot-and-Filler Structures: Semantic Nets, Frames.

Strong Slot-and-Filler Structures: Conceptual Dependency, Scripts, CYC.

Game Playing and Planning: Overview, Mini Max Search, Alpha-Beta Cut-off, Iterative deepening, Components of a Planning System, Goal Stack Planning, Hierarchical Planning.

Unit – V

Natural Language Processing: Introduction, Syntactic Processing, Semantic Analysis, Semantic Analysis, Discourse and Pragmatic Processing, Spell Checking.

Connectionist Models: Learning in Neural Network, Application of Neural Networks, Recurrent Networks, Distributed Representations.

Text Books:

1. Elaine Rich and Kevin Knight – Artificial Intelligence, 3rd Edition, Tata Mcgraw-Hill, 2010.
2. Stuart Russell & Peter Norvig – Artificial Intelligence: A Modern Approach, Prentice-Hall, Third Edition, 2016.

Reference Books:

1. Nils J Nilsson – Principles of Artificial Intelligence, Illustrated Reprint Edition, Springer Heidelberg, 2014.
2. Ian GoodFellow, Yoshua Bengio & Aaron Courville – Deep Learning, MIT Press, 2016.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_cs56/preview
2. https://onlinecourses.nptel.ac.in/noc22_ge29/preview
3. <https://archive.nptel.ac.in/courses/106/105/106105077/>
4. <https://www.simplilearn.com/learn-ai-basics-skillup>
5. <https://online.stanford.edu/artificial-intelligence/AI-for-engineers>

ELECTRONIC MEASUREMENTS AND INSTRUMENTATION
(Professional elective-I)

V Semester	L	T	P	C
Course Code: 231EC5E03	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:** Interpret the working principle of oscilloscopes.
- CO3:** Choose a suitable bridge for parameter measurement.
- CO4:** Contrast Signal generators and wave analyzers based on their performance.
- CO5:** Make use of transducers and intelligent sensors for physical parameter measurement.

Mapping of Course Outcomes with Program Outcomes:

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

Measuring Instruments: Introduction, Errors in Measurement, Accuracy, Precision, Resolution and Significant figures, Basic PMMC Meter- construction and working, DC and AC Voltmeters- Multirange, Range extension, DC Ammeter, Multimeter for Voltage, Current and resistance measurements.

Digital Instruments: Digital Voltmeters – Introduction, DVM's based on V-T, V-F and Successive approximation principles, Resolution and sensitivity, General specifications, Digital Multimeters, Digital frequency meters, Digital measurement of time.

Unit – II

Bridges: DC Bridges for Measurement of resistance - Wheat stone bridge, Kelvin's Bridge, AC Bridges for Measurement of inductance- Maxwell's bridge, Hay's Bridge, Anderson bridge, Measurement of capacitance - Schearing Bridge, Wien Bridge, Errors and precautions in using bridges.

Unit – III

Signal Generators: Introduction, Fixed and variable AF oscillator, Standard signal generator, Laboratory type signal generator, AF sine and Square wave generator, Function generator, Square and Pulse generator, Sweep frequency generator.

Unit – IV

Transducers: Introduction, Types of Transducers, Electrical transducers, Selecting a transducer, Resistive transducer, Strain gauges, Piezoelectric transducer, Photoelectric transducer, Photovoltaic transducer, Temperature transducers-RTD, LVDT.

Intelligent Sensors: definition of intelligent instrumentation, types of instruments, Classification, Smart sensors, Cogent Sensors, Soft or Virtual sensors, Self-Adaptive Sensors, Self-Validating Sensors, Temperature Compensating Intelligent Sensors, Pressure Sensor, Indirect Sensing.

Unit – V**Signal Conditioning Circuits:**

Signal Conditioning, review on operational amplifiers, OPAMPS circuits used in instrumentation, Instrumentation amplifiers, Amplitude Modulation and Demodulation circuits for Measurement Systems

Text Books:

1. Electronic Instrumentation, H.S.Kalsi, 2nd edition, Tata MCgraw Hill, 2004
2. Modern electronic Instrumentation and measurement techniques, A.D.Helfric, W.D.Cooper, 5th edition, PHI, 2002.

Reference Books:

1. A.K. Sawhney, Dhanpat Rai & Co., “A course in Electrical and Electronic Measurements and Instrumentation”, 9th Edition, 2010.
2. David A. Bell, “Electronic Instrumentation & Measurements”, PHI, 2nd Edition, 2006.
3. Manabendra Bhuyan, —Intelligent Instrumentation: Principles and Applications CRC Press, 2011

Web Links:

1. <https://www.allaboutcircuits.com/textbook/alternating-current/chpt-12/ac-bridge-circuits/>
2. <https://www.science-ebooks.com/bridge-circuit.html>

COMPUTER ORGANIZATION AND ARCHITECTURE
(Professional elective-I)

V Semester	L	T	P	C
Course Code: 231EC5E04	3	0	0	3

Course Outcomes:

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

- CO1:** Explain the representation of data, register transfer language, and micro-operations.
- CO2:** Describe the basic computer organization and design, including programming the basic computer and the structure of the microprogrammed control unit.
- CO3:** Make use of various algorithms for computer arithmetic operations.
- CO4:** Explain the operation of interface circuits that connect I/O devices to the processor and memory, ensuring proper data exchange.
- CO5:** Summarize the memory hierarchy and the different types of memory.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-
CO5	3	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

Introduction: Digital Computers, Von Neumann computers, Basic organization of a computer,
Data Representation: Data types, Complements, Fixed-point representation, Conversion of fractions, Floating-point representation.

Register Transfer and Micro operations: Register transfer language, Register transfer, Bus and Memory transfers, Arithmetic Micro operations, Logic Micro operations, Shift Micro operations, Arithmetic Logic Shift Unit.

Unit – II

Basic Computer Organization and Design: Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory-Reference instructions, Input-Output and Interrupt, Complete Computer Description, Design of Basic computer.

Micro programmed Control: Control Memory, Address Sequencing, Micro program Example, Design of Control Unit

Unit – III

Central Processing Unit: Introduction, General Register Organization, Stack organization, Instruction Formats, Addressing Modes, Data transfer and Manipulation, Program Control, Reduced Instruction Set Computer

Computer Arithmetic: Introduction, Addition and Subtraction, Multiplication Algorithms,

Division Algorithms, Floating-Point Arithmetic Operations, Decimal Arithmetic Operations.

Unit – IV

Input-Output Organization: Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt, Direct Memory Access (DMA), Input-Output Processor (IOP), Serial Communication.

Unit – V

Memory Organization: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory.

Text Books:

1. Computer System Architecture by M.Morris Mano Pearson Publishers, Revised Third Edition, ISBN: 978 8131700709.
2. Computer Architecture and Organization by John P Hayes, Mc-Graw Hill Publishers, Third Edition, ISBN: 978-1259028564.

Reference Books:

1. Computer Organization by Carl Hamacher, Tata Mc-Graw Hill Publishers, Fifth Edition., ISBN: 978-9355323729.
2. Computer Organization & Architecture: Designing for Performance, William Stallings, PHI, 7th edition, ISBN: 9780136073734.

Web Links:

1. <http://nptel.ac.in/courses/106106092/>
2. <http://nptel.ac.in/courses/106103068/2>
3. <https://www.geeksforgeeks.org/computer-arithmetic-set-1/>
4. <https://youtu.be/gGB-X3KmAZU?si=oCECtRbIyaC6XxpX>

WASTE WATER MANAGEMENT (Open Elective-I)

V Semester

Course Code: 231CE5001

L	T	P	C
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 waste water characteristics
- CO5:** Outline various waste water treatment technologies and effluent disposal methods

Mapping of Course Outcomes with Program Outcomes:

CO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
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 waste water–generation of waste water– types – collection and conveyance of waste water– classification of sewerage systems.

Unit – II

Sewage Flow and Pumping:

Estimation of sewage flow and storm water drainage–fluctuations. Types of sewers– hydraulics of sewers– appurtenances in sewerage. Pumping of waste water: pumping stations–location– components– types of pumps and their suitability with regards to waste waters.

Unit – III

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

Text Books:

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

Reference Books:

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

Web Links:

1. https://web.iitd.ac.in/~arunku/files/CVL100_Y16/LecSep1220.pdf
2. <http://www.civil.iitm.ac.in/dwwm/sites/default/files/presentations>

CONSTRUCTION TECHNOLOGY AND MANAGEMENT**(Open Elective-I)**

V Semester	L	T	P	C
Course Code: 231CE5002	3	0	0	3

Course Outcomes:

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

- CO1:** Demonstrate understanding of project planning, scheduling, and monitoring techniques using tools like bar charts, milestone charts, and CPM.
- CO2:** Analyze and optimize project timelines and resources using PERT, crashing methods, and project management software like Primavera.
- CO3:** Evaluate the working, capacity, and productivity of earthwork and hoisting equipment such as dump trucks, cranes, bulldozers, and rollers.
- CO4:** Understand the usage and operation of concreting equipment including batching plants, mixers, and techniques for placing and finishing concrete.
- CO5:** Apply modern construction techniques involving formwork, piling, fabrication, quality control, safety practices, and integrate BIM in project planning.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes

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

UNIT – I

Construction project management and its relevance – qualities of a project manager – project planning – coordination –scheduling - monitoring – bar charts – milestone charts – critical path method

UNIT – II

Project evaluation and review technique–cost analysis–updating–crashing for optimum cost crashing for optimum resources–allocation of resources introduction to software’s for construction management, project management using PRIMAVERA (or) equivalent.

UNIT – III

Construction equipment – economical considerations – earthwork equipment – Trucks and handling equipment – rear dump trucks – capacities of trucks and handling equipment – calculation of truck production – compaction equipment – types of compaction rollers Hoisting and earth work equipment–hoists–cranes–tractors–bull dozers–graders–scrapers draglines clam shell buck

UNIT-IV

Concreting equipment— concrete mixers–Batching plants, mobile using plants like “Ajax” etc. mixing and placing of concrete – consolidating and finishing.

UNIT-V

Construction methods – earthwork – piling – placing of concrete – form work – fabrication and erection – quality control and safety engineering. BIM for Civil Engineers (Building Information Modelling)

Textbooks:

1. Construction Planning, Equipment and Methods’ by Peurifoy and Schexnayder, Shapira, Tata McGraw hill.
2. Construction Project Management Theory and Practice’ by Kumar NeerajJha (2011), Pearson.

Reference Books:

1. Construction Project Management-An Integrated Approach ’by Peter Fewings, Taylor and Francis
2. Construction Management Emerging Trends and Technologies’ by Trefor Williams , Cengage learning

Web Links:

1. [NPTEL :: Civil Engineering - NOC:Principles of Construction Management](#)
2. [NPTEL :: Civil Engineering - Construction Planning and Management](#)

GREEN BUILDINGS**(Open Elective-I)****V Semester****Course Code: 231CE5003**

L	T	P	C
3	0	0	3

Course Outcomes:

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

CO1: Understand the fundamental concepts, benefits, and sustainable features of green buildings.

CO2: Describe and analyze green building rating systems and sustainability practices in construction.

CO3: Apply principles of energy-efficient green design and evaluate renewable energy integration.

CO4: Assess HVAC design strategies and energy modeling used in green building projects.

CO5: Evaluate indoor air quality measures, sustainable material use, and occupant well-being strategies.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes

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

UNIT – I**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 – II

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-III

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- IV

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 –V

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, Indore air quality, Sick building syndrome, Tobacco smoke control, Minimum fresh air requirements avoid use of asbestos in the building, improved fresh air ventilation, Measure of IAQ, Reasons for poor IAQ, Measures to achieve Acceptable IAQ levels,

Text Books:

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

Reference Books:

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

Web Links:

1. <https://nptel.ac.in/courses/105107213>
2. <https://nptel.ac.in/courses/105107212>

**RENEWABLE ENERGY SOURCES
(OPEN ELECTIVE-I)**

V Semester	L	T	P	C
Course Code: 231EE5001	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	PO 12
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	PSO 1	PSO 2
CO 1	-	-
CO 2	-	-
CO 3	-	-
CO 4	-	-
CO 5	-	-

UNIT – I

Solar Energy

Introduction - Renewable Sources - prospects, solar radiation at the Earth Surface - Equivalent circuit of a Photovoltaic (PV) Cell - I-V & P-V Characteristics - Solar Energy Collectors: Flat plate Collectors, concentrating collectors - Solar Energy storage systems and Applications: Solar Pond - Solar water heating - Solar Green house.

UNIT – II

Wind Energy

Introduction - basic Principles of Wind Energy Conversion, the nature of Wind - the power in the wind - Wind Energy Conversion - Site selection considerations - basic components of Wind Energy Conversion Systems (WECS) - Classification - Applications.

UNIT – III**Biomass, Hydel and Geothermal Energy**

Biomass: Introduction - Biomass conversion technologies- Photosynthesis. Factors affecting Bio digestion.

Hydro plants: Basic working principle – Classification of hydro systems: Large, small, micro hydel plants.

Geothermal Energy: Introduction, Geothermal Sources – Applications - operational and Environmental problems.

UNIT – IV**Energy From oceans, Waves & Tides:**

Oceans: Introduction - Ocean Thermal Electric Conversion (OTEC) – methods - prospects of OTEC in India.

Waves: Introduction - Energy and Power from the waves - Wave Energy conversion devices.

Tides: Basic principle of Tide Energy -Components of Tidal Energy.

UNIT – V**Chemical Energy Sources:**

Fuel Cells: Introduction - Fuel Cell Equivalent Circuit - operation of Fuel cell - types of Fuel Cells - Applications.

Hydrogen Energy: Introduction - Methods of Hydrogen production - Storage and Applications

Magneto Hydro Dynamic (MHD) Power generation: Principle of Operation - Types.

Text Books:

- 1 G.D.Rai, Non-Conventional Energy Sources, Khanna Publications, 2011.
- 2 John Twidell& Tony Weir, Renewable Energy Sources, Taylor & Francis, 2013.

Reference Books:

- 1 S.P.Sukhatme&J.K.Nayak, Solar Energy-Principles of Thermal Collection and Storage, TMH, 2011.
- 2 John Andrews & Nick Jelly, Energy Science- principles, Technologies and Impacts, Oxford, 2nd edition, 2013.
- 3 ShobaNath Singh, Non- Conventional Energy Resources, Pearson Publications, 2015.

Web Links:

- 1 <https://archive.nptel.ac.in/courses/103/103/103103206>
- 2 <https://archive.nptel.ac.in/courses/103/107/103107157>

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

V Semester	L	T	P	C
Course Code: 231EE5002	3	0	0	3

Course Outcomes:

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

- CO1** Understand the principles of energy audit along with various Energy related terminologies.
- CO2** Asses the role of Energy Manager and Energy Management program.
- CO3** Design a energy efficient motors and good lighting system.
- CO4** Analyse the methods to improve the power factor and identify the energy instruments for various real time applications.
- CO5** Evaluate the computational techniques with regard to economic aspects.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
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

Basic Principles of Energy Audit

Energy audit- definitions - concept - types of Energy audit - energy index - cost index - pie charts - Sankey diagrams and load profiles - Energy conservation schemes- Energy audit of industries- energy saving potential - energy audit of process industry, thermal power station - building energy audit - Conservation of Energy Building Codes (ECBC-2017)

UNIT – II

Energy Management

Principles of energy management - organizing energy management program - initiating - planning - controlling - promoting - monitoring - reporting. Energy manager - qualities and

functions - language - Questionnaire – check list for top management.

UNIT – III

Energy Efficient Motors and Lighting

Energy efficient motors - factors affecting efficiency - loss distribution - constructional details - characteristics – variable speed - RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. lighting system design and practice - lighting control - lighting energy audit.

UNIT – IV

Power Factor Improvement and Energy Instruments

Power factor – methods of improvement - location of capacitors - Power factor with non-linear loads - effect of harmonics on power factor - power factor motor controllers – Energy Instruments- watt meter - data loggers - thermocouples - pyrometers - lux meters - tongue testers.

UNIT – V

Economic Aspects and their Computation

Economics Analysis depreciation Methods - time value of money - rate of return - present worth method - replacement analysis - lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method - net present value method- Power factor correction - lighting – Applications of life cycle costing analysis - return on investment.

Text Books:

- 1 Energy management by W.R.Murphy & G.Mckay Butter worth - Heinemann publications - 1982.
- 2 Energy management hand book by W.CTurner - John wiley and sons - 1982.

Reference Books:

- 1 Energy efficient electric motors by John.C.Andreas - Marcel Dekker Inc Ltd-2nd edition - 1995.
- 2 Energy management by Paul o' Callaghan - Mc-graw Hill Book company-1st edition - 1998.
- 3 Energy management and good lighting practice : fuel efficiency- booklet12-EEO.

Web Links:

- 1 <https://nptel.ac.in/courses/108106022>
- 2 <https://archive.nptel.ac.in/courses/108/106/108106022>

SUSTAINABLE ENERGY TECHNOLOGIES

(OPEN ELECTIVE-I)

V Semester

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:

CO/PO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
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 titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

Unit – II

Solar Energy Collection: Flat plate and concentrating collectors, classification of concentrating collectors, orientation.

Solar Energy Storage and Applications: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

Unit – III**Solar PV Modules and PV Systems:**

PV Module Circuit Design, Module Structure, Electrical and Mechanical Insulation, Lifetime of PV Modules, Degradation and Failure, PV Module Parameters, Efficiency of PV Module, Solar PV Systems-Design of Off Grid Solar Power Plant. Installation and Maintenance.

Storage in PV Systems:

Battery Operation, Types of Batteries, Battery Parameters, Application and Selection of Batteries for Solar PV System.

Unit – IV

Wind Energy: Sources and potentials, types of winds, horizontal and vertical axis windmills, performance characteristics, Betz criteria.

Bio-Mass: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels.

Unit – V

Geothermal Energy: Origin, Applications, Types of Geothermal Resources, Relative Merits

Ocean Energy: Ocean Thermal Energy; Open Cycle & Closed Cycle OTEC Plants, Environmental Impacts, Challenges

Fuel Cells: Introduction, Applications, Classification, Different Types of Fuel Cells Such as Phosphoric Acid Fuel Cell, Alkaline Fuel Cell, PEM Fuel Cell, MC Fuel Cell.

Text Books:

- 1 Non-conventional energy source, B.H. Khan, McGraw Hill Education India Private Limited, 3rd edition, 2017
- 2 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:

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

Weblinks:

- 1 <https://nptel.ac.in/courses/112105051>
- 2 <https://www.eia.gov/energyexplained/renewable-sources/>

APPLIED OPERATIONS RESEARCH (OPEN ELECTIVE-I)

V Semester	L	T	P	C
Course Code: 231ME5002	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 dynamic programming and simulation.

Mapping of Course Outcomes with Program Outcomes:

CO\PO	PO1	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:

	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:

- 1 Operations Research-An Introduction/Hamdy A Taha/Pearson publishers
- 2 Operations Research –Theory & publications / S.D.Sharma Kedarnath/McMillan publishers India Ltd

Reference Books:

- 1 Introduction to O.R/Hiller & Libermann/TMH
- 2 Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.

Web links:

- 1 <https://ocw.mit.edu/courses/find-by-topic/#cat=engineering&subcat=operationsresearch>
- 2 <https://nptel.ac.in/courses/112/107/112107209/>

**NANO TECHNOLOGY
(OPEN ELECTIVE-I)**

V Semester	L	T	P	C
Course Code: 231ME5003	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:

CO/PO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	2	-	2	-	-	-	-	-	-	-
CO5	3	-	-	-	-	1	1	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

INTRODUCTION: History and Scope, Classification of Nano structured Materials, Fascinating Nanostructures, and applications of nano-materials, challenges and future prospects.

UNIT – II

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 – III

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 – IV

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 – V

APPLICATIONS OF NANO MATERIALS: Nano-electronics, Micro- and Nano-electromechanical systems (MEMS/NEMS), Nano sensors, Nano catalysts, Food and Agricultural Industry, Cosmetic and Consumer Goods, Structure and Engineering, Automotive Industry, Water-Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defense and Space Applications, Concerns and challenges of Nanotechnology

TEXT BOOKS:

1. Introduction to Nano Technology by Charles. P. Poole Jr & Frank J. Owens. Wiley India Pvt. Ltd.
2. Nano Materials- A.K.Bandyopadhyay/ New Age Publishers.
3. Nano Essentials- T.Pradeep/TMH

REFERENCE:

1. Solid State physics by Pillai, Wiley Eastern Ltd.
2. Introduction to solid state physics 7th edition by Kittel. John Wiley & sons (Asia) Pvt Ltd.

THERMAL MANAGEMENT OF ELECTRONIC SYSTEMS

(OPEN ELECTIVE-I)

V Semester

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:

CO\PO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
CO1	3	2	2	1	3	2	3	2	2	3	1	1
CO2	3	2	3	3	2	1	2	3	1	2	2	1
CO3	3	2	2	2	1	3	1	2	2	2	3	1
CO4	3	2	2	2	1	2	1	1	3	1	1	1
CO5	3	2	1	2	1	1	1	1	2	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:

- 1 Thermal Analysis and Control of Electronic Equipment – Allan D. Kraus and Avram BarCohen, McGraw Hill, New York, NY, 1983.
- 2 Fundamentals of Microelectronics Packaging – Ed: Rao Tummala, McGraw Hill, New York, NY, 2001.1.
- 3 Packaging of Electronic Systems – James W. Dally, McGraw Hill, New York, NY, 1990

Reference Books:

- 1 Fundamentals of Microelectronics Packaging – Edited by Rao Tummala, McGraw Hill, New York, NY, 2001.
- 2 Heat Transfer: Thermal Management of Electronics – Younes Shabany, CRC Press, 2009
- 3 HoSung Lee, Thermal Design: Heat Sinks, Thermoelectrics, Heat Pipes, Compact Heat Exchangers, and Solar Cells, 2011 John Wiley & Sons, Inc.

Weblinks:

- 1 <https://nptel.ac.in/courses/108108110>
- 2 https://ocw.mit.edu/courses/6-622-power-electronics-spring-2023/resources/mit6_622s23_lecture_01_mp4/
- 3 <https://www.coursera.org/courses?query=electronics>

ENTREPRENEURSHIP (OPEN ELECTIVE-I)

V Semester	L	T	P	C
Course Code: 231ME5005	2	0	0	2

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 Organisational Services

Unit - III

Industrial Policies : Central and State Government Industrial Policies and Regulations -Schemes- International Business.

Unit - IV

Business Plan Preparation : Sources of Product for Business -Business model canvas-Business model generation- Prefeasibility Study - Criteria for Selection of Product - Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.

Unit – V

Launching Of Small Business: Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching – Incubation, Venture capital, IT startups.

Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business.

Text Books:

- 1 Robert D Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2013.
- 2 Dr. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, 2001

Reference Books:

- 1 Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 1996..
- 2 Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra ,2nd Edition ,2005
- 3 P.Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai -1997.
- 4 Arya Kumar. Entrepreneurship. Pearson. 2012

Weblinks:

- 1 <https://www.nptel.ac.in/courses/127105007>
- 2 <https://www.youtube.com/watch?v=7NI5P4KqrAs&t=1s>

PRINCIPLES OF SIGNALS & SYSTEMS
(Open Elective-I)

V Semester	L	T	P	C
Course Code: 231EC5001	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:

1. Signals and Systems - A.V. Oppenheim, A.S. Willsky, and S.H. Nawab, PHI, 2nd Edition, 2016.
2. Signals, Systems & Communications - B.P. Lathi, BS Publications, 2003.

Reference Books:

1. Signals & Systems - Simon Haykin and Van Veen, Wiley, 2nd Edition
2. Signals and Systems – A. Anand Kumar, PHI, 4th Edition, 2017.

Web Links:

1. <https://freevidelectures.com/course/3540/signals-and-systems-i>(Signals and Systems lby Prof. K.S.Venktesh IIT Kanpur)
2. <https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/>
3. <https://nptel.ac.in/courses/108104100>(Principles of Signals and Systems, Video course, Coordinator by Prof. Aditya, K. Jagannatham, IIT Kanpur)

INTRODUCTION TO INTERNET OF THINGS (Open Elective-I)

V Semester
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:

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

Reference Books:

1. Adrian McEwen, Hakim Cassimally “Designing the Internet of Things”, John Wiley & Sons, 2014.
2. Peter Friess, ' Internet of Things—From Research and Innovation to Market Deployment', River Publishers, 2014
3. Misra,S.,Mukherjee,A.,&Roy,A.(2021).Introduction to IoT. Cambridge:Cambridge University Press. doi:10.1017/9781108913560.

Web Links:

1. <https://onlinecourses.nptel.ac.in/noc2lee85/course>
2. <https://onlinecourses.nptel.ac.in/noc2lcs17/preview>
3. <https://nptel.ac.in/courses/106/105/106105166/>

**DIGITAL ELECTRONICS AND LOGIC DESIGN
(Open Elective-I)**

V Semester
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:

1. Digital Design, Morris Mano, Pearson, 3rd Edition, 2002.
2. Fundamentals of Logic Design, Charles H. Roth Jr., Jaico Publishers, 2004.

Reference Books:

1. Modern Digital Electronics, RP Jain, Tata Mc Graw Hill, 4th Edition, 2010.
2. Introduction to Switching Theory and Logic Design, Fredriac J. Hill, Gerald R. Peterson, 3rd Edition, John Wiley & Sons Inc., 1982.
3. Switching and Finite Automata Theory, ZviKohavi&NirajK.Jha, 3rdEdition 2010.

Web Links:

1. <http://nptel.ac.in/courses/117/106/117106086/> (By Prof. Goutam Saha, Electronics & Electrical Communication Engineering Dept, IIT Kharagpur).
2. <https://www.nptelvideos.in/2012/12/digital-circuits-and-systems.html>(By Prof. Santanu Chattopadhyay, Electronics & Electrical Communication Engineering Dept, IIT Kharagpur).
3. <https://www.smartzworld.com/notes/switching-theory-and-logic-design-stld/>.

DATA BASE MANAGEMENT SYSTEMS
(Open Elective-I)

V Semester

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.

Textbooks:

1. Database Management Systems, 3/e, Raghurama Krishnan, Johannes Gehrke, TMH
2. Database System Concepts, 5/e, Silberschatz, Korth, TMH

Reference Books:

1. Introduction to Database Systems, 8/e C J Date, PEA.
2. Database Management System, 6/e Ramez Elmasri, Shamkant B. Navathe, PEA
3. Database Principles Fundamentals of Design Implementation and Management, Corlos Coronel, Steven Morris, Peter Robb, Cengage Learning.

Web Links:

1. <https://nptel.ac.in/courses/106/105/106105175/>
2. <https://www.geeksforgeeks.org/introduction-to-nosql/>
3. <https://www.youtube.com/watch?v=wKOD6mbXc2M>
4. <https://beginnersbook.com/2015/05/normalization-in-dbms/>

PYTHON PROGRAMMING (Open Elective-I)

V Semester
Course Code: 231DS5001

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

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 Loops

Unit – II

Control Statement: Definite iteration for Loop Formatting Text for output, Selection if and if else Statement Conditional Iteration The While Loop Strings and Text Files: Accessing Character and Substring in Strings, Data Encryption, Strings and Number Systems, String Methods Text Files

Unit – III

List and Dictionaries: Lists, Defining Simple Functions, Dictionaries Design with Function: Functions as Abstraction Mechanisms, Problem Solving with Top Down Design, Design with Recursive Functions, Case Study Gathering Information from a File System, Managing a Program's Namespace, Higher Order Function. Modules: Modules, Standard Modules, Packages

Unit – IV

Object Oriented Programming: Concept of class, object and instances, Constructor, class attributes and destructors, Real time use of class in live projects, Inheritance , overlapping and overloading operators, Adding and retrieving dynamic attributes of classes, Programming using Oops support Design with Classes: Objects and Classes, Data modeling Examples, Case Study An ATM, Structuring Classes with Inheritance and Polymorphism File Operations: Reading config files in python, Writing log files in python, Understanding read functions, read(), readline() and readlines(), Understanding write functions, write() and writelines(), Manipulating file pointer using seek, Programming using file operations

Unit – V

Errors and Exceptions: Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, User- defined Exceptions, Defining Clean-up Actions, Redefined Clean up Actions. Graphical User Interfaces: The Behavior of Terminal Based Programs and GUI - Based, Programs, Coding Simple GUI-Based Programs, Other Useful GUI Resources.

Text Books:

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

Reference Books:

1. Introduction to Python Programming, Gowrishankar.S, Veena A, CRC Press
2. Introduction to Programming Using Python, Y. Daniel Liang, Pearson, 2017.
3. Think Python, Allen Downey, Green Tea Press,2012 .
4. Python for Everybody Exploring Data in Python 3, Charles Russell Severance, Sue Blumenberg.

Web Links:

1. <https://www.python.org/>
2. <https://www.coursera.org/courses?query=Python%20programming>
3. <https://www.learnpython.org/>
4. https://www.tutorialspoint.com/python3/python_tutorial.pdf

COMPUTER ORGANIZATION
(Open Elective-I)

V Semester
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.

Unit – V

Multi Processors: Introduction, Characteristics of Multiprocessors, Interconnection Structures, Inter Processor Arbitration.

Pipeline: Parallel Processing, Pipelining, Instruction Pipeline, RISC Pipeline, Array Processor.

Text Books:

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

Reference Books:

1. Computer Organization and Architecture, William Stallings, 6/e, Pearson, 2006.
2. Structured Computer Organization, Andrew S. Tanenbaum, 4/e, Pearson, 2005.
3. Fundamentals of Computer Organization and Design, Sivarama P. Dandamudi, Springer, 2006

Web Links:

1. <https://nptel.ac.in/courses/106/105/106105163/>
2. <https://nptel.ac.in/courses/106/106/106106092/>
3. <https://www.udemy.com/course/computer-architecture-computer-organization-course/>
4. <http://www.cuc.ucc.ie/CS1101/David%20Tarnoff.pd>

OBJECT ORIENTED PROGRAMMING THROUGH JAVA (Open Elective-I)

V Semester	L	T	P	C
Course Code: 231AM5001	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 Class Object Class, Inhibiting Inheritance of Class Using Final, Access Control and Inheritance, Multilevel Inheritance, Application of Keyword Super, Constructor Method and Inheritance, Method Overriding, Dynamic Method Dispatch, Abstract Classes, Interfaces and Inheritance.

Interfaces: Introduction, Declaration of Interface, Implementation of Interface, Multiple Interfaces, Nested Interfaces, Inheritance of Interfaces, Default Methods in Interfaces, Static Methods in Interface, Functional Interfaces, Annotations.

UNIT – IV**Packages and Java Library:**

Introduction, Defining Package, Importing Packages and Classes into Programs, Path and Class Path, Access Control, Packages in Java SE, Java.lang Package and its Classes, Class Object, Enumeration, class Math, Wrapper Classes, 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 Thread Creation of New Threads, Thread States, Thread Priority Synchronization, 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:

- 1 JAVA one step ahead, Anitha Seth, B.L.Juneja, Oxford.
- 2 Joy with JAVA, Fundamentals of Object Oriented Programming, DebasisSamanta, MonalisaSarma, Cambridge, 2023.
- 3 JAVA 9 for Programmers, Paul Deitel, Harvey Deitel, 4th Edition, Pearson.

Reference Books:

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

Web Links:

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

INTRODUCTION TO PETROLEUM ENGINEERING (OPEN ELECTIVE-I)

V Semester

L T P C

Course Code: 231PT5001

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:

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

Reference Books:

1. Petroleum engineering handbook: Howard.B. Bradley,SPE,1987
2. Petroleum engineering hand book: Larry .W.lake, SPE, volume II, 2006.
3. Petroleum engineering handbook: Production operations engineering, volume IV, Joe Dunn Clegg, 2009.

**INTRODUCTION TO PETROLEUM GEOLOGY
(OPEN ELECTIVE-I)**

V Semester

Course Code: 231PT5002

Course Outcomes:

L T P C
3 0 0 3

- 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:

1. Bell, F.G., Engineering Geology, 2nd Edition, Butterworth Heimann, 2007.
2. Mukharje, P.K., Text book of Geology, P.K The World Press Pvt Ltd., 2005.

Reference Books:

1. Gribble, C. D., Rutley's Elements of Mineralogy, 27th Edition. CBS Publishers, 2005.
2. David Duff, Homes' Principles of Physical Geology, Nelson Thornes Ltd; 4th Revised edition, 1992.
3. Mahapatra, G.B., Text Book of Physical Geology, CBS Publishers, 2002.
4. Bangar, K.M., Principles of Engineering Geology, 2nd Edition, Standard Publishers, 2009.

INTRODUCTION TO WELL LOGGING (OPEN ELECTIVE-I)

V Semester	L	T	P	C
Course Code: 231PT5003	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, Sonic Neutron cross plots-Hingle plot-Mid plot –Correlation- Hydrocarbon reserve estimate.

TEXT BOOKS:

1. Formation evaluation, Edward J. Lynch, Harper & Row, 1962.
2. Well logging and formation evaluation, Toby Darling, Elsevier, New York, 2005.
3. Well Logging & Reservoir Evaluation, Oberto Serra, Editions Technip, 2007.

REFERENCE BOOKS:

1. Hydrocarbon well logging recommended practice, Society of professional well log analysts.
2. Open – Hole log analysis and formation evaluation, Richard M. Batemons, International Human Resources Development Corporation, Bostan, 1985.
3. Well Logging for Earth Scientists, Darwin V. Ellis, Julian M. Singer, Springer, 2007.
4. Fundamentals of Well Log Interpretation: The Acquisition of Data, Oberto Serra,Elsevier, 1984.
5. Well Logging Handbook, Oberto Serra, Editions Technip, 2008.

**INTRODUCTION TO UNDERGROUND MINING
(OPEN ELECTIVE – I)**

V Semester

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	PSO3
CO1	-	-	-
CO2	-	-	-
CO3	-	-	-
CO4	-	-	-
CO5	-	-	-

UNIT-I

Introduction: Present situation and future growth of coal mining industry in India and world, different coal mining industries in India, factors effecting selection of mode of entry and different types of mode entry: incline, shaft, inclined shaft, coal mine development and its scenario, different terminology used in coal mine development, different coal mining methods, factors influencing choice of coal mining methods. Software application in coal mines for development and depillaring operations.

UNIT-II

Bord and Pillar Mining: applicability, limitations, advantages and disadvantages of Bord and pillar mining method, development and depillaring sequence operations in Bord and Pillar mining, and its related calculations, local fall, main fall, airblast. Dangers associated with B& Pmethod and precautions. Case study with layout.

UNIT-III

Longwall Mining: Applicability, limitations, merits and demerits, different long wall mining methods, factors influencing selection of long wall method, method of development and depillaring and its related calculations. Thin seam and thick seam mining with long wall mining method, Case study with layout.

UNIT-IV

Thick Seam and deep seam Mining: Problems associated with thick and deep seam Mining, selection of mining method, caving and stowing methods, limitations and applicability: different slicing methods- (inclined Slicing, Horizontal Slicing, Diagonal Slicing, Transversely Inclined Slicing), and Caving methods (Sublevel Caving) Working Steep and Moderately Thick Seams: Blasting Gallery Method, room and pillar method,

UNIT- V

Modern coal mining methods: applicability, limitations, merits and demerits of Inseam Mining and Horizon Mining, Hydraulic Mining, plough methods, working underneath surface features, extraction of multi seams, problems and issues:

Future Innovations: blind long hole pre-shattering methods, scientific mining approach, application of mining software for mine development and extraction and production planning and design of workings, Size and grade control by CSP and CWP, case study.

TEXTBOOKS:

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

REFERENCEBOOKS:

1. Under ground Coal Mining Methods–J.G.Singh, BrajKalpa Publishers, Varnasi,2000.
2. Coal Mining – I.C.F. Statham, Vol. I, II, III and Vol. III. The Caxton Publishing CompanyLtd.Inc.1958.
3. Elements of Mining technology-D.JDeshmukhVol.1
4. Modern Coal mining Technology: SamirkumarDas
5. Under ground winning of coal:T.NSingh

Web Links:

1. <https://arlweb.msha.gov/Fatals/AccidentClassifications.asp>
2. http://www.hsa.ie/eng/Topics/Managing_Health_and_Safety/Safety_Statement and _
3. <http://www.sciencedirect.com/topics/earth-and-planetary-sciences/rock-mechanics>

**INTRODUCTION TO SURFACE MINING
(OPEN ELECTIVE – I)**

V Semester

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	PSO3
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 box cut.

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 surface miners.

UNIT-V

Transport Equipment: Dumpers, Aerial ropeways-monocable and bicable types and their constructional details. Shovel – dumper combination, high angle conveyor and in-pit crusher. Selection of equipment.

TEXT BOOKS:

1. Surface Mining Technology by S.K.Das, Lovely Prakashan, Dhanbad,1994.
2. Surface Mining by G.B. Mishra, Dhanbad Publishers,1978.

REFERENCE BOOKS:

1. Elements of Mining Technology, Vol.–I, D.J.Deshmukh, 6thEdition, Central Techno Publications, Nagpur,1998.
2. Opencast Mining–R.T.Deshmukh, M.Publications, Nagpur,1996.
3. Latest Development of Heavy Earth Moving Machinery Amithosh De, Annapurna Publishers, Dhanbad,1995.
4. Rock Slope Engineering, Hoek and Bray, theInstitutionofMiningandMetallurgy,1981.
5. Introductory Mining Engineering, Hartman, John Wiley and Sons,1987.

Web Links:

1. <https://arlweb.msha.gov/Fatals/AccidentClassifications.asp>
2. http://www.hsa.ie/eng/Topics/Managing_Health_and_Safety/Safety_Statement_and_
3. <http://www.sciencedirect.com/topics/earth-and-planetary-sciences/rock-mechanics>

**TUNNELLING & UNDERGROUND SPACE DESIGN
(OPEN ELECTIVE – I)**

V Semester

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3
CO1	-	-	-
CO2	-	-	-
CO3	-	-	-
CO4	-	-	-
CO5	-	-	-

UNIT I

INTRODUCTION: Congestion in cities and its impact on development of social infrastructure for transport, water and power supply, separation of pedestrian and motorized vehicles and its movements, storage of materials, defense facilities including civil shelters. Parameters influencing location, shape and size; geological aspects; planning and site investigations. Tunnels for various purposes like road, rail, hydropower tunnels and caverns, Underground storage applications.

UNIT II

TUNNELLING METHODS: Types and purpose of tunnels; factors affecting choice of excavation techniques; soil and rock sampling and testing, Methods - soft ground tunneling, hard rock tunneling, shallow tunneling, deep tunneling; Shallow tunnels – cut and cover, cover and cut, pipe jacking, jacked box excavation techniques, methods of muck disposal, supporting, problems encountered and remedial measures.

UNIT III

TUNNELLING BY DRILLING AND BLASTING: Unit operations in conventional tunneling; Drilling - drilling principles, drilling equipment, drilling tools, drill selection, specific drilling, rock drillability factors; Blasting - explosives, initiators, blasting mechanics, blast holes nomenclature; types of cuts - fan, wedge and others; 21 blast design, tunnel blast performance - powder factor, parameters influencing, models for prediction; mucking and transportation equipment selection.

UNIT IV

MECHANIZED TUNNELLING: Cutting principles, method of excavation, selection, performance, limitations and problems. Boring principles, method of excavation, selection, performance, limitations and problems; Road headers, Impact Hammers, Tunnel Boring Machines and applications.

UNIT V

TUNNEL DESIGN: Planning and design, Assessment of behavior of tunneling media, deformation modulus and rock pressure assessment; determination of appropriate size and shape; Design of openings in rocks with the help of field data; Instrumentation and monitoring; Numerical modeling to assess the stability.

TEXT BOOKS:

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

REFERENCES:

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

Web Links:

1. <https://arlweb.msha.gov/Fatals/AccidentClassifications.asp>
2. http://www.hsa.ie/eng/Topics/Managing_Health_and_Safety/Safety_Statement_and_
3. <http://www.sciencedirect.com/topics/earth-and-planetary-sciences/rock-mechanics>

**INTRODUCTION TO MINE ENVIRONMENT
(OPEN ELECTIVE – I)**

V Semester

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	PSO3
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:

- 1) Mine Environment by G.B. Mishra
- 2) Elements of Mining Tech. Vol.2 by D. J. Deshmukh
- 3) Subsurface Mine Ventilation. by Mcpherson

Reference Books:

- 1) Mine fires by Dr. Ramlu
- 2) Underground Mine Environment, M. Mcpherson
- 3) Subsurface Mine Ventilation, H.L. Hartman

Web Links:

1. <https://arlweb.msha.gov/Fatals/AccidentClassifications.asp>
2. http://www.hsa.ie/eng/Topics/Managing_Health_and_Safety/Safety_Statement_and_
3. <http://www.sciencedirect.com/topics/earth-and-planetary-sciences/rock-mechanics>

BASIC CROP PRODUCTION PRACTICES
(Open Elective-I)

V Semester

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:

1. Rajendra Prasad, Text Book of Field Crop Production. Directorate of Information and Publication, Krishi Anusandhan Bhavan, Pusa, New Delhi, 2015.
2. Reddy T. Sankara G.H. Yellamanda Reddi, Principles of Agronomy, Kalyani Publishers, New Delhi, 2005.
3. Handbook of Agriculture. ICAR Publications, New Delhi, 2011.

Reference Books:

1. Bose T. K. and L.P.Yadav. Commercial Flowers, Naya Prakash, Calcutta.1989.
2. Crop Production Guide, Tamil Nadu Agricultural University Publication, Coimbatore. 2005.
3. Kumar, N., Abdul Khader, M. Rangaswami, P. and Irulappan, I. Introduction to spices, plantation crops, medicinal and aromatic plants. Rajalakshmi Publications, Nagercoil. 1993.
4. Kumar, N., "Introduction to Horticulture", Rajalakshmi Publications. Nagercoil, 7th edition, 2015.
5. Shanmugavel, K.G. Production Technology of Vegetable Crops. Oxford India Publications, New Delhi. 1989.

Web Links:

1. <https://www.careerlauncher.com/cbse-ncert/class-8/Science/CBSE-CropProductionandManagement-Notes.html#:~:text=%E2%80%A2%20Basic%20Practices%20of%20Crop,is%20called%20ploughing%20or%20tilling.>
2. https://www.edubeans.com/Class_VIII_Science_Crop-Production-and-Management.php
3. <https://byjus.com/biology/basic-practices-of-crop-production/>
4. <http://www.apagrisnet.gov.in/pdf/farmerbook.pdf>

GROUNDWATER, WELLS AND PUMPS
(Open Elective-I)

V Semester	L	T	P	C
Course Code: 231AG5002	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:

1. Water Well and Pumps, Michael AM, Khepar SD. and SK Sondhi, 2nd Edition, Tata Mc-Graw Hill, 2008.
2. Irrigation-Theory and Practice, Michael AM., 2nd Edition. Vikas Publishing House Pvt. Ltd, 2018.
3. Principles of Agricultural Engineering Vol-II, Michael A.M. and Ojha T.P. 5th Edition. Jain Brothers Publication, New Delhi, 2014.

Reference Books:

1. Land and Water Management Engineering, Murthy, V.V.N and Jha, M.K. Sixth Edition, Kalyani Publishers, Ludhiana, 2011.
2. Ground Water, Third Edition, New Age International, Raghunath, H.M. Publishers, New Delhi, 2007.
3. Groundwater Development and Management, Sarma, P.B.S., Allied Publishers Pvt. Ltd., New Delhi, 2009.
4. Ground Water Hydrology, Todd, D.K. John Wiley & Sons, New York, 2004.

Web Links:

1. <http://ecoursesonline.iasri.res.in/course/view.php?id=513>
2. <https://nptel.ac.in/courses/105/105/105105042/>

ANALOG AND DIGITAL IC APPLICATIONS LAB

V Semester	L	T	P	C
Course Code: 231EC5L01	0	0	3	1.5

Course Outcomes:

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

- CO1:** Build analog circuits using operational amplifiers and ICs.
- CO2:** Develop timer circuits, PLLs, VCOs, and DACs using IC 555, IC 565, IC 566, and operational amplifiers.
- CO3:** Make use of analog circuits to build and verify signal processing blocks.
- CO4:** Develop the Verilog code for digital logic circuits.
- CO5:** Analyze the cost parameters – area, delay and power dissipation of Digital Circuits on FPGA Hardware

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

List of Experiments:

Part-A

1. OP AMP Applications – Adder, Subtractor, Comparator Circuits.
2. Integrator and Differentiator Circuits using IC 741
3. Active Filter Applications – LPF, HPF and BPF
4. IC 555 Timer – Astable & Mono-stable Operation Circuit.
5. Schmitt Trigger Circuits – using IC 741 and IC 555.

Part-B

(The students are required to design and draw the internal structure of the following Digital Integrated Circuits and to develop HDL(VHDL, Verilog HDL) source code, perform simulation using relevant simulator and analyze the obtained simulation results using appropriate synthesizer. Further, it is required to verify the logic with necessary hardware.)

6. Realization of Logic Gates

7. 3 to 8 Decoder- 74138
8. 8*1 Multiplexer-74151 and 1*2 De-multiplexer-74155
9. 4-Bit Comparator-7485.
10. D Flip-Flop- 7474

List of Augmented Experiments:

(Any two of the following experiments can be performed- preferably one from Analog and One from Digital)

5. IC 565 – PLL Applications
6. IC 566 – VCO Applications
7. 4 bit DAC using OP AMP
8. Decade Counter- 7490
9. Universal shift register-74194/195
10. RAM (16*4)-74189 (read and write operations)

Tools Required:

Part-A

1. RPS
2. CRO
3. Function Generator
4. Multi Meters
5. IC Trainer Kits (Optional)
6. Bread Boards
7. Components: - IC741, IC555, IC565, IC1496, IC723, 7805, 7809, 7912 etc.
8. Analog IC Tester

Part-B

1. Xilinx Vivado/Equivalent Standard IDE
2. Personal computer with necessary peripherals
3. Hardware kits- Various FPGA families.

Text Books:

1. Ramakanth A. Gayakwad-Op-Amps & Linear ICs, PHI.
2. Floyd and Jain-Digital Fundamentals, 8thEd., Pearson Education.

Reference Books:

1. D. Roy Chowdhury–Linear Integrated Circuits, New Age International(p) Ltd, 2ndEd.
2. John.F.Wakerly–Digital Design Principles and Practices, 3rdEd., Pearson.

Web Links:

1. <https://be-iitkgp.vlabs.ac.in/exp/operational-amplifier/>
2. <https://www.asic-world.com/>
3. https://mddl-iitb.vlabs.ac.in/sequence_detector/index.html

ANALOG AND DIGITAL COMMUNICATIONS LAB

V Semester

Course Code: 231EC5L02

L	T	P	C
0	0	3	1.5

Course Outcomes:

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

- CO1:** Analyze analog modulation and demodulation techniques.
- CO2:** Examine analog to digital conversion techniques.
- CO3:** Analyze shift keying techniques.
- CO4:** Compute the efficiency of the source coding techniques.
- CO5:** Compare error control coding schemes.

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	2	-	-	-	1	1	-	1
CO2	2	2	-	1	2	-	-	-	1	1	-	1
CO3	2	2	-	1	2	-	-	-	1	1	-	1
CO4	2	2	-	1	2	-	-	-	1	1	-	1
CO5	2	2	-	1	2	-	-	-	1	1	-	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. Generate AM-DSBSC modulated signal and demodulate the modulated signal.
2. Generate Frequency Modulated signal, determine the modulation index and bandwidth, also demodulate the frequency modulated signal.
3. Generate Pulse Position Modulation and Demodulation waveforms.
4. Verify the process of Multiplexing and De-Multiplexing using TDM technique.
5. Study the characteristics of Pulse Code Modulation.
6. Convert analog voltages into their digital equivalents using Delta Modulation and observe the waveforms.
7. Observe the process of Frequency Shift Keying technique.
8. Observe the process of Phase Shift Keying technique.
9. Minimize coding redundancy using Source Encoder and Decoder.
10. Perform error detection and correction using Linear Block Code-Encoder and Decoder.

List of Augmented Experiments:

(Any two of the following experiments can be performed)

1. Generate pulse Amplitude Modulation and Demodulation waveforms.
2. Verify the process of Differential Pulse Code Modulation and Demodulation.
3. Perform error detection and correction using Convolution Code – Encoder and Decoder.
4. Plot the frequency response of Pre-emphasis and De-emphasis circuits.

Tools Required:

Hardware and MATLAB

Text Books:

1. Signals & Systems - Simon Haykin and Van Veen, Wiley, 2nd Edition, 2021.
2. Principles of Communication Systems, Simon Haykin, John Wiley, 2nd Edition, 2007.
3. Principles of Communication Systems, Herbert Taub, Donald L. Schilling, Goutam Saha, 4th Edition, McGrawHill, 2013

Web Links:

1. <https://www.mathworks.com/support/learn-with-matlab-tutorials.html>
2. <https://www.edx.org/learn/engineering/iitbombay-signals-and-systems-part-1>
3. <http://nptel.ac.in/courses/117101051/>

APPLICATIONS OF LAB VIEW FOR INSTRUMENTATION & COMMUNICATIONS

V Semester	L	T	P	C
Course Code: 231EC5S01	0	1	2	2

Course Outcomes:

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

- CO1:** Develop loops, case structures, arrays, and clusters.
- CO2:** Realize real time applications using NI DAQ hardware
- CO3:** Implement Coding techniques using LabVIEW
- CO4:** Design automation and process control application.
- CO5:** Apply LabVIEW for data processing applications

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Introduction to LabVIEW & Virtual Instrumentation: Overview of LabVIEW: Graphical programming paradigm, LabVIEW Environment: Front panel, block diagram, data flow programming, Creating simple Virtual Instruments (VIs), Debugging and troubleshooting techniques, Implementing loops, case structures, arrays, and clusters.

Unit – II

Data Acquisition & Signal Processing: Interfacing sensors (temperature, pressure, light, etc.) with LabVIEW, Real-time data acquisition using NI DAQ hardware, Signal generation: Sine, Square, Triangular waves, Fourier Transform (FFT) for frequency analysis, Filtering techniques: Low-pass, High-pass, Band-pass filters.

Unit – III

Communication System Implementation: AM and FM Modulation/Demodulation using LabVIEW, Simulation of Digital Modulation Schemes (ASK, PSK, FSK), Eye diagrams and constellation plots for digital signals, Error detection and correction: Parity, CRC, Hamming Code.

Unit – IV**Instrumentation & Automation Applications:**

Real-time data logging and file handling (Excel/CSV), PID Controller Design for automation and process control, Motor speed control using LabVIEW and DAQ, Signal visualization and user interface design.

Unit – V**Advanced Applications:**

Image Processing using LabVIEW, Wireless communication using Bluetooth & Wi-Fi in LabVIEW, IoT Integration-Cloud-based monitoring and remote data access, Project-based learning

Text Books:

1. R. W. Larsen, LabVIEW for Engineers, 1st ed., Prentice Hall, 2011.
2. G. W. Johnson and R. Jennings, LabVIEW Graphical Programming, 4th ed., McGraw-Hill, 2017.

Reference Books:

1. National Instruments, "LabVIEW Tutorials & Documentation," Available: <https://www.ni.com>. J. Jerome, Virtual Instrumentation Using LabVIEW, 1st ed., PHI Learning Pvt

Web Links:

1. <https://www.ni.com>
2. <https://www.ni.com/documentation/en/labview/>
3. <https://www.ni.com/en-us/support/documentation/supplemental/06/getting-started-with-labview.html>
4. <https://learn.ni.com/>
5. <https://forums.ni.com/>

DESIGN OF PCB /ANTENNAS LAB

V Semester	L	T	P	C
Course Code: 231EC5L03	0	0	2	1

Course Outcomes:

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

- CO1:** Analyze impedance matching and polarization using smith chart techniques.
- CO2:** Plot and interpret dipole and monopole radiation patterns.
- CO3:** Evaluate array antennas including uniform and Yagi-Uda types.
- CO4:** Measure radiation patterns of planar, reflector, and helical antennas.
- CO5:** Analyze EM wave generation, velocity, and propagation path loss.

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

List of Experiments:

1. Impedance Matching using Smith Chart.
2. Plot of Radiation pattern of dipole antenna.
3. Plot of Radiation pattern of monopole antenna.
4. Plot of Radiation pattern of Uniform Linear Array.
5. Generation of EM-Wave.
6. Calculation of phase and group velocity.
7. Analysis of co-polarization and cross polarization
8. Radio wave propagation path loss calculations.
9. Measurement of radiation pattern of aperture antennas
10. In house PCB proto type manufacturing process.
11. How to convert simulation results into real time Electronic boards/ Projects.
12. Designing according to project requirements

List of Augmented Experiments:

(Any two of the following experiments can be performed)

1. Performance analysis of Yagi -Uda antenna.
2. Performance analysis of Helix antenna.
3. Acrylic sheets. Engraving on aluminium.
4. Explore to design the proto type products.

Tools Required:

MATLAB / AMS/ HFSS.

Text Books:

1. Antenna Theory: Analysis And Design- Constantine A. Balanis, 3rd Edition, A John Wiley & Sons, Inc., Publication
2. Antennas for All Applications – John D. Kraus and Ronald J. Marhefka, 3rd Edition, TMH, 2003.

Reference Books:

1. Antennas and Wave Propagation-G.S.N. Raju
2. Transmission and Propagation – E.V.D. Glazier and H.R.L. Lamont
3. Antennas – John D. Kraus

Web Links:

1. <http://nptel.ac.in/courses/117104127/2>
2. <http://www.amanogawa.com/antenna.html>
3. <http://www.radio-electronics.com/info/antennas/>
4. <http://nptel.ac.in/courses/117107035/> by Dr. Amalendu Patnaik
5. <http://www.radartutorial.eu/index.en.html>

PROFESSIONAL ETHICS AND HUMAN VALUES
(Common to all branches)

V Semester	L	T	P	C
Course Code: 231MC5T01	2	0	0	0

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

CO1: Make use of values, morals and ethics in their day-to-day life.

CO2: Identify what is right and wrong through moral ethics.

CO3: Analyze experimental learning while developing the society with ethics.

CO4: Apply ethical principles to resolve the problems that arise in workplace.

CO5: Apply adequate knowledge of the global code of conduct.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Human Values: Morals, Values and Ethics – Integrity –Trustworthiness - Work Ethics – Service Learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty –Courage – Value Time – Co-operation – Commitment – Empathy – Self confidence – Spirituality- Character

Unit – II

Principles for Harmony: Truthfulness – Customs and Traditions -Value Education – Human Dignity – Human Rights – Fundamental Duties - Aspirations and Harmony (I, We & Nature) – Gender Bias - Emotional Intelligence – Salovey – Mayer Model – Emotional Competencies – Conscientiousness.

Unit – III

Engineering Ethics and Social Experimentation: History of Ethics - Need of Engineering Ethics - Senses of Engineering Ethics- Profession and Professionalism —Self Interest - Moral Autonomy – Utilitarianism – Virtue Theory - Uses of Ethical Theories - Deontology- Types of Inquiry –Kohlberg’s Theory - Gilligan’s Argument –Heinz’s Dilemma - Comparison with Standard Experiments — Learning from the Past –Engineers as Managers – Consultants and Leaders – Balanced Outlook on Law - Role of Codes – Codes and Experimental Nature of Engineering

Unit – IV

Engineers' Responsibilities towards Safety and Risk: Concept of Safety - Safety and Risk – Types of Risks – Voluntary v/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:

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

Reference Books:

1. Engineering Ethics & Human Values By M.Govindarajan, S.Natarajan And V.S.Senthil Kumar-PHI Learning Pvt. Ltd – 2009.
2. Human Values And Professional Ethics By Jayshree Suresh And B. S. Raghavan, S.Chand Publications
3. Professional Ethics And Human Values By Prof.D.R.Kiran-Tata Mcgraw-Hill – 2014
4. Engineering Ethics By Harris, Pritchard And Rabins, Cengage Learning, New Delhi.

Web Links:

1. <https://nptel.ac.in/courses/109104068>
2. <https://www.reelnreel.com/roles-and-responsibilities-of-a-typical-video-engineer/>
3. <http://nptel.ac.in/courses/109104068/30>
4. http://nptel.ac.in/courses/122106031/Pdfs/2_1.pdf

SUMMER INTERNSHIP-I

V Semester	L	T	P	C
Course Code: 231EC5P01	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	-	-	-	-	-	-	-	-
CO5	-	-	-	-	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.

VLSI DESIGN

VI Semester
Course Code: 231EC6T01

L	T	P	C
3	0	0	3

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

- CO1** Outline the fundamental concepts related to MOS and Bi-CMOS Circuits fabrication.
- CO2** Analyze the electrical properties of MOS and Bi-CMOS Circuits.
- CO3** Make use of design rules for developing stick and layout diagrams.
- CO4** Interpret the issues related to subsystem design.
- CO5** Interpret FPGA and ASIC design approaches for semi-custom 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	3	2	2	-	-	-	-	-	-	-	-	1
CO2	2	3	2	-	-	-	-	-	-	-	-	1
CO3	2	1	3	-	-	-	-	-	-	-	-	1
CO4	2	2	1	-	-	-	-	-	-	-	-	1
CO5	3	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

Unit - I

Introduction: Introduction to IC Technology, MOS and related VLSI Technology, Basic MOS Transistors, Enhancement and Depletion modes of transistor action, IC production process, MOS and CMOS Fabrication processes, Bi-CMOS Technology, Comparison between CMOS and Bipolar technologies.

Unit – II

Basic Electrical Properties of MOS and Bi-CMOS Circuits: I_{ds} versus V_{ds} Relationships, Aspects of MOS transistor: Threshold Voltage, MOS transistor Trans-conductance, Output Conductance and Figure of Merit. The Pass transistor, NMOS Inverter, Alternative forms of the pull-up, The CMOS Inverter, Bi- CMOS Inverter. Transistor switches, Schematics of Inverter, NAND, NOR gates using NMOS, PMOS, and CMOS technologies.

Unit – III

MOS Circuit Design Processes: MOS Layers, Design Rules, General observations of design rules, $2\mu\text{m}$ Double Metal, Double Poly, CMOS rules, $1.2\mu\text{m}$ Double Metal, Double Poly CMOS rules, Stick Diagrams, Layout Diagrams of NAND and NOR gates and CMOS inverter.

Unit – IV

Basic Circuit Concepts & Scaling of MOS Circuits: Sheet Resistance, Sheet Resistance concept applied to MOS transistors and Inverters, Area Capacitance of Layers, Standard unit of capacitance, The Delay Unit, Inverter Delays, Propagation Delays, Wiring Capacitances. Scaling models, Scaling factors for device parameters,

Subsystem Design: Architectural issues, switch logic, Gate logic, structured design, clocked sequential circuits, system considerations, the design process of the arithmetic processor.

Unit – V

IC Design: PLAs, PLDs, FPGA, ASIC, Selection of an Appropriate Integrated Circuit.

FPGA Design Process: Architectures of Popular FPGAs, Choosing an FPGA, FPGA Design Process, FPGA Families of Different Vendors, FPGA Design Examples.

Text Books:

1. Essentials of VLSI Circuits and Systems By Kamran Eshraghian, Douglas and A. Pucknell, Sholeh Eshraghian, Prentice-Hall of India Private Limited, 2005.
2. VLSI Design, Black Book by Dr. K.V.K.K. Prasad, KattulaShyamala, Kogent Learning Solutions Inc, 2012.

Reference Books:

1. CMOS Digital Integrated Circuits Analysis & Design, Sung-Mo (Steve) Kang, Yusuf Leblebici, Tata McGraw-Hill, 3rd Edition, 2002.
2. Modern VLSI Design-Wolf Wayne, Pearson Edition, 3rd Edition, 1997.
3. VLSI Design, K. LalKishore, V.S.V.Prabhakar, I.K. International Publishing House Private Limited, 1st Edition, 2009.

Web Links:

1. <https://nptel.ac.in/courses/106/105/106105161/> Prof. IndranilSengupta, IIT Kharagpur
2. <https://nptel.ac.in/courses/117/101/117101004/> Prof. A. N. Chandorkar, IIT Bombay

MICROPROCESSORS & MICROCONTROLLERS

VI Semester

Course Code: 231EC6T02

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Interpret the architecture of microcomputer systems
- CO2:** Develop assembly language program for 8086.
- CO3:** Demonstrate the interfacing of peripherals to microprocessor.
- CO4:** Interpret the architecture of 8051 microcontroller.
- CO5:** Demonstrate the interfacing of peripherals to 8051 microcontroller.

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

Introduction: Basic Microprocessor architecture, Harvard and Von Neumann architectures with examples, Microprocessor Unit versus Microcontroller Unit, History and classifications of Microprocessor and Microcontroller.

8086 Architecture: Register organization, internal architecture of 8086, pin description of 8086, minimum mode and maximum mode of 8086 operation and timing diagrams.

Unit – II

8086 Programming: Instruction set, addressing modes, assembler directives, programming with an assembler, writing simple programs with an assembler, stack and stack structure, interrupts and interrupt service routines 8086 system.

Unit – III

8086 Interfacing: Semiconductor memories interfacing (RAM, ROM), Intel 8255 programmable peripheral interface, Interfacing switches and LEDs, Interfacing seven segment displays, Interfacing stepper motor, A/D and D/A converters, Intel 8251 USART architecture and interfacing, Intel 8237a DMA controller, Need for 8259 programmable interrupt controllers.

Unit – IV**Intel 8051 Microcontroller**

Architecture, Hardware concepts, Input/output ports and circuits, external memory, counters/timers, serial data input/output, interrupts. Assembly language programming: Instructions, addressing modes, simple programs.

Unit – V**8051 Interfacing**

Interfacing to 8051: A/D and D/A Convertors, Stepper motor interface, keyboard, LCD Interfacing, Traffic light control.

Text Books:

1. Microprocessors & Interfacing, Douglas V Hall, McGraw Hill, 2ndEdition, 2005.
2. The 8051 Micro Controller Architecture, Programming and Applications, Kenneth J Ayala, Thomson Publishers, 3rdEdition, 2004.

Reference Books:

1. Advanced Microprocessors and Interfacing, K.M. Bhurchandi, A.K. Ray, Tata McGraw Hill, 3rd Edition, 2012.
2. The 8051 Microcontrollers and Embedded systems: Using Assembly and C, Muhammad Ali Mazidi, Janice Gillespie Mazidi and Rollin D. McKinlay; Pearson 2ndEdition, 2011
3. Microprocessors and Microcontrollers, N. Senthil Kumar, M. Saravanan, S. Jeevananthan, Oxford University Press, 2ndEdition, 2016.

Web Links:

1. <https://nptel.ac.in/courses/108/105/108105102/> Prof. Santanu Chattopadhyay
2. <https://edutechlearners.com/download/MP/8255%20&%20IO%20Interfacing.pdf>
3. https://www.keil.com/dd/docs/datashts/atmel/at89c51_ds.pdf

DIGITAL SIGNAL PROCESSING

VI Semester

Course Code: 231EC6T03

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Analyse the concepts of discrete signals and discrete systems with its characteristics in the frequency domain.
- CO2:** Design the algorithms for the efficient computation of DFT coefficients of signals.
- CO3:** Design and realize the digital IIR filters.
- CO4:** Design and realize the digital FIR filters.
- CO5:** Understand the concept of Multi rate 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	2	-	1	-	-	-	-	-	-	-	1
CO2	3	2	1	2	-	-	-	-	-	-	-	1
CO3	3	2	1	2	-	-	-	-	-	-	-	1
CO4	2	2	3	1	-	-	-	-	-	-	-	1
CO5	3	-	-	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

Introduction: Basic elements of DSP system, Advantages, Disadvantages and Applications
 Frequency Analysis of Discrete Time Signals, Discrete-Time Fourier Transform, Properties of DTFT. Frequency domain characteristics of LTI systems

The Discrete Fourier Transform: Its Properties and Applications: Frequency Domain Sampling: The Discrete Fourier Transform, Properties of the DFT, Linear Filtering Methods Based on the DFT, Frequency Analysis of Signals Using DFT

Unit – II

Efficient Computation of the DFT: Fast Fourier Transform Algorithms: Direct Computation of the DFT, Radix-2 Decimation in Time Fast Fourier Transform, Radix-2 Decimation in Frequency Fast Fourier Transform, Inverse Fast Fourier Transform.

Response of LTI system for long data sequence: Overlap-Add and Overlap-Save methods

Unit – III

Design of Digital Filters: General Considerations: Causality and Its Implications, Characteristics of Practical Frequency Selective Filters.

Design of IIR Filters From Analog Filters: IIR Filter Design by Approximation of Derivatives,

IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation.

Structures for IIR Systems: Discrete Form Structures, Cascade Form Structures, Parallel Form Structures.

Unit – IV

Design of FIR Filters: Symmetric and Antisymmetric FIR Filters, Design of Linear Phase FIR Filters Using Windows, Design of Linear Phase FIR Filters by the Frequency Sampling Method.

Structures for FIR Systems: Direct Form Structure, Cascade Form Structures, Linear Phase Structures.

Unit – V

Multi Rate Signals and Systems: Multi Rate digital signal processing fundamentals, Decimation and Interpolation, Time and frequency domain analysis, Multi Rate structures and analysis.

Text Books:

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G. Manolakis, 4th Edition, Pearson Education, 2007.
2. Digital Signal Processing - Tarun Kumar Rawat, Oxford University Press, 2015.

Reference Books:

1. Discrete Time Signal Processing – A.V. Oppenheim and R.W. Schaffer, 3rd Edition, Pearson, 2014.
2. Digital Signal Processing-P. Ramesh Babu, 5th Edition, SCITECH Publishers.

Web Links:

1. <https://nptel.ac.in/courses/117/102/117102060/> (Digital Signal Processing by Prof. S.C. Dutta Roy, IIT Delhi)
2. [https://nptel.ac.in/courses/117/102/117102060/\(Digital Signal Processing - Video course, Coordinator BY Prof. S.C. Dutta Roy Department of Electrical Engineering IIT Delhi\).](https://nptel.ac.in/courses/117/102/117102060/(Digital%20Signal%20Processing%20-%20Video%20course,%20Coordinator%20BY%20Prof.%20S.C.%20Dutta%20Roy%20Department%20of%20Electrical%20Engineering%20IIT%20Delhi).)
3. <http://www.dspguide.com/pdfbook.htm>
4. <http://vlabs.iitkgp.ernet.in/dsp/>

ANALOG IC DESIGN
(Professional elective-II)

VI Semester

Course Code: 231EC6E01

L	T	P	C
3	0	0	3

Course Outcomes:

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

CO1: Analyze the small signal and large signal models of CMOS transistors.

CO2: Analyze the characteristics of different CMOS circuits.

CO3: Develop the two stage CMOS operational amplifiers.

CO4: Compare different performance parameters of comparators.

CO5: Explain the design principles of oscillator and phase-locked loop circuits.

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

Unit – I

MOS Devices and Modelling: The MOS Transistor, Passive Components- Capacitor & Resistor, Integrated circuit Layout, CMOS Device Modelling - Simple MOS Large-Signal Model, Other Model Parameters, Small-Signal Model for the MOS Transistor, Computer Simulation Models, Sub-threshold MOS Model.

Unit – II

Analog CMOS Sub-Circuits:

MOS Switch, MOS Diode, MOS Active Resistor, Current Sinks and Sources, Current Mirrors- Current mirror with Beta Helper, Degeneration, Cascode current Mirror and Wilson Current Mirror, Current and Voltage References, Band gap Reference.

Unit – III

CMOS Amplifiers:

Inverters, Differential Amplifiers, Cascode Amplifiers, Current Amplifiers, Output Amplifiers, High Gain Amplifiers Architectures. CMOS Operational Amplifiers: Design of CMOS Op Amps, Compensation of Op Amps, Design of Two-Stage Op Amps, Power- Supply Rejection Ratio of Two-Stage Op Amps, Cascode Op Amps, Measurement Techniques of OP Amp.

Unit – IV

Comparators: Characterization of Comparator, Two-Stage, Open-Loop Comparators, Other Open-Loop Comparators, Improving the Performance of Open-Loop Comparators, Discrete- Time Comparators.

Unit – V

Oscillators & Phase-Locked Loops: General Considerations, Ring Oscillators, LC Oscillators, Voltage Controlled Oscillators. Simple PLL, Charge Pump PLLs, Non-Ideal Effects in PLLs, Delay Locked Loops, Applications.

Text Books:

1. Design of Analog CMOS Integrated Circuits- Behzad Razavi, McGraw Hill Education, 2nd Edition, 2017.
2. CMOS Analog Circuit Design - Philip E. Allen and Douglas R. Holberg, Oxford University Press, 3rd Edition, 2013.

Reference Books:

1. Analysis and Design of Analog Integrated Circuits- Paul R. Gray, Paul J. Hurst, S. Lewis and R. G. Meyer, John Wiley & Sons, 5th Edition, 2010.
2. Analog Integrated Circuit Design- David A. Johns, Ken Martin, John Wiley & Sons 2nd Edition, 2013.

Web Links:

1. <https://nptel.ac.in/courses/117101105>
2. <https://nptel.ac.in/courses/108108038>
3. <https://www.synopsys.com/glossary/what-is-analog-design.html>

SATELLITE COMMUNICATIONS
(Professional elective-II)

VI Semester

Course Code: 231EC6E02

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 Satellite communications, orbital mechanics and launchers
- CO2:** Illustrate satellite subsystems
- CO3:** Derive the expression for G/T ratio and to solve some analytical problems on satellite link design.
- CO4:** Understand the multiple access techniques and architecture of earth-station design
- CO5:** Outline LEO and NGSO systems and concepts of GPS

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	-	-	-	-	-	-	-	-	-	1
CO2	3	3	-	-	-	-	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	2	3	-	-	-	-	-	-	-	-	-	1
CO5	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

INTRODUCTION: Origin of Satellite Communications, Historical Back-ground, Basic Concepts of Satellite Communications, Frequency allocations for Satellite Services, Applications, Future Trends of Satellite Communications.

ORBITAL MECHANICS AND LAUNCHERS: Orbital Mechanics, Look Angle determination, Orbital perturbations, Orbit determination, launches and launch vehicles, Orbital effects in communication systems performance.

Unit – II

SATELLITE SUBSYSTEMS: Attitude and orbit control system, telemetry, tracking, Command and monitoring system, power systems, communication subsystems, Satellite antennas, Equipment reliability and Space qualification.

Unit – III

SATELLITE LINK DESIGN: Basic transmission theory, link equation, C/N ratio, system noise temperature and G/T ratio, Design of down links, up link design, Design of satellite links for specified C/N, System design example.

Unit – IV

MULTIPLE ACCESS: Frequency division multiple access (FDMA): Intermodulation, Calculation of C/N. Time division Multiple Access (TDMA); Frame structure, Examples. Code Division Multiple access (CDMA): Spread spectrum transmission and reception.

EARTH STATION TECHNOLOGY: Introduction, basic architecture, Transmitters, Receivers, Antennas, Tracking systems, Terrestrial interface, Primary power test methods.

Unit – V

LOW EARTH ORBIT AND GEO-STATIONARY SATELLITE SYSTEMS: Orbit consideration, coverage and frequency considerations, Delay & Throughput considerations, System considerations, Operational NGSO constellation Designs

GLOBAL NAVIGATION SATELLITE SYSTEM(GNSS): Introduction, GPS-location principle, GPS navigation message, GPS receiver operation, differential GPS

CONCEPTS OF VSAT: introduction, overview, network architectures, access control protocols, basic techniques.

Text Books:

1. Satellite Communications – Timothy Pratt, Charles Bostian and Jeremy Allnutt, WSE, Wiley Publications, 3RD Edition, 2020.
2. Satellite Communications Engineering – Wilbur L. Pritchard, Robert A Nelson and Henri G.Suyderhoud, 2nd Edition, Pearson Publications, 2003.

Reference Books:

1. Satellite Communications: Design Principles- M. Richharia, B S publications, 2nd Edition, 2003.
2. Satellite Communication- D.C Agarwal, Khanna Publications, 5th Edition.
3. Fundamentals of Satellite Communications- K.N. Raja Rao, PHI, 2004

Web Links:

1. <https://archive.nptel.ac.in/courses/117/105/117105131/>
2. <https://www.javatpoint.com/applications-of-satellite-systems>
3. <https://www.britannica.com/technology/satellite-communication>
4. <https://www.coursera.org/learn/satellite-communications>
5. <https://www.itu.int/hub/2020/05/satellite-communications-an-essential-link-for-a-connected-world/>

SMART AND WIRELESS INSTRUMENTATION
(Professional elective-II)

VI Semester

Course Code: 231EC6E03

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Understand the fundamentals of smart instrumentation and wireless sensor networks (WSNs).
- CO2:** Analyze the architecture of sensor nodes and evaluate their subsystems and communication interfaces.
- CO3:** Evaluate short-haul wireless communication technologies such as Bluetooth, Zigbee, Wi-Fi, and NFC for proximity-based industrial applications.
- CO4:** Assess long-haul wireless communication systems like LoRa, NB-IoT, Cellular (4G/5G), and satellite links for wide-area monitoring and IoT connectivity.
- CO5:** Apply WSN-based smart instrumentation solutions in various real-time applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	2	-	1	-	-	-	-	-	-	1
CO2	3	3	2	-	2	-	-	-	-	-	-	1
CO3	2	2	3	2	3	-	-	-	-	-	-	1
CO4	2	2	3	2	3	-	-	-	-	-	-	1
CO5	3	2	3	2	2	-	-	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Introduction: Smart Instrumentation (Materials, automation systems, ensign and Sensors, Sensor Classifications, Wireless Sensor Networks, History of Wireless Sensor networks (WSN), Communication in a WSN, important design constraints of a WSN like Energy, Self-Management, Wireless Networking, Decentralized Management, Design Constraints, Security etc.

Unit – II

Node architecture: The sensing subsystem, Analog to Digital converter, the processor subsystem, architectural overview, microcontroller, digital signal processor, application specific integrated circuit, field programmable gate array (FPGA), comparison, communication interfaces, serial peripheral interface, inter integrated circuit, the IMote node architecture, The XYZ node architecture, the Hog throb node architecture.

Unit – III

Short-Haul Wireless Communication: Characteristics and requirements of short-range links, Bluetooth: architecture, protocols, use cases, Zigbee: IEEE 802.15.4, low power mesh networking, Wi-Fi: IEEE 802.11, features for smart instrumentation, Infrared (IR), NFC, and other proximity-based systems, Selection criteria for industrial smart applications

Unit – IV

Long-Haul Wireless Communication: LoRa and LoRaWAN: spread spectrum, MAC layer, applications, NB-IoT: LTE-based narrowband protocol for low power long-range, Cellular (4G/5G): architecture for IoT/smart systems, Satellite Communication in instrumentation, Gateway integration and cloud connectivity, Comparative analysis: range, latency, power, and reliability

Unit – V

Applications: Structural health monitoring - sensing seismic events, single damage detection using natural frequencies, multiple damage detection using natural frequencies, multiple damage detection using mode shapes, coherence, piezoelectric effect, traffic control, health care - available sensors, pipeline monitoring, precision agriculture, active volcano, underground mining.

Text Books:

1. Fundamentals of wireless sensor networks: theory and practice - WalteneusDargie, Christian Poellabauer, A John Wiley and Sons, Ltd., Publication.
2. Smart Sensors, Measurement and Instrumentation, Subhas Chandra Mukhopadhyay, Springer Heidelberg, New York, Dordrecht London, 2013.
3. Wireless Sensors and Instruments: Networks, Design and Applications, HalitEren, CRC Press, Taylor and Francis Group, 2006.

Reference Books:

1. Uvais Qidwai, Smart Instrumentation: A data flow approach to Interfacing, Chapman & Hall; 1st Edn, December 2013.
2. Wireless Sensor Networks: Architectures and Protocols, Edgar H. Callaway Jr. and Edgar H. Callaway.
3. Wireless Networking Technology From Principles to Successful Implementation, [Steve Rackley](#), [Elsevier Science](#), 2011.

Web Links:

1. <https://nptel.ac.in/courses/106/105/106105160/>
2. <https://www.ijser.org/researchpaper/A-Review-on-Wireless-Sensor-Network-Architecture.pdf>
3. <https://nptel.ac.in/courses/117/105/117105144/>
4. <https://nptel.ac.in/courses/108/105/108105160/>

MACHINE LEARNING (Professional elective-II)

VI Semester **L** **T** **P** **C**
Course Code: 231EC6E04 **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 emphasize on statistical learning with different types and understand their applications.
- CO2:** Demonstrate various regression techniques and linear models for binary classification
- CO3:** Illustrate the Clustering Techniques and Dimensionality Reduction Models in Machine Learning
- CO4:** Analyze the role of Ensemble Learning Methods and Support Vector Machines in Machine Learning
- CO5:** Discuss the Model Evaluation and Basics of Feature 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	3	3	2	2	2	-	-	-	-	-	-	2
CO2	3	3	3	2	3	-	-	-	-	-	-	2
CO3	3	3	2	2	3	-	-	-	-	-	-	2
CO4	3	3	3	2	3	-	-	-	-	-	-	2
CO5	3	2	2	2	3	-	-	-	-	-	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	2	1
CO2	3	2
CO3	3	3
CO4	3	3
CO5	2	3

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 Techniques:(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

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 – IV

Ensemble Learning & Artificial Neural Networks: Introduction, Voting Classifiers, Bagging and Pasting, Random Forests, Boosting, Stacking. Support Vector Machine: Linear SVM Classification, Nonlinear SVM Classification, SVM Regression. Introduction to Artificial Neural Networks.

Unit – V

Model Evaluation & Basics of Feature Engineering: Introduction, selecting a Model, training a Model (for Supervised Learning), Model Representation and Interpretability, Evaluating Performance of a Model, Improving Performance of a Model. Basics of Feature Engineering: Introduction, Feature Transformation, Feature Subset Selection.

Text Books:

1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Publications, 2019
2. Data Science and Machine Learning Mathematical and Statistical Methods, Dirk P. Kroese, Zdravko I. Botev, Thomas Taimre, Radislav Vaisman, 25th November 2020

Reference Books:

1. Machine Learning Probabilistic Approach, Kevin P. Murphy, MIT Press, 2012
2. Stephen Marsland, "Machine Learning -An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
3. Andreas C. Müller and Sarah Guido "Introduction to Machine Learning with Python: A Guide for Data Scientists", O'Reilly

Web Links:

1. <https://www.deeplearning.ai/machine-learning/>
2. <https://www.cse.huji.ac.il/~shais/UnderstandingMachineLearning/index.html>
3. https://onlinecourses.nptel.ac.in/noc21_cs24/preview
4. <https://www.udemy.com/course/machinelearning/>

BIOMEDICAL INSTRUMENTATION
(Professional elective-III)

VI Semester	L	T	P	C
Course Code: 231EC6E05	3	0	0	3

Course Outcomes:

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

- CO1:** Demonstrate a foundational understanding of the anatomy and physiology of the human body.
- CO2:** Apply knowledge of different techniques used for measuring various physiological parameters.
- CO3:** Explain modern imaging techniques employed in medical diagnosis and identify the diverse therapeutic equipment utilized in the biomedical field.
- CO4:** Understand and apply bio-telemetry principles for transmitting bioelectrical variables.
- CO5:** Analyze patient safety measures and evaluate recent advancements in the medical field.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	2	-	-	-	-	-	-	-	-	1
CO2	3	3	3	2	-	-	-	-	-	-	-	1
CO3	3	3	3	2	-	-	-	-	-	-	-	1
CO4	3	3	3	2	-	-	-	-	-	-	-	1
CO5	3	3	3	2	-	-	-	-	-	-	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Introduction: Factors to be considered in the design of medical instrumentation systems, Basic objectives of medical instrumentation system, Physiological systems of human body, Sources of Bioelectric potentials: Resisting and Action Potentials, Propagation of Action Potentials, The Bioelectric Potentials. Electrodes: Electrode theory, Bio Potential Electrodes, Biochemical Transducers, Introduction to bio-medical signals.

Unit – II

The Cardiovascular System: The Heart and Cardiovascular System, The Heart, Blood Pressure, Characteristics of Blood Flow, Heart Sounds, Cardio Vascular Measurements, Electrocardiography, Measurement of Blood Pressure, Measurement of Blood Flow and Cardiac output, Plethysmography, Measurement of Heart Sounds, Event detection, PQRS & T-Waves in ECG, the first & second Heart beats, ECG rhythm analysis, the di-crotic notch in the carotid pulse detection of events and waves, analysis of exercise ECG, analysis of event related potentials, correlation analysis of EEG channels, correlation of muscular contraction.

Unit – III

Patient Care & Monitory and Measurements in Respiratory System: The elements of Intensive Care Monitory, Diagnosis, Calibration and reparability of Patient Monitoring equipment, other instrumentation for monitoring patients, pace makers, defibrillators, the physiology of respiratory system, tests and instrumentation for mechanics of breathing, respiratory theory equipment, analysis of respiration.

Unit – IV

Bio telemetry and Instrumentation for the Clinical Laboratory, Introduction to bio telemetry, Physiological parameters adaptable to bio telemetry, the components of bio telemetry system, implantable units, applications of telemetry in patient care – The blood, tests on blood cells, chemical test, automation of chemical tests.

Unit – V

X-ray and radioisotope instrumentation and electrical safety of medical equipment: Generation of Ionizing radiation, instrumentation for diagnostic X-rays, special techniques, instrumentation for the medical use of radioisotopes, radiation therapy - Physiological effects of electrical current, shock Hazards from electrical equipment, Methods of accident prevention, Modern Imaging Systems: Tomography, Magnetic Resonance Imaging System, Ultrasonic Imaging System, Medical Thermography.

Text Books:

1. Biomedical Instrumentation and Measurements C.Cromwell,F.J.Weibell,E.A.Pfeiffer – Pearson education.
2. Biomedical Signal Analysis – Rangaraj, M. Rangayya – Wiley Inter Science – JohnWilley & Sons Inc.

Reference Books:

1. Hand Book of Bio-Medical Instrumentation – R.S. Khandpur, TMH.
2. Introduction to Bio-Medical Engineering – Domach, Pearson.
3. Introduction to Bio-Medical Equipment Technology – Cart, Pearson.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_ee17/preview, IIT Kharagpur, By Prof. Sudipta Mukhopadhyay
2. <https://www.class-central.com/course/nptel-medical-image-analysis-7934>, IIT Kharagpur, By Prof. Debdoot Sheet
3. [https://www. https://www.electrical4u.com/introduction-to-biomedical-instrumentation/](https://www.electrical4u.com/introduction-to-biomedical-instrumentation/)

MICROWAVE ENGINEERING
(Professional elective-III)

VI Semester

Course Code: 231EC6E06

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Examine waveguide modes and calculate microstrip line parameters.
- CO2:** Study klystron behavior and analyze reflex klystron performance.
- CO3:** Understand TWT amplification and magnetron working with π -mode resonance.
- CO4:** Calculate S-matrix for various waveguide components and splitting the microwave energy in a desired direction.
- CO5:** Measure various microwave parameters using a Micro wave test bench.

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

MICROWAVE TRANSMISSION LINES: Introduction, Microwave Spectrum and Bands, Applications of Microwaves. Rectangular Waveguides – TE/TM mode analysis, Expressions for Fields, Characteristic Equation and Cut-off Frequencies, Filter Characteristics, Dominant and Degenerate Modes, Mode Characteristics – Phase and Group Velocities, Wavelengths and Impedance Relations, Related Problems. Microstrip Lines– Introduction, Zo Relations, Effective Dielectric Constant, Losses, Q factor.

Unit – II

MICROWAVE TUBES: Limitations and Losses of conventional tubes at microwave frequencies. Microwave tubes – O type and M type classifications. O-type tubes: 2 Cavity Klystrons – Structure, Re-entrant Cavities, Velocity Modulation Process and Applegate Diagram, Bunching Process– Expressions for o/p Power and Efficiency. Reflex Klystrons – Structure, Applegate Diagram and Principle of working, Mathematical Theory of Bunching, Power Output, Efficiency, Oscillating Modes and o/p Characteristics.

Unit – III

HELIX TWTS: Significance, Types and Characteristics of Slow Wave Structures; Structure of TWT and Amplification Process, Suppression of Oscillations, Nature of the four Propagation Constants, Gain Considerations.

M-type Tubes:

Introduction, Cross-field effects, Magnetrons – Different Types, 8-Cavity Cylindrical Travelling Wave Magnetron – Hull Cut-off and Hartree Conditions, Modes of Resonance and PI-Mode Operation, Separation of PI-Mode, o/p characteristics.

Unit – IV

WAVEGUIDE COMPONENTS AND APPLICATIONS: Waveguide Discontinuities – Waveguide irises, Tuning Screws and Posts, Matched Loads. Waveguide Attenuators – Resistive Card, Rotary Vane types; Waveguide Phase Shifters – Dielectric, Rotary Vane types, Scattering Matrix– Significance, Formulation and Properties, E-plane and H-plane Tees, Magic Tee, Directional Couplers – 2Hole, Bethe Hole types, S-Matrix Calculations, Ferrite Components– Faraday Rotation, Gyrator, Isolator, Circulator.

Unit – V

MICROWAVE SOLID STATE DEVICES: Introduction, Classification, Applications. TEDs – Introduction, Gunn Diode – Principle, RWH Theory, Characteristics, Basic Modes of Operation, Oscillation Modes, Gunn diode as a detector.

MICROWAVE MEASUREMENTS: Description of Microwave Bench – Different Blocks and their Features, Precautions; Microwave Power Measurement – Bolometer Method. Measurement of Attenuation, Frequency, Q- factor, Phase shift, VSWR, Impedance Measurement.

Text Books:

1. Foundations for Microwave Engineering – R.E. Collin, 2nd edition, 2001.
2. Microwave Engineering, David M Pozar, John Wiley, 4th edition, 2011.

Reference Books:

1. Microwave Devices and circuits, Samuel Y. Liao, PHI, 3rd edition, 7 print 2011.
2. Microwave Engineering – G S N Raju, I.K. International Publishing House Pvt. Limited, 2013.
3. Microwave and Radar Engineering- M. Kulkarni, 4th Edition, 2012.

Web Links:

1. <https://archive.nptel.ac.in/courses/108/101/108101112//by> Prof. Girish Kumar, Department of Electrical Engineering, IIT Bombay.
2. <https://archive.nptel.ac.in/courses/108/103/108103141/by> Prof. Ratnajit Bhattacharjee Department of Electronics & Electrical Engineering, IIT Guwahati.
3. <http://nptel.ac.in/courses/117107035/by> Dr. Amalendu Patnaik.
4. <https://archive.nptel.ac.in/courses/108/105/108105181//courses/108/101/108101112/> by Prof. Bratin Ghosh, Department of E & ECE, IIT Kharagpur.
5. https://www.tutorialspoint.com/microwave_engineering/microwave_engineering_measurement_devices.htm

EMBEDDED SYSTEMS
(Professional Elective-III)

VI Semester

Course Code: 231EC6E07

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:** Examine to integrate hardware and firmware for an embedded system.
- CO5:** Outline the process of embedded system development and Choose the tools.

Mapping of Course Outcomes with Program Outcomes:

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

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 crosscompilation, Deassembler/ Decompiler, Simulators, Emulators and Debugging, Target hardware debugging, Boundary Scan, Embedded Software development process and tools. Embedded System Implementation and Testing: The main software utility tool, CAD and the hardware, Translation tools-Pre-processors, Interpreters, Compilers and Linkers, Debugging tools, Quality assurance and testing of the design, Testing on host machine.

Text Books:

1. Embedded Systems, Shibu.K. V, Tata McGraw Hill Education Private Limited, 2013.
2. Embedded Systems-Architectures, Programming and Design, Raj Kamal, Tata McGraw Hill Publications.

Reference Books:

1. Embedded System Design, Frank Vahid and Tony Givargis, John Wiley Publications, 2013.
2. Hardware Software Co-Design Principles and Practice, J. Staunstrup, Springer Publications.
3. Embedded Systems Architecture, Tammy Noergaard, Elsevier Publications, 2013.

Web Links:

1. <https://www.iitk.ac.in/tkic/workshop/sensors-and-actuators/ppt/sandeep.pdf>
2. http://www.artistembedded.org/docs/Events/2006/ChinaSchool/1_ESIntroduction.pdf
3. <https://web.cecs.pdx.edu/~mperkows/temp/hardware-software-codesign.pdf>
4. <https://www.inf.ed.ac.uk/teaching/courses/es/PDFs/RTOS.pdf>
5. <https://www.vtresearch.com/fi/inf/pdf/publications/2004/P526.pdf>

OPTICAL COMMUNICATIONS
(Professional elective-III)

VI Semester

Course Code: 231EC6E08

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Interpret the properties of optical fiber.
- CO2:** Examine the losses and dispersion characteristics of optical fiber.
- CO3:** Choose appropriate fiber connectors for signal transmission.
- CO4:** Interpret the properties of optical sources and detectors.
- CO5:** Interpret source to fiber power launching, link power and rise time budgeting.

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

Overview of Optical Fiber communication: Historical development, the general system, advantages of optical fiber communications. Optical fiber wave guides- Introduction, Ray theory transmission, Total Internal Reflection, Acceptance angle, Numerical Aperture, Skew rays, cylindrical fibers- Modes, V-number, Mode coupling, Step Index fibers, Graded Index fibers, Single mode fibers- Cut off wavelength, Mode Field Diameter, Effective Refractive Index, Related problems.

Unit – II**Fiber materials:**

Glass, Halide, Active glass, Chalcogenide glass, Plastic optical fibers. Signal distortion in optical fibers; Attenuation, Absorption, Scattering and Bending losses, Core and Cladding losses, Information capacity determination, Group delay, Types of Dispersion: Material dispersion, Waveguide dispersion, Polarization Mode dispersion, Intermodal dispersion, Pulse broadening in Graded index fiber, Related problems.

Unit – III

Optical Fiber Connectors: Connector types, Single mode fiberconnectors, Connector return loss, Fiber Splicing- Splicing techniques, Splicing single mode fibers, Fiber alignment and joint loss- Multimode fiber joints, single mode fiber joints.

Unit – IV

Optical Sources: LEDs, Structures, Materials, Quantum efficiency, Power, Modulation, Power bandwidth product. Injection Laser Diodes- Modes, Threshold conditions, External quantum efficiency, Laser diode rate equations, Resonant frequencies, Reliability of LED& ILD, Optical detectors-Physical principles of PIN and APD, Detector response time, Temperature effect on Avalanche gain, Comparison of Photo detectors, Related problems.

Unit – V

Source to Fiber Power Launching: Output patterns, Power coupling, Power launching, Equilibrium Numerical Aperture, Laser diode to fiber coupling. Optical system design - Point-to-point links- Component choice and considerations, Link power budget, Rise time budget with examples, Line coding in Optical links.

Text Books:

1. Optical Fiber Communications, Gerd Keiser, McGraw-Hill International edition, 3rd Edition, 2000.
2. Fiber Optic Communications – Joseph C. Palais, Pearson Education, 4th Edition 2004.

Reference Books:

1. Fiber Optic Communications, D.K. Mynbaev, S.C. Gupta and Lowell L. Scheiner, Pearson Education, 2005.
2. Optical Fiber Communication and its Applications, S.C.Gupta, PHI, 2005.
3. Optical Fiber Communications, John M. Senior, PHI, 2nd Edition, 2002.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc25_ee90/preview
2. <https://www.smartzworld.com/notes/optical-communication-oc-notes-pdf/>

BASIC CONCRETE TECHNOLOGY
(Open Elective-II)

VI Semester
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	PO 12
CO1	2	1	-	-	-	-	-	-	-	-	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	-
CO3	2	1	1	-	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-
CO5	3	1	2	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO 1	PSO 2
CO1	-	3
CO2	-	3
CO3	-	3
CO4	-	3
CO5	-	3

Unit – I

Ingredients of Concrete cements & Admixtures

Portland cement – Chemical composition – Hydration, Setting of cement, Fineness of cement
Structure of hydrate cement – Test for physical properties – Different grades of cements –
Admixtures – Mineral and chemical admixtures – accelerators, retarders, air entrainers,
plasticizers, super plasticizers, fly ash and silica fume.

Aggregates Classification of aggregate – Particle shape & texture – Bond, strength & other
mechanical properties of aggregates – Specific gravity, Bulk density, porosity, adsorption &
moisture content of aggregate – Bulking of sand – Deleterious substance in aggregate –
Soundness of aggregate – Alkali aggregate reaction – Thermal properties – Sieve analysis –
Fineness modulus – Grading curves – Grading of fine & coarse Aggregates – Gap graded and
well graded aggregate as per relevant IS code – Maximum aggregate size. Quality of mixing
water.

Unit – II

Fresh Concrete

Steps in Manufacture of Concrete–proportion, mixing, placing, compaction, finishing, curing – including various types in each stage. Properties of fresh concrete-Workability – Factors affecting workability – Measurement of workability by different tests, Setting times of concrete, Effect of time and temperature on workability – Segregation & bleeding – Mixing and vibration of concrete, Ready mixed concrete, Concrete.

Unit – III

Hardened Concrete

Water / Cement ratio – Abram’s Law – Gel space ratio –Nature of strength of concrete – Maturity concept – Strength in tension & compression – Factors affecting strength – Relation between compression & tensile strength – Curing, Testing of Hardened Concrete: Compression tests – Tension tests – Factors affecting strength – Flexure tests – Splitting tests – Non-destructive testing methods – codal provisions for NDT. Anti washout concrete.

Unit – IV

Elasticity, Creep & Shrinkage

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

Mix Design Factors in the choice of mix proportions – Durability of concrete –Quality Control of concrete – Statistical methods – Acceptance criteria – Concepts Proportioning of concrete mixes by various methods – BIS method of mix design

Unit – V

Special Concretes

Ready mixed concrete, Shotcrete, Light weight aggregate concrete, Cellular concrete, No-fines concrete, High density concrete, Fiber reinforced concrete, Different types of fibers, Factors affecting properties of F.R.C, Polymer concrete, Types of Polymer concrete, Properties of polymer concrete, High performance concrete – Self consolidating concrete, SIFCON, self-healing concrete, Recycled concrete

Text Books:

1. Concrete Technology: Theory and Practice, M.L. Gambhir, McGraw Hill, 5th Edition, 2017.
2. Concrete Technology, M.S.Shetty, Chand Publication, 2006

Reference Books:

1. Concrete Technology, A.M. Neville and J.J. Brooks, Pearson,2019.
2. Concrete Technology, A.R. Santhakumar, Oxford,2018.

Web Links:

1. <https://nptel.ac.in/courses/105102012>
2. www.brightengineering.com › Concrete Technology

BASIC SURVEYING
(Open Elective-II)

VI Semester
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	PO 12
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:

1. B.C. Punmia, "Surveying Vol.1", Laxmi Publications pvt. Ltd., New Delhi –2017.
2. Kanetkar T P and S V Kulkarni , Surveying and Leveling Part I, Pune VidyarthiGrihaPrakashan,2015

Reference Books:

1. S.K. Duggal, "Surveying Vol.1", Tata McGraw Hill Publishing Co. Ltd. New Delhi.2019.
2. K.R. Arora, "Surveying Vol. 1" Standard Book House, New Delhi. –2017

Web Links:

1. nptel.iitm.ac.in
2. <https://nptel.ac.in/courses/105/105/105105176/>

**REPAIR AND REHABILITATION OF STRUCTURES
(Open Elective-II)**

VI Semester
Course Code: 231CE6003

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO 1	PSO2
CO1	-	-
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 upsheet, bolted plate, near surface mounted FRP, fundamental debonding mechanisms-intermediate crack debonding-CDC debonding-plate end de bonding-strengthening of floor of structures post grout tests. Introduction to Liquefaction & its effects & applications.

UNIT: IV

Fiber reinforced concrete-Properties of constituent materials-Mix proportions, mixing and casting methods-Mechanical properties of fiber reinforced concrete-applications of fiber reinforced concretes-Lightweight concrete-properties of light weight concrete-No fines concrete-design of light weight concrete-Fly ash concrete-Introduction-classification of fly ash-properties and reaction mechanism of fly ash-Properties of fly ash concrete in fresh state and hardened state-Durability of fly ash concretes.

UNIT:V

High performance concretes-Introduction-Development of high performance concretes-Materials of high performance concretes-Properties of high performance concretes-Self Consolidating concrete-properties-qualifications.

TEXT BOOKS

1. Maintenance Repair Rehabilitation & Minor works of Buildings -P.C.Varghese, PHI Publications
2. Repair and Rehabilitation of Concrete Structures–P.I.Modi,C.N.Patel,PHI Publications

REFERENCE:

1. Concrete Technology Theory and Practice-M.S.Shetty,SChandand Company
2. Concrete Repair and Maintenance illustrated-PeterHEmmons

WEB LINKS:

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

**FUNDAMENTALS OF ELECTRIC VEHICLES
(OPEN ELECTIVE-II)**

VI Semester	L	T	P	C
Course Code: 231EE6001	3	0	0	3

Course Outcomes:

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

- CO1** Illustrate the use and advantages of different types of electric vehicles
- CO2** Use suitable power converters for EV application.
- CO3** Select suitable electric motor for EV power train
- CO4** Design HEV configuration for a specific application.
- CO5** Analyse various storage systems and battery management system for EVs.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
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:

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

Reference Books:

- 1 Kumar - L. Ashok - and S. Albert Alexander. Power Converters for Electric Vehicles. CRC Press - 2020.
- 2 Chau - Kwok Tong. Electric vehicle machines and drives: design - analysis and application. John Wiley & Sons - 2015.
- 3 Berg - Helena. Batteries for electric vehicles: materials and electrochemistry. Cambridge university press - 2015.

Web Links:

- 1 <https://www.edx.org/learn/electric-cars>
- 2 <https://archive.nptel.ac.in/courses/108/106/108106170>

**ELECTRICAL WIRING ESTIMATION AND COSTING
(OPEN ELECTIVE-II)**

VI Semester	L	T	P	C
Course Code: 231EE6O02	3	0	0	3

Course Outcomes:

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

- CO1** Demonstrate the various electrical apparatus and their interconnections
- CO2** Examine various components of electrical installations.
- CO3** Estimate the cost for installation of wiring for different types of building and small industries.
- CO4** Illustrate the components of electrical substations
- CO5** Design suitable control circuit for starting of three phase induction motor and synchronous motor..

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	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:

- 1 Electrical Design and Estimation Costing - [K. B. Raina](#) and S.K.Bhattacharya – New Age International Publishers - 2007

Reference Books:

- 1 Electrical wiring estimating and costing – S.L.Uppal and G.C.Garg – Khanna publishers - 6th edition – 1987.
- 2 A course in electrical installation estimating and costing – J.B.Gupta – Kataria SK & Sons - 2013.

Web Links:

- 1 https://onlinecourses.swayam2.ac.in/nou25_ec07/preview

INTRODUCTION TO INDUSTRIAL ROBOTICS (Open Elective-II)

VI Semester	L	T	P	C
Course Code: 231ME6001	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	PO11	PO12
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:

1. Industrial Robotics / Groover M P /Mc Graw Hill
2. Introduction to Industrial Robotics / Ramachandran Nagarajan / Pearson

REFERENCE BOOKS:

1. Robot Dynamics and Controls / Spony and Vidyasagar / John Wiley
2. Robot Analysis and control / Asada, Slotine / Wiley Inter-Science
3. Robotics – Fu et al / TMH Publications

Weblink

1. https://onlinecourses.nptel.ac.in/noc23_me143/preview
2. https://www.youtube.com/playlist?list=PLXDsvE7qtfNf_N99hJZbdTEM001mOii6

INDUSTRIAL MANAGEMENT (Open Elective-II)

VI Semester	L	T	P	C
Course Code: 231ME6002	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
- W3** https://onlinecourses.nptel.ac.in/noc20_me43/preview

ADDITIVE MANUFACTURING (Open Elective-II)

VI Semester

Course Code: 231ME6003

L	T	P	C
2	0	0	2

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

- CO1:** Demonstrate appropriate level of understanding on principles of additive manufacturing processes.
- CO2:** Identify the materials for solid based AM process.
- CO3:** Apply powder-based RP systems.
- CO4:** Analyze and apply various rapid tooling techniques.
- CO5:** Represent a 3D model in STL format and other RP data formats to store and retrieve the geometric data of the object.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
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 – I

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 – II

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 – III**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 – IV**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 – V**RAPID PROTOTYPING DATA FORMATS:**

STL Format, STL File Problems, consequence of building valid and invalid tessellated models, STL file Repairs: Generic Solution, other Translators, and Newly Proposed Formats.

AM APPLICATIONS: Application in engineering, analysis and planning, aerospace industry, automotive industry, jewelry industry, coin industry, GIS application, RP medical and bioengineering applications: customized implants and prosthesis, forensic sciences.

Text Books:

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

Reference Books:

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

Weblinks:

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

VEHICLE TECHNOLOGY
(Open Elective-II)

VI Semester

Course Code: 231ME6O04

L	T	P	C
2	0	0	2

Course Outcomes:**At the end of the Course, Student will be able to:****CO1:** Discuss the latest trends in engine technology**CO2:** Discuss the need of advanced combustion technologies and its impact on reducing carbon foot-print on the environment.**CO3:** Analyzing the basic characteristics of low carbon fuels, its impact over conventional fuels and in achieving sustainable development goals.**CO4:** Discuss the working and energy flow in various hybrid and electric configurations.**CO5:** Analyzing the need for fuel cell technology in automotive applications.**Mapping of Course Outcomes with Program Outcomes:**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
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:

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

Reference Books:

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

Weblinks:

- 1 https://onlinecourses.nptel.ac.in/noc20_ee18/preview
- 2 <https://nptel.ac.in/courses/108106170>

INDUSTRIAL SAFETY (Open Elective-II)

VI Semester

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 the smart machines and smart sensors

CO3: Apply IoT to Industry 4.0 and they are able to make a system tailor-made as per requirement of the industry

CO4: Explain about fire prevention and protection systems.

CO5: Understand and apply the fire safety principles in buildings

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
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 of systems.

Unit - IV

Fire Prevention and Protection:

Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E-Fire extinguishing agents- Water, Foam, Dry chemical powder, Carbon-dioxide Halon alternatives Halocarbon compounds-Inert gases, dry powders – types of fire extinguishers – fire stoppers –hydrant pipes – hoses – monitors – fire watchers – layout of stand pipes – fire station-fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills –first aid for burns.

Unit-V

Building Fire Safety: Objectives of fire safe building design, Fire load, fire resistant material and fire testing – structural fire protection – structural integrity – concept of egress design -exit– width calculations –fire certificates – fire safety requirements for high-rise buildings.

Text Books:

- 1 Industrial Maintenance Management Srivastava, S.K.-S. Chandand Co.
- 2 Occupational Safety Management and Engineering Willie Hammer–Prentice Hall
- 3 PurandareD.D & Abhay D.Purandare, “Hand book on Industrial Fire Safety”P &A pub lications, NewDelhi, 2006
- 4 McElroy, FrankE., “Accident Prevention Manual for Industrial Operations”, NSC, Chicago, 1988
- 5 Green, A.E., “ High Risk Safety Technology”, John Wiley and Sons, 1984.

Reference Books:

- 1 Installation, Servicing and Maintenance Bhattacharya, S.N.-S.ChandandCo.
- 2 JainVK“FireSafetyinBuilding”NewAgeInternational1996.
- 3 Reliability, Maintenance and Safety Engineering by Dr.A. K.Guptha
- 4 A Text book of Reliability and Maintenance Engineering by Alakesh Manna

Web links:

- 1 <https://nptel.ac.in/courses/110105094>
- 2 https://onlinecourses.swayam2.ac.in/nou23_ge81/preview
- 3 <https://www.youtube.com/watch?v=jFDWIKayrTc>

PRINCIPLES OF COMMUNICATIONS (Open Elective-II)

VI Semester

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	PO6	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:

1. Principles of Communication Systems, H Taub, D L Schilling, Gautam Sahe, TMH, 4th Edition, 2017.
2. Communication Systems – B. P. Lathi, BS Publication, 2006

Reference Books:

1. Principles of Communication Systems - Simon Haykin, John Wiley, 2nd Edition.
2. Electronics & Communication System – George Kennedy and Bernard Davis, TMH 2004.
3. Analog and Digital Communications: Theory and Lab Work- Abhay Gandhi, Cengage, 2015.

Web Links:

1. <https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ee08/>,Principles of Communication Systems-I, Prof.Aditya K.Jagannatham, IIT Kanpur.
2. [https://onlinecourses.nptel.ac.in/noc21_ee74/preview,AnalogCommunication,Prof.GoutamDas , IITKharagpur.](https://onlinecourses.nptel.ac.in/noc21_ee74/preview,AnalogCommunication,Prof.GoutamDas,IITKharagpur)
3. [https://www.scribd.com/document/266137872/sanjay-sharma-pdf.](https://www.scribd.com/document/266137872/sanjay-sharma-pdf)
4. [http://bayanbox.ir/view/914409083519889086/Book-Modern-Digital-And-AnalogCommunicationSystems-4th-edition-by-Lathi.pdf.](http://bayanbox.ir/view/914409083519889086/Book-Modern-Digital-And-AnalogCommunicationSystems-4th-edition-by-Lathi.pdf)
5. <https://soaneemrana.org/onewebmedia/ELECTRONICS%20COMMUNICATION%20SYSTEM%20BY%20GEORGE%20KENNEDY.pdf>

**BIOMEDICAL ENGINEERING
(Open Elective-II)**

VI Semester

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** Understand the principles of biomedical instrumentation, bioelectric potentials, transducers, biosensors, and electrical safety.
- CO2** Measure and analyze biopotential signals such as ECG, EEG, EMG, ERG, EOG, and EGG
- CO3** Perform non-electrical physiological measurements related to cardiovascular and respiratory systems.
- CO4** Explain the working of critical care and therapeutic equipment used in clinical applications.
- CO5** Apply diagnostic techniques and biotelemetry systems in telemedicine and healthcare monitoring.

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	-	2	3	-	2	-	2	-	1
CO2	3	3	3	2	3	-	-	-	-	2	-	1
CO3	3	3	3	2	3	3	-	-	-	2	-	1
CO4	3	2	3	2	3	3	-	-	-	2	-	1
CO5	3	3	3	2	3	3	-	-	-	3	-	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 analysers, 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 and Therapeutic Equipment: Elements of intensive-care monitoring – Clinical laboratory instruments – Biomaterials – Ventilators: Types, classification, and positive pressure ventilators – Cardiac defibrillators: Types and applications – Cardiac pacemakers: External and implantable – Audiometers and hearing aids – Myoelectric arm – Physiotherapy equipment: Diathermy (short wave, microwave, ultrasonic) – Electrotherapy equipment: Nerve muscle stimulator, Functional electrical stimulator.

Unit – V

Diagnostic Techniques and Biotelemetry: Ultrasonic measurement and imaging – Applications of ultrasound in diagnosis and therapy – X-Ray instrumentation – CAT scan – Emission computerized tomography – MRI – Introduction to telemedicine and cyber medicine – Applications of telemedicine – Biotelemetry: Components and physiological parameters – Implantable telemetry units – Telemetry for ECG and emergency monitoring – Wireless wearable health care technology.

Text Books:

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

Reference Books:

1. Handbook of Bio-Medical Instrumentation, Khandapur, R.S., McGrawHill, 2nd edition, 2003
2. Biomedical Instrumentation, Arumugam, M., Anuradha Publications, 2006.
3. Health Care Systems, Technology and Techniques, Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Springer, 1st Edition, 2011.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_ee17/preview, IIT Kharagpur, By Prof. Sudipta Mukhopadhyay
2. <https://www.class-central.com/course/nptel-medical-image-analysis-7934>, IIT Kharagpur, By Prof. Debdoot Sheet
3. <https://www.electrical4u.com/introduction-to-biomedical-instrumentation/>

**ECAD TOOLS
(Open Elective-II)**

VI Semester

Course Code: 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:

1. Circuit analysis with PSPICE, Nassir H. Sabah, 2017.
2. MATLAB and Simulink, Adrian B. Biran, CRC press Taylor& Francis group.

Reference Books:

1. Electronics Circuits and Systems, Owen Bishop, 4th edition, 2011.
2. MATLAB for Electrical and computer engineering, Roland Priemer, 2013.

Web Links:

1. <https://www.mccormick.northwestern.edu/documents/students/undergraduate/introduction-to-matlab.pdf>
2. <https://vdocument.in/orcad-bspice-course-material.html>

WEB TECHNOLOGIES
(Open Elective-II)

VI Semester

Course Code: 231CS6001

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:

1. Programming the World Wide Web, 7th Edition, Robert W Sebesta, Pearson.
2. Pro Mean Stack Development, 1st Edition, Elad Elrom, Apress O'Reilly.
3. React Explained, 2020 Edition, Zac Gordon, OStraining.
4. MongoDB – The Definitive Guide, 2nd Edition, Kristina Chodorow, O'Reilly.

Reference Books:

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

Web Links:

1. <https://www.w3schools.com/> (html, css, js, xml, nodejs, angular, react, php)
2. <https://www.angular.io/docs>
3. <https://www.reactjs.org/docs/getting-started.html>
4. <https://www.university.mongodb.com/>

INTRODUCTION TO DATA SCIENCE
(open Elective-II)

VI Semester

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 and importance of pre-processing techniques
- CO 4** Show the results and present them in a pictorial format
- CO 5** Facilitate new solutions for visualization of datasets by using different plotting techniques.

Mapping of course outcomes with program outcomes:

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

Mapping of course outcomes with program Specific Outcomes:

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

UNIT I

Data science: definition, Datafication, Exploratory Data Analysis, The Data science process, A data scientist role in this process. NumPy Basics: The NumPy ndarray: A Multidimensional Array Object, Creating ndarrays ,Data Types for ndarrays, Operations between Arrays and Scalars, Basic Indexing and Slicing, Boolean Indexing, Fancy Indexing, Data Processing Using Arrays, Expressing Conditional Logic as Array Operations, Methods for Boolean Arrays , Sorting , Unique.

UNIT II

Getting Started with pandas: Introduction to pandas, Library Architecture, Features, Applications, Data Structures, Series, DataFrame, Index Objects, Essential Functionality (Reindexing, Dropping entries from an axis, Indexing, selection, and filtering), Sorting and ranking, Summarizing and Computing Descriptive Statistics, Unique Values, Value Counts, Handling Missing Data, filtering out missing data.

UNIT III

Data Loading, Storage, and File Formats : Reading and Writing Data in Text Format, Reading Text Files in Pieces, Writing Data Out to Text Format, Manually Working with Delimited Formats, JSON Data, XML and HTML: Web Scraping, Binary Data Formats,Using HDF5 Format, Reading Microsoft Excel Files, Interacting with Databases, Storing and Loading Data in MongoDB .

UNIT IV

Data Wrangling: Combining and Merging Data Sets, Database style DataFrame Merges, Merging on Index, Concatenating Along an Axis, Combining Data with Overlap , Reshaping and Pivoting, Reshaping with Hierarchical Indexing, Data Transformation, Removing Duplicates, Replacing Values.

UNIT V

Plotting and Visualization: A Brief matplotlib API Primer, Figures and Subplots, Colors, Markers, and Line Styles, Ticks, Labels, and Legends, Annotations and Drawing on a Subplot, Saving Plots to File,Plotting Functions in pandas, Line Plots, Bar Plots, Histograms and Density Plots, Scatter Plots.

Text Books:

T1: Wes McKinney, “Python for Data Analysis”,O’REILLY, ISBN:978-1-449-31979-3, 1st edition, October 2012.

T2:Rachel Schutt & O’neil, “Doing Data Science”, O’REILLY, ISBN:978-1-449-35865-5, 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.

Web Links:

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

OPERATING SYSTEMS

(Open Elective-II)

VI Semester	L	T	P	C
Course Code: 231IT6001	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:

1. Operating System Concepts, Silberschatz A, GalvinPB, GagneG, 10th Edition, Wiley, 2018.
2. Modern Operating Systems, Tanenbaum AS, 4th Edition, Pearson, 2016

Reference Books:

1. Operating Systems -Internals and Design Principles, Stallings W, 9th edition, Pearson, 2018
2. Operating Systems: A Concept Based Approach, D. M Dhamdhere, 3rd Edition, McGraw Hill, 2013

Web Links:

1. <https://archive.nptel.ac.in/courses/106/105/106105214/>
2. <https://www.coursera.org/specializations/codio-introduction-operating-systems>
3. <https://www.codecademy.com/learn/fundamentals-of-operating-systems>

**COMPUTER ORGANIZATION ARCHITECTURE
(Open Elective-II)**

VI Semester	L	T	P	C
Course Code: 231AM6001	3	0	0	3

Course Outcomes:

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

- CO1:** Describe the basic structure of a computer system, various number systems and arithmetic operations
- CO2:** Explain the Operation of CPUs including RTL, ALU, Instruction Cycle and Buses
- CO3:** Demonstrate the architecture and functionality of central processing unit
- CO4:** Illustrate the I/O and memory organization in an efficient way.
- CO5:** Make use of multi processors and pipelining to improve the efficiency of computer system.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	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	-	-	-	-	-	-	-

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:

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

Reference Books:

- 1 Computer Organization and Architecture, William Stallings, 6/e, Pearson, 2006.
- 2 Structured Computer Organization, Andrew S. Tanenbaum, 4/e, Pearson, 2005.
- 3 Fundamentals of Computer Organization and Design, Sivarama P. Dandamudi, Springer, 2006

Web Links:

- 1 <https://nptel.ac.in/courses/106/105/106105163/>
- 2 <https://nptel.ac.in/courses/106/106/106106092/>
- 3 <https://www.udemy.com/course/computer-architecture-computer-organization-course/>
- 4 <http://www.cuc.ucc.ie/CS1101/David%20Tarnoff.pdf>

**INTRODUCTION TO DRILLING TECHNOLOGY
(OPEN ELECTIVE – II)**

VI Semester

Course Code: 231PT6O01

Course Outcomes:

L T P C
3 0 0 3

- 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:

1. Petroleum Engineering: Drilling and Well Completion, Carl Gatlin, Prentice-Hall, Inc., 1960.
2. Drilling Engineering, J.J. Azar and G.Robello Samuel, PennWell Books, 2007.
3. Working Guide to Drilling Equipment and Operations, William Lyons, Gulf Publishing, 2009.

REFERENCE BOOKS:

1. Oil Well Drilling Engineering: Principles and Practice, H. Rabia, Graham & Trotman, 1985.
2. Drilling Engineering: A Complete Well Planning Approach, Neal Adams, Tommie Charrier Pennwell, 1985.
3. Practical Well Planning and Drilling Manual, Steve Devereux, Pennwell, 1998.

INTRODUCTION TO WELL COMPLETIONS (OPEN ELECTIVE-II)

VI Semester

Course Code: 231PT6O02

Course Outcomes:

L	T	P	C
3	0	0	3

- 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:

1. Well Completion and Servicing, D. Perrin, Micheal Caron, Georges Gaillot, Editions Technip, 1999.
2. Primer of Well Service, Workover and Completion, Petroleum Extension Service (PETEX), University of Texas at Austin, 1997.
3. Well Testing, John Lee, Society of Petroleum Engineers, 1982.

REFERENCE BOOKS:

1. Well Completion Design, Jonathan Bellarby, Elsevier, 2009.
2. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman, Inc., 1986.
3. Advanced Well Completion Engineering, Wan Renpu, Gulf Professional Publishing, 2011.

**INTRODUCTION TO PETROLEUM PRODUCTION ENGINEERING
(OPEN ELECTIVE – II)**

VI Semester	L	T	P	C
Course Code: 231PT6O03	3	0	0	3
Course Outcomes:				

- 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:

1. Petroleum Production Engineering: A computer Assisted Approach, Boyun Guo, William C. Lyons, Ali Ghalambor, Elsevier Science & Technology Books, 2007. 2. Petroleum Production Systems, M. J. Economides, A. Daniel Hill & C. E. Economides, Prentice- Hall, N. J – 07488, 1994.

REFERENCE BOOKS:

1. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.
2. The Technology of Artificial Lift Method, Brown, K.E., Volume 1, PennWell Books, 1977.

**MINERAL ECONOMICS
(OPEN ELECTIVE – II)**

VI Semester

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3
CO1	-	3	-
CO2	-	3	-
CO3	-	3	-
CO4	-	3	-
CO5	-	3	-

UNIT-I

General: Economic importance of the mineral industry; Risky nature of the mining industry; Demand and Supply analysis, National mineral policy;

Mineral price and pricing: International monetary system, Factors affecting mineral price, kinds of price quotation, Mineral price index, Mineral prices.

UNIT-II

Mineral Resource/Reserve: Concept, classification and estimation of reserves. Applications of Geostatistics.

Mineral inventory: concept, characteristic features, composition and economic significance; Estimation of life index.

Demand analysis and Market survey: Meaning and law of demand; methodology of demand analysis, Market survey.

UNIT-III

Conservation of mineral resources – Means of conservation and limitations in the scope of Conservation

Mine Sampling: Definition, purpose and scope, Preparation of samples, methods and computations; Application of statistical methods in sampling.

b - Classification and incorporation of losses, co-efficient of completeness of mineral extraction, Dilution and recovery

Examination of mineral properties: Definition, purpose, type and scope of examination.

UNIT-IV

Mine valuation: Basic concept, Earlier approaches to mine valuation, recent approaches to evaluation **Investment Appraisal:** Elements of investment appraisal, Static methods of investment appraisal, Dynamic methods of appraisal, discounted cash flow analysis

Mining costs: Capital and operating costs; Factors affecting operating cost; Methods of estimating future costs; Standard cost and forecast; Budget and budgetary control.

Mine finance: Capital – its importance, various forms and formation; mine accountancy and book keeping.

UNIT-V

Mineral Taxation System: Theory of taxation on minerals, Mineral tax designing, Types of mineral taxes, Taxes affecting mineral sector

Internal and External Trade: Taxes and duties; Imports and exports; International investment and trade in mineral materials & products.

Mineral information system: Data-information-informatics-data base, Mineral information system in India and problems, Mineral information system in outside India.

TEXT BOOKS:

- 1) Alwyn E. Annels, Mineral Deposit Evaluation: A Practical Approach, Chapman Hall, 1991.
- 2) Deshmukh R.T. Mine and Mineral Economics, Emdee Publishers, 1986.
- 3) Arogyaswamy, R.N.P. Courses in Mining Geology, Oxford and IBH Publishing Co., 1994.

REFERENCES:

- 1) Sloan, D.A., Mine Management, Chapman and Hall, London, 1983.
- 2) Chatterjee, K.K., Mineral economics, Wiley Eastern, 1992.
- 3) Park, R.J., Examination and Valuation of mineral property
- 4) How to read a balance sheet ILO 1992.

Web Links:

1. <https://pubs.usgs.gov/circ/1953/0231/report.pdf>
2. <https://www.min.int/impact/whatis.shtml>
3. <https://www3.nd.edu/~cneal/planetearth/Chapt-15-Marshak.pdf>

**LANDSLIDES & SLOPE STABILITY ENGINEERING
(OPEN ELECTIVE – II)**

VI Semester:	L T P C
Course Code: 231MI6O02	3 0 0 3

Course Outcomes:

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

- CO 1:** Classify types of mine slopes and slope failures, and identify key factors affecting slope stability for effective slope investigation planning.
- CO 2:** Acquire and interpret geological and geotechnical data required for evaluating highwall slope stability, including shear strength characteristics.
- CO 3:** Explain water flow mechanisms through various materials in mine slopes, and apply seepage analysis using flow nets and permeability estimation.
- CO 4:** Apply analytical and probabilistic methods for the design and stability assessment of pit slopes, waste dumps, and backfills.
- CO 5:** Analyze slope failure mechanisms using physical, empirical, and numerical models; evaluate stabilization and monitoring techniques with case study applications.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3
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:

- 1) Hoek, E. and Bray, J.W; Rock Slope Engineering; John Wiley & Sons; New York; 1984
- 2) Brawner, C.O; Stability in surface mining, SME of USA; New York, 1982.

REFERENCES:

- 1) Giani, F; Rock Slope Stability Analysis; Balkema; Rotterdam; 1992.
- 2) Fundamentals and applications of rock mechanics, Deb.D and Verma A.K, PHI Publications.

Web Links:

- 1 <http://www.roscience.com/learning/resource-library/books-by-r-e-goodman>
- .
- 2 <http://www.sciencedirect.com/topics/earth-and-planetary-sciences/rock-mechanics>
- .
- 3 <https://www.brighthubengineering.com/geotechnical-engineering/96483-rock-mechanics-defined/>
- .

**REMOTE SENSING AND GIS
(OPEN ELECTIVE – II)**

VI Semester

Course Code: 231MI6O03

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

- 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	PSO 3
CO1	-	-	-
CO2	-	-	-
CO3	-	-	-
CO4	-	-	-
CO5	-	-	-

UNIT – I

Introduction to Remote sensing: Basic concepts of remote sensing, interaction with atmosphere, energy interaction with the earth surfaces, characteristics of remote sensing systems, types of resolutions, types of sensors, airborne remote sensing, space borne remote sensing, image data characteristics, digital image data formats-band interleaved by pixel, band interleaved by line, band sequential, IRS, LANDSAT, SPOT & Recent satellite.

UNIT – II

Image analysis: Introduction, elements of visual interpretations, digital image processing-image preprocessing, image enhancement, image classification, supervised classification, unsupervised classification.

UNIT – III

Geographic Information System: Basic Principles, components, application areas of GIS, map projections. Data entry and preparation: spatial data structures, raster and vector data formats, data inputs, data manipulation, data retrieval, data analysis and data display.

UNIT – IV

Spatial data analysis: Introduction, overlay function-vector overlay operations, raster overlay operations, arithmetic operators, comparison and logical operators, conditional expressions, overlay using a decision table, network analysis-optimal path finding, network allocation, network tracing.

UNIT – V

Applications: Land cover and land use, agriculture, forestry, geology, geomorphology, urban & transportation, Hydrology and Water Resources: Flood zoning and mapping, groundwater prospects, groundwater quality monitoring and potential recharge zones, watershed management of application with case studies.

TEXTBOOKS:

1. 'Remote Sensing and Image Interpretation, by Lillesand, T.M, R.W. Kiefer and J.W. Chipman, Wiley India Pvt. Ltd., (2015), 7th Edition.
2. 'Remote Sensing - Models and Methods for Image Processing' by Robert A Schowenger, Elsevier publishers, (2009).
3. 'Fundamentals of Remote Sensing' by George Joseph, Universities Press, (2013) 3rd Edition.
4. 'Fundamentals of Geographic Information Systems' by Michael N. Demers, Wiley India Pvt. Ltd, (2012) 4th Edition.
5. 'Remote Sensing and GIS', by Bhatta B, Oxford University Press, (2011) 2nd Edition'.

**GEOSTATISTICS
(OPEN ELECTIVE – II)**

VI Semester

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	PSO3
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:

1. Sarma DD. Geo statistics with applications in earth sciences. Springer publications. 2009.

References:

1. Journel AG and Huijbregts C J. Mining geo statistics. Academic press. 1981.
2. Andereson F. Geo statistics by example approach using R. 2006.

Web Links:

- 1 <https://pdfcoffee.com/surpac-tutorialpdf-pdf-free.html>
- .
- 2 <https://baixardoc.com/documents/surpac-introduction-tutorial-system%20software-technology-5dbde76f19168>
- .
- 3 <https://www.brighthubengineering.com/geotechnical-engineering/96483-rock-mechanics-defined/>
- .

**ENGINEERING PROPERTIES OF AGRICULTURAL PRODUCE
(Open Elective-II)**

VI Semester
Course Code: 231AG6001

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

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 profit drag or pressure drag. Terminal velocity of different grains, working of pneumatic conveyor based on aerodynamic properties.

Unit – V

Electrical properties: Di-electrical properties; Dielectric loss factor and dielectric constant. Applications and role of electrical properties in food processing. Thermal Properties: Introduction to thermal properties; Specific heat, thermal conductivity, thermal diffusivity, latent heat of vaporization, latent heat of fusion, sensible heat, enthalpy and heat energy calculation.

Text Books:

1. Physical properties of plant and animal materials, Mohsenin N N, Gordon and Breach Science Publishers, New York, 2nd edition, 1986.
2. Engineering Properties of Foods, Rao M A, Syed S H Rizvi and Ashim K Datta, CRC Press – Taylor & Francis Group, Boca Raton, FL, 4th edition, 2014

Reference Books:

1. Food and Process Engineering Technology, Wilhelm LR, Suler W A and Brusewitz, G H, American Society of Agricultural Engineers (ASAE), St. Joseph, MI.
2. Engineering Properties of Biological Materials, O.P. Singhal and D.V.K. Samuel, Saroj Prakashan, Allahabad, 1st edition, 2003.

Web Links:

1. http://ecourses.iasri.res.in/email_authentication.aspx?Degree_Id=04
2. <http://ecoursesonline.iasri.res.in/course/view.php?id=25>
3. <http://www.cigr.org/documents/CIGRHandbookVol4.pdf>
4. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=1011>
5. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=1013>

PLASTIC APPLICATIONS IN AGRICULTURE

(Open Elective-II)

VI Semester
Course Code: 231AG6O02

L **T** **P** **C**
3 **0** **0** **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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

Unit - I

Introduction of plasticulture - types and quality of plastics used in soil and water conservation, production agriculture and post harvest management. Quality control measures. Present status and future prospective of plasticulture in India. Water management - use of plastics in in-situ moisture conservation and rain water harvesting. Plastic film lining in canal, pond and reservoir. Design, estimation and laying of plastic films in lining of canal, reservoir and water harvesting Ponds.

Unit – II

Plastic pipes for irrigation water management, bore-well casing and subsurface drainage. Study of plastic components of drip and sprinkler irrigation systems, laying and flushing of laterals. Use of polymers in control of percolation losses in fields. Soil conditioning - soil solarisation, effects of different colour plastic mulching in surface covered cultivation.

Unit – III

Nursery management - Use of plastics in nursery raising, nursery bags, trays etc. Controlled environmental cultivation - plastics as cladding material, green / poly / shade net houses, wind breaks, poly tunnels and crop covers. Design, estimation and installation of green, poly and shade net houses, low tunnels etc.

Unit-IV

Plastic nets for crop protection - anti insect nets, bird protection nets. Plastic fencing. Plastics in drying, preservation, handling and storage of agricultural produce, innovative plastic packaging solutions for processed food products. Plastic cap covers for storage of food grains in open. Silage film technique for fodder preservation.

Unit-V

Use of plastics as alternate material for manufacturing farm equipment and machinery. Plastics for aquacultural engineering and animal husbandry - animal shelters, vermi-beds and inland fisheries. Agencies involved in the promotion of plasticulture in agriculture at national and state level. Human resource development in particular applications.

Text Books:

1. Dubois. 1978. Plastics in Agriculture. Applied Science Publishers Limited, Essex, England. y Manas Chanda, Salil K. Roy. 2008. Plastics Fundamentals, Properties, and Testing. CRC Press.
2. Charles A. Harper. 2006. Handbook of Plastics Technologies. The Complete Guide to Properties and Performance. McGraw-Hill, New Delhi.
3. Central Pollution Control Board. 2012. Material on Plastic Waste Management. Parivesh Bhawan, East Arjun Nagar, Delhi-110032.
4. Brown, R.P. 2004. Polymers in Agriculture and Horticulture. RAPRA Review Reports : Vol. 15, No. 2, RAPRA Technology Limited, U.K

Reference Books:

1. Brahma Singh, Balraj Singh, Naved Sabir and Murtaza Hasan. 2014. Advances in Protected Cultivation. New India Publishing Agency, New Delhi.
2. Shankar, A.N. 2014. Integrated Horticulture Development in Eastern Himalayas, Plasticulture in Agri- Horticulture Systems, 241-247.
3. Ojha, T.P. and Michael, A.M., 2012, Principles of Agricultural Engineering - I. Jain Brothers, Karol Bagh, New Delhi.
4. Pandey, P.H. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana, India.

Web Links:

1. <https://krishi.icar.gov.in/jspui/bitstream/123456789/42008/1/Article%201.pdf>
2. https://ec.europa.eu/eip/agriculture/sites/default/files/eipagri_fg_plastic_footprint_minipaper_c_final.pdf

VLSI DESIGN LAB

VI Semester

Course Code: 231EC6L01

L	T	P	C
0	0	3	1.5

Course Outcomes:

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

- CO1** Design basic digital logic circuits such as inverters, universal gates, adders, and subtractors using CMOS technology.
- CO2** Realize memory and latch circuits such as RS and D-latches using transistor-level design.
- CO3** Design and simulate analog building blocks like differential amplifiers and ring oscillators, analyzing their performance parameters.
- CO4** Develop memory elements including Static RAM cells, evaluating their stability and performance under various conditions.
- CO5** Interpret the concepts of DRC, LVS and PEX in designing the ICs.

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

List of Experiments:

1. Design and implementation of an inverter
2. Design and implementation of universal gates
3. Design and implementation of full adder
4. Design and implementation of full subtractor.
5. Design and implementation of RS-latch.
6. Design and implementation of D-latch
7. Design and Implementation of ring oscillator
8. Design and Implementation of static RAM cell
9. Design and implementation asynchronous counter.
10. Design and Implementation of differential amplifier

List of Augmented Experiments:

(Any two of the following experiments can be performed)

11. Perform an experiment on aspects of MOSFET.
12. Perform an experiment on Z_{pu}/Z_{pd} and its impact in IC design.

Tools Required:

Mentor Graphics Software / Cadence/Synopsys/Tanner or Equivalent Industry Standard/CAD Tool.

Desktop computer with appropriate Operating System that supports the EDA tools.

Reference Books:

1. CMOS Digital Integrated Circuits, Sung Mo Kang, MHEducation, 3rd Edition
2. Fundamentals of Digital Logic with Verilog Design- Stephen Brown, Zvonko Vranesic, McGrawHill, 3rd Edition, 2013

Web Links:

1. https://onlinecourses-archive.nptel.ac.in/noc17_cs21/course by Prof. Indranil Sen Gupta, IIT Kharagpur
3. <http://nptel.ac.in/courses/117106086/1> by Prof.S.Srinivasan, IIT Madras
4. <http://nptel.ac.in/courses/117108040/> by Kuruvilla Varghese, IISc Bangalore

MICROPROCESSOR AND MICROCONTROLLERS LAB

VI Semester

Course Code: 231EC6L02

L	T	P	C
0	0	3	1.5

Course Outcomes:

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

- CO1:** Make use of the 8086 instruction set for writing assembly language programs.
- CO2:** Perform the interfacing of peripherals to 8086.
- CO3:** Develop assembly language programs using 8051 instruction set.
- CO4:** Perform the interfacing of peripherals to 8051.
- CO5:** Develop assembly language program to perform serial communication using 8051 instruction set

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

PART- A: 8086 Assembly Language Programming and Interfacing

1. Programs for 16-bit arithmetic operations (using Various Addressing Modes).
 - a. Addition and subtraction of n-BCD numbers.
 - b. Multiplication and Division operations.
 - c. Addition of an array of numbers with overflow detection.
2. Program for sorting an array.
3. Program for Factorial of given n-numbers.
4. Interfacing DAC to 8086.
5. Interfacing stepper motor to 8086.

PART-B: 8051 Assembly Language Programming and Interfacing

6. Finding number of 1's and number of 0's in a given 8-bit number.
7. Average of n-numbers.
8. Timer control based square wave generation program using 8051002E
9. Interface of UART with 8051.
10. Interface LCD to 8051.

List of Augmented Experiments:

(Any two of the following experiments can be performed)

1. Interfacing ADC to 8086
2. Interface of 8086 with Traffic Light Controller.
3. Interface keyboard to 8051.
4. Interface Switches and LEDs to 8051.

Hardware/Software Required:

1. 8086 Microprocessor Kits
2. 8051 Microcontroller Kits
3. MASM/TASM software
4. KEIL μ -Vision software

Text Books:

1. Microprocessors and Interfacing, Douglas V Hall, McGraw Hill, 2nd Edition, 2005.
2. The 8051 Micro Controller Architecture, Programming and Applications, Kenneth J Ayala, Thomson Publishers, 3rd Edition, 2004.

Reference Books:

1. Advanced Microprocessors and Interfacing, K.M. Bhurchandi, A.K. Ray, Tata McGraw Hill, 3rd Edition, 2012.
2. The 8051 Microcontrollers and Embedded systems Using Assembly and C, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; Pearson 2-Edition, 2011.

Web Links:

1. <http://online-masm-8086-compiler.html> .
2. <http://www.circuitstoday.com/interfacing-adc-to-8051>.
3. http://www.keil.com/support/man/docs/is51/is51_instructions.html .
4. <https://nptel.ac.in/courses/108/105/108105102/> Prof. Santanu Chattopadhyay.

MACHINE LEARNING LAB

VI Semester	L	T	P	C
Course Code: 231EC6S01	0	1	2	2

Course Outcomes:

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

- CO1:** Understand the Mathematical and statistical prospective of machine learning algorithms through python programming
- CO2:** Appreciate the importance of visualization in the data analytics solution.
- CO3:** Derive insights using Machine learning algorithms
- CO4:** Make use of Data sets in implementing the machine learning algorithms
- CO5:** Implement the machine learning concepts and algorithms in any suitable language of choice.

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

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

List of Experiments:

1. To implement **Ordinary Least Squares (OLS)** method to find the best-fit line for a given set of data using **Simple Linear Regression**.
2. For a given set of training data examples implement and demonstrate Exploring the data ,fitting and evaluating the model.
3. Write a program for Dimensionality reduction PCA using iris data set.
4. Write a program for Decision tree using iris data set.
5. Write a program to implement Binary classification with logistic regression and finding performance metrics.
6. Train Naïve Bayes, decision trees, KNN, SVM algorithms with scikit-learn .Measure accuracy, precision, recall, F1-Score, ROCAUC.
7. Train Clustering with the K-Means algorithm using suitable data set.
8. Write a program to implement Classifying handwritten digits
9. Write a program to Classifying characters in natural images
10. Training Bagging, Boosting, Random Forest, with scikit-learn.

List of Augmented Experiments:**(Any two of the following experiments can be performed)**

1. Extracting features from categorical variables, text, and pixel intensities
2. Train Clustering with the K-Means algorithm
3. Predict Stock market trends using LSTM
4. Detecting faces from images

Tools Required:

MATLAB /Google Co-Lab/Jupyter

Text Books:

1. Mastering Machine Learning with scikit-learn, Gavin Hackeling, Packt Publishing
2. “Hands-on Machine Learning with Scikit-Learn, Keras& TensorFlow”, Aurelien Geron, O’Reilly Publications.

Reference Books:

1. Hands-On Machine Learning with Scikit-Learn and TensorFlow, Aurélien Géron
2. Python Machine Learning Workbook for beginners, AI Publishing, 2020.

Web Links:

1. Machine Learning A-Z (Python & R in Data Science Course) | Udemy
2. colab.research.google.com / Scikit-learn GitHub Examples
3. datasetsearch.research.google.com

TECHNICAL PAPER WRITING AND IPR

VI Semester

Course Code: 231MC6T01

L	T	P	C
2	0	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:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	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/>

CELLULAR & MOBILE COMMUNICATIONS

VII Semester

Course Code: 231EC7T01

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain the fundamentals of cellular communication systems, mobile radio environment and system design concepts.
- CO2:** Apply propagation models, fading concepts and multiple access techniques including WCDMA for wireless communication analysis
- CO3:** Analyze LTE core network architecture, Enhanced Packet Core (EPC) components and basic signalling procedures.
- CO4:** Evaluate LTE architecture, radio resource management techniques and Voice over LTE (VoLTE) integration.
- CO5:** Describe 4G system implementation concepts, QoS mechanisms and the evolution towards 5G cellular networks and 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	2	1	1	2	-	-	-	-	-	-	-	1
CO2	2	3	1	2	-	-	-	-	-	-	-	1
CO3	2	2	3	2	-	-	-	-	-	-	-	1
CO4	2	3	2	2	-	-	-	-	-	-	-	2
CO5	2	2	2	2	-	-	-	-	-	-	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Introduction to Cellular Systems: Evolution of mobile communication systems from 1G to Beyond 5G, fundamentals of cellular concept, performance metrics, characteristics of mobile radio environment, operation of cellular networks.

Cellular System Design: Frequency reuse, channel assignment strategies, handoff techniques, co-channel and adjacent channel interference, system capacity improvement methods, coverage enhancement techniques.

Unit – II

Mobile Radio Propagation: Large-scale path loss models, reflection, diffraction and scattering mechanisms, outdoor and indoor propagation models, practical link budget design.

Small-Scale Fading and Multipath Propagation: Rayleigh and Rician distributions, Doppler effects, fading characteristics. Multiple Access Techniques for Wireless Communications – TDMA, FDMA, CDMA and WCDMA architecture

Unit – III

Enhanced Packet Core (EPC): Introduction to LTE core network, EPC architecture – Mobility Management Entity (MME), Serving Gateway (SGW), PDN Gateway (PGW), Policy and Charging Rules Function (PCRF), control plane and user plane separation. **Integration of EPC with LTE:** Radio access network, interworking with legacy 3G systems. LTE Signaling Procedures (Conceptual Level)- Attach procedure overview and mobility signaling concepts., Signaling Optimization (Overview) - paging optimization and handover optimization

Unit – IV

LTE Architecture : LTE network architecture and interfaces, E-UTRAN components, LTE protocol stack overview, OFDMA and SC-FDMA principles, frame structure, resource blocks and channel types.

Radio resource management and VoLTE: link adaptation, scheduling algorithms, HARQ, power control and handover mechanisms. Voice over LTE (VoLTE) - IMS architecture overview, basic SIP signaling concepts and high-level LTE voice call flow.

Unit – V

4G Architecture Implementation and Optimization: End-to-end 4G network architecture, EPC deployment models, LTE-IMS integration, QoS architecture and bearer management.

Introduction to 5G cellular systems: eMBB, URLLC and mMTC use cases, key requirements and KPIs, basic 5G network architecture and applications.

Text Books:

1. **Wireless Communications: Principles and Practice**, Theodore S. Rappaport, Pearson Education, **2nd Edition**, 2002.
2. **LTE for UMTS: Evolution to LTE-Advanced**, Harri Holma and Antti Toskala, John Wiley & Sons, **2nd Edition**, 2011.
3. **EPC and 4G Packet Networks: Driving the Mobile Broadband Revolution**, Magnus Olsson, Catherine Mulligan, Shabnam Sultana and others, Academic Press (Elsevier), **1st Edition**, 2012.

Reference Books:

1. **LTE Signaling: Troubleshooting and Optimization**, Ralf Kreher and Karsten Gaenger, John Wiley & Sons, **1st Edition**, 2010.
2. **Voice over LTE (VoLTE)**, Miikka Poikselkä, Georg Mayer, Hisham Khartabil and Aki Niemi, John Wiley & Sons, **1st Edition**, 2012.
3. **From GSM to LTE-Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband**, Martin Sauter, John Wiley & Sons, **3rd Edition**, 2017.

Web Links:

1. <https://nptel.ac.in/courses/117102062> by Prof.Ranjan Bose, Department of Electrical Engineering, IIT Delhi
2. <https://archive.nptel.ac.in/courses/117/104/117104099/> by Prof. Aditya Jagannadam, Department of Electrical Engineering, IIT Kanpur
3. <https://archive.nptel.ac.in/courses/108/106/106106167/> by Prof.David Koilpillai, Department of Electrical Engineering, IIT Madras

4. <https://nptel.ac.in/courses/108105134> by Prof. Suvra Sekhar Das, School of Telecommunications, IIT Kharagpur
5. <https://www.coursera.org/learn/4g-network-fundamentals>

MANAGEMENT SCIENCE

VII Semester	L	T	P	C
Course Code: 231HS7T03	3	0	0	3

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

- CO1:** Summarize management and motivation theories to renovate the practice of management
- CO2:** Explain concepts of quality management and use process control charts, concepts and tools of quality engineering.
- CO3:** Illustrate the functional management challenges associated with different changes in the organizations.
- CO4:** Compute Optimum Project Duration and Cost in Crashing of PERT and CPM Networks
- CO5:** Interpret the process of strategic management and to provide basic insights into contemporary management practices.

Mapping of Course Outcomes with Program Outcomes:

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

Unit – I

Introduction to Management:

Concept nature and importance of Management, Generic Functions of Management, and Evaluation of Management thought, Theories of Motivation, Decision making process, Designing organization structure, Principles of organization.

Unit – II

Operations Management:

Principles and Types of Management, Work study-, Statistical Quality Control, Control charts (P-chart, R- chart, and C-chart) Simple problems, Material Management: Need for Inventory control, EOQ, ABC analysis (simple problems) and Types of ABC analysis (HML, SDE, VED, and FSN analysis), Just-in- Time (JIT) system, Total Quality, Management (TQM), Six sigma, supply chain management

Unit – III

Functional Management:

Concept of HRM, HRD and PMIR, Functions of HR Manager, Wage payment plans (Simple Problems), Job Evaluation and Merit Rating, Marketing Management, Functions of Marketing, strategies based on product Life Cycle, Channels of distributions.

Unit – IV**Project Management:**

Development of Network, Difference between PERT and CPM, Fulkerson's Rule, Finding Critical Path, Probability of completion of project, Project Crashing.

Unit – V**Strategic Management:**

Vision, Mission, Goals, Strategy, Elements of Corporate Planning Process, Environmental Scanning, SWOT analysis, Steps in Strategy Formulation and Implementation, Generic Strategy Alternatives, Basic concepts of MIS, ERP, Capability Maturity Model (CMM) Levels, Balanced Score Card.

Text Books:

1. Management Science by Aryasri; Publisher: Tata McGraw Hill, 2009.
2. Management by James Arthur, Finch Stoner, R. Edward Freeman, and Daniel R. Gilbert 6th Ed; Publisher: Pearson Education/Prentice Hall.

Reference Books:

1. Principles of Marketing: A South Asian Perspective by Kotler Philip, Gary Armstrong, Prafulla Y. Agnihotri, and Eshan ul Haque , 2010, 13th Edition, Publisher: Pearson Education/ Prentice Hall of India.
2. A Handbook of Human Resource Management Practice by Michael Armstrong, 2010; Publisher: Kogan Page Publishers.
3. Quantitative Techniques in Management by N.D. Vohra, 4th edition, 2010; Publisher: Tata McGraw Hill.
4. Operations Management: Theory and Practice by B. Mahadevan, 2010; Publisher: Pearson Education.

Web Links:

1. www.managementstudyguide.com
2. www.citehr.com
3. www.nptel.ac.in/courses/122106032
4. www.btechguru.com/courses--nptel--basic-course

LOW POWER VLSI DESIGN
(Professional elective-IV)

VII Semester

Course Code: 231EC7E01

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 principles of low-power logic design and their impact on power dissipation.
- CO2:** Apply system-level low-power design techniques to reduce power consumption in digital systems.
- CO3:** Analyze power constraints in digital circuits using switch-level low-power design techniques.
- CO4:** Evaluate and compare adder and multiplier architectures for energy-efficient subsystem design.
- CO5:** Analyze design constraints and optimization techniques for low-power memory architectures.

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	3	2	-	-	-	-	-	-	-	-	-	1
CO4	3	2	1	-	-	-	-	-	-	-	-	1
CO5	3	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

Unit – I

Fundamentals of Low Power VLSI Design: Need for Low Power Circuit Design, Sources of Power Dissipation – Switching Power Dissipation, Short Circuit Power Dissipation, Leakage Power Dissipation, Glitching Power Dissipation, Short Channel Effects – Drain Induced Barrier Lowering and Punch Through, Surface Scattering, Velocity Saturation, Impact Ionization, Hot Electron Effect.

Unit – II

Low-Power Design Approaches: Low-Power Design through Voltage Scaling: VTCMOS circuits, MTCMOS circuits, Architectural Level Approach – Pipelining and Parallel Processing Approaches, Switched Capacitance Minimization Approaches: System Level Measures, Circuit Level Measures, Mask level Measures.

Unit – III

Low Voltage Low-Power Design Techniques: Trends of Technology and Power Supply Voltage, Low- Voltage Low-Power Logic Styles.

Difficulties for Low-Power and Low-Voltage Operations, Schematic design for low power logic, gate level logic simulation, capacitive power estimation, static state power and gate level capacitance estimation.

Unit – IV

Low-Voltage Low-Power Adders & Multipliers:

Adders-Introduction, Standard Adder Cells, CMOS Adder's Architectures – Ripple Carry Adders, Carry Look- Ahead Adders, Carry Select Adders, Carry Save Adders, Low-Voltage Multipliers- Introduction, Overview of Multiplication, Types of Multiplier Architectures, Braun Multiplier, Baugh- Wooley Multiplier, Booth Multiplier

Unit – V

Low-Voltage Low-Power Memories:

Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Precharge and Equalization Circuit, Low-Power SRAM Technologies, Basics of DRAM, Self- Refresh Circuit, Future Trend and Development of DRAM

Text Books:

1. Low-Voltage, Low-Power VLSI Subsystems – Kiat-Seng Yeo, Kaushik Roy, TMH Professional Engineering.
2. Low Power CMOS VLSI Circuit Design – Kaushik Roy, Sharat C. Prasad, John Wiley & Sons, 2000.

Reference Books:

1. Practical Low Power Digital VLSI Design – Gary K. Yeap, Kluwer Academic Press, 2002.
2. Low-Voltage CMOS VLSI Circuits-James B. KuoJea-Hong Lou Ntuee Taipei, Taiwan,John Wiley Publications,1999
3. Synthesis and Organization of Digital Circuits, De Micheli, McGraw Hill, 1994. ISBN 9780070163331.

Web Links:

1. <https://www.synopsys.com/glossary/what-is-low-power-design.html>
2. <http://mooney.gatech.edu/Courses/ECE6132/lectures/index.html>
3. http://gn.dronacharya.info/ECEDept/Downloads/QuestionPapers/7th_Sem/VLSI-DESIGN/UNIT-5/Lecture-4.pdf
4. <https://www.synopsys.com/glossary/what-is-low-power-design.html>
5. <http://mooney.gatech.edu/Courses/ECE6132/lectures/index.html>

CODING THEORY AND APPLICATIONS
(Professional elective-IV)

VII Semester

Course Code: 231EC7E02

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Analyze the structure and implementation of advanced linear block, cyclic, and BCH codes
- CO2:** Apply encoding and decoding techniques for convolutional and iterative codes using trellis representation and Viterbi algorithm
- CO3:** Analyze the error detection and correction capabilities of different coding schemes
- CO4:** Analyze advanced wireless communication techniques such as MIMO, OFDM, space-time block codes, and error correction in fading channels
- CO5:** Apply source coding and compression techniques for efficient transmission and storage of image, speech, and multimedia data.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping Course Outcomes with Program Specific Outcomes:

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

Unit – I

Advanced Block and Cyclic Codes: Advanced decoding of linear block codes using syndrome and coset methods, cyclic code structures and polynomial domain operations, systematic encoding and decoding, burst error correction, BCH codes, error-correcting capability analysis, applications in digital communication and storage systems.

Unit – II

Convolutional and Iterative Codes: Convolutional code structures and state-space representation, trellis diagrams, Viterbi decoding algorithm, sequential decoding, constraint length and code rate trade-offs, performance evaluation, punctured convolutional codes, iterative decoding principles.

Unit – III

Advanced error control codes: Advanced error control codes: Reed–Solomon codes, interleaving, turbo codes, LDPC codes, applications in communication systems.

Unit – IV

Advanced wireless Coding Techniques: Advanced wireless techniques, overview of advanced wireless communication techniques, MIMO systems, OFDM systems, space-time block codes, cooperative communication, massive MIMO, spectral efficiency improvement, error correction in fading channels, wireless technologies for 5G and beyond.

Unit – V

Source Coding and Multimedia Applications: Information theory fundamentals, lossless compression techniques, image compression basics (JPEG), voice coding techniques (SBC, AAC, LDAC, LHDC, AMR-WB, EVS), data compression for storage and multimedia transmission, coding simulation tools.

Text Books:

1. Lin, Shu, and Daniel J. Costello. 'Error Control Coding: Fundamentals and Applications.' Pearson Education, 2nd Edition, 2004
2. Ranjan Bose, 'Information Theory, Coding and Cryptography,' Tata McGraw-Hill, 2nd Edition, 2007
3. Simon Haykin, Communication Systems, Wiley, 5th Edition, 2013.

Reference Books:

1. Todd K. Moon, 'Error Correction Coding: Mathematical Methods and Algorithms,' Wiley, 2021
2. S. Gravano, 'Introduction to Error Control Codes,' Oxford University Press, 2007

Web Links:

1. <https://archive.nptel.ac.in/courses/117/104/117104121/>
2. <https://ocw.mit.edu/courses/6-02-introduction-to-eecs-ii-digital-communication-systems-fall-2012/>
3. <https://www.edx.org/learn/engineering/the-hong-kong-university-of-science-and-technology-a-system-view-of-communications-from-signals-to-packets-part-2?index=product&queryId=fc34d39341d4092d701e60aee6fa6038&position=3>
4. <https://nptel.ac.in/courses/117105085>
5. <https://archive.nptel.ac.in/courses/108/102/108102096/>

DIGITAL SIGNAL PROCESSORS AND ARCHITECTURES
(Professional elective-IV)

VII Semester	L	T	P	C
Course Code: 231EC7E03	3	0	0	3

Course Outcomes:

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

- CO1:** Summarize the concepts of number formats and various DSP related errors
- CO2:** Illustrate the architectural features of Programmable digital signal processors.
- CO3:** Infer the TMS320C54XX processor architecture details, addressing modes and on-Chip peripherals.
- CO4:** Implement the basic DSP algorithms using digital signal processors.
- CO5:** Interpret the interfacing of devices with digital signal processors.

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

Computational Accuracy in DSP implementations: Review of Digital signal processing, Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors

Unit – II

Architectures for Programmable DSP Devices: Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External interfacing.

Unit – III

Programmable Digital Signal Processors: Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX DSPs, Data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX Processors, Program Control, TMS320C54XX Instructions and Programming, On Chip Peripherals, Interrupts of TMS320C54XX Processors, Pipeline Operation of TMS320C54XX Processors. Architectural features of TMS320C67XXProcessors.

Unit – IV

Implementations of basic DSP algorithms: The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, Decimation Filters, PID Controller, Adaptive Filters, An FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and scaling, Bit-Reversed index generation, An 8-Point FFT implementation on the TMS320C54XX, Computation of the signal spectrum.

Unit – V

Interfacing Memory and I/O Peripherals to Programmable DSP Devices: Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts, Direct memory access (DMA).

Text Books:

1. Digital Signal Processing, Avtar Singh and S. Srinivasan, Thomson Publications, 1st Edition, 2004
2. Digital Signal Processors, Architecture, Programming and Applications, B. Venkataramani M Bhaskar ,TMH Publications, 1st Edition, 2002.

Reference Books:

1. A Practical Approach to Digital Signal Processing, K Padmanabhan, R.Vijayarajeswaran, and Ananthi S, New Age International, 2nd Edition 2016.
2. Embedded Signal Processing with the Micro Signal Architecture, Woon-Seng Gan, and Sen M. Kuo, Wiley-IEEE Press, 1st Edition, 2007
3. DSP Processor Fundamentals, Architectures & Features, Lapsley et al, S. Chand &Co, 1st Edition, 2000.

Web Links:

1. <https://nptel.ac.in/courses/108/101/108101174> NPTEL course on “Digital Signal Processing”
2. <https://nptel.ac.in/courses/108106149>NPTEL course on “Mapping Signal Processing Algorithms”
3. <https://www.analog.com/en/design-center/landing-pages/001/beginners-guide-to-dsp.html>
4. <https://www.dspguide.com/ch28/3.html>

SOFT COMPUTING TECHNIQUES (Professional elective-IV)

VII Semester	L	T	P	C
Course Code: 231EC7E04	3	0	0	3

Course Outcomes:

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

- CO1:** Infer the fundamentals of soft computing paradigms.
- CO2:** Infer the artificial neural network models.
- CO3:** Apply the knowledge of fuzzy logic for nonlinear system modelling
- CO4:** Infer genetic algorithms for solving optimization problems.
- CO5:** Apply swarm intelligence techniques for real-world optimization 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	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	1	-	-	-	-	-	-	-	-
CO3	3	-	2	2	-	-	-	-	-	-	-	-
CO4	3	2	-	3	2	-	-	-	-	-	-	-
CO5	3	2	2	2	2	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Introduction to soft computing: Introduction, Artificial Intelligence, Artificial Neural Networks, Fuzzy systems, Genetic Algorithm and Evolutionary programming, Swarm Intelligent systems, Expert systems, Comparison among Intelligent systems.

Unit – II

Artificial Neural Networks: Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, Single Neuron/Perceptron networks: training methodology, typical application to linearly separable problems. Feed-forward Multilayer Perceptron, Multilayer Perceptron: Back propagation algorithm, virtues and limitation of BP algorithm, modifications to back-propagation, Hopfield network, Self-organizing network and Recurrent network.

Unit – III

Fuzzy Logic System: Introduction to Fuzzy systems, Membership function, basic fuzzy set operation and approximate reasoning, Introduction to fuzzy logic modeling and control, Fuzzification, inferencing and de-fuzzification, Fuzzy modeling and control schemes for nonlinear systems, Self-organizing fuzzy logic control.

Unit – IV

Genetic Algorithm: Basic concept of Genetic algorithm and detail algorithmic steps, Search space, working principle. Encoding: binary, Octal, Hexadecimal, permutation, Value and Tree. Decoding, fitness function, Selection: Roulette wheel, Boltzmann, Tournament, Rank and Steady-state. Elitism, Crossover: single-point, two-point, multi-point, uniform, matrix and crossover rate, Mutation: mutation, mutation rate, traveling sales man problem

Unit – V

Swarm Intelligent system: Introduction to swarm intelligence, back ground, Ant colony system, working of ant colony optimization, Particle swarm intelligent systems, Artificial bee colony system, cuckoo search algorithm

Text Books:

1. Soft computing with MATLAB programming—N.P.Padhy, S.P.Simon, Oxford university press, 2015
2. Neural Networks and Fuzzy Systems - Kosko, B., Prentice-Hall of India Pvt. Ltd., 1994.

Reference Books:

1. Fuzzy Sets, Uncertainty and Information - Klir G.J. & Folger T.A., Prentice-Hall of India Pvt. Ltd., 1993.
2. Artificial Neural Network –Simon Haykin, 2nd Ed., Pearson Education.
3. Swarm Intelligence: From natural to Artificial Systems, E. Bonabeau, M. Dorigo and G. Theraulaz (Santa Fe Institute Studies in the Sciences of Complexity Proceedings), 1999.

Web Links:

1. <https://archive.nptel.ac.in/courses/106/105/106105173/>
2. https://onlinecourses.nptel.ac.in/noc21_ge07/preview
3. <https://cse.iitkgp.ac.in/~dsamanta/courses/archive/sca/Slides.htm>

DESIGN FOR TESTABILITY
(Professional Elective-V)

VII Semester

Course Code: 231EC7E05

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain the types of faults in digital circuits and the principles of logic simulation.
- CO2:** Apply fault diagnosis and test generation techniques for combinational logic circuits.
- CO3:** Develop test strategies for sequential circuits using structural and functional models.
- CO4:** Design testable sequential circuits using scan-based and non-scan techniques.
- CO5:** Analyze memory testing techniques, including BIST, ATPG, and embedded RAM 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	1	1	-	-	-	-	-	-	-	1
CO2	2	3	2	1	-	-	-	-	-	-	-	1
CO3	2	2	3	2	-	-	-	-	-	-	-	1
CO4	2	2	3	2	-	-	-	-	-	-	-	1
CO5	2	2	2	2	-	-	-	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Faults and Logic Simulation: Faults in digital circuits: Failures and Faults, Modeling of faults, Temporary Faults. Logic Simulation: Applications, Problems in simulation based design verification, types of simulation, The unknown logic values, compiled simulation, event-driven simulation, Delay models, Element evaluation, Hazard detection, Gate-level event-driven Simulation.

Unit – II

Fault diagnosis and Testing: Test generation for Combinational Logic circuits: Fault Diagnosis of digital circuits, Test generation techniques for combinational circuits, Detection of multiple faults in Combinational logic circuits.

Testable Combinational logic circuit design-I: The Read-Muller expansion technique, three level OR-AND-OR design, Automatic synthesis of testable logic.

Unit – III

Testing of logic circuits: Testable Combinational logic circuit design-II: Testable design of multilevel combinational circuits, Synthesis of random pattern testable combinational circuits, Path delay fault testable combinational logic design, Testable PLA design.

Test generation for Sequential circuits: Testing of sequential circuits as Iterative combinational circuits, State Table verification, Test generation based on Circuit Structure, Functional Fault models, Test Generation based on Functional Fault models.

Unit – IV

Design of testable sequential circuits: Controllability and Observability, Ad-Hoc design rules for improving testability, design of diagnosable sequential circuits, the scan-path technique for testable sequential circuit design, Level Sensitive Scan Design (LSSD), Random Access Scan Technique, Partial scan, testable sequential circuit design using Nonscan Techniques, Crosscheck, Boundary Scan.

Unit – V

Fault diagnosis of memories: Built-In Self Test: Test pattern generation for BIST, Output response analysis, Circular BIST, BIST Architectures, Introduction to ATPG and SCAN Test procedure.

Testable Memory Design: RAM Fault Models, Test algorithms for RAMs, Detection of pattern-sensitive faults, BIST techniques for RAM chips, Test generation and BIST for Embedded RAMs.

Text Books:

- 1 Digital Circuit Testing and Testability, Parag K Lala, New York, Academic Press, 1997.
- 2 Digital Systems Testing and Testable Design, Miron Abramovici, Melvin A Breuer and Arthur D Friedman, Wiley, 1994.

Reference Books:

- 1 Essential of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits, Vishwani D Agarwal, Springer, 2002.
- 2 VLSI Test Principles and Architectures, Laung-Terng Wang, Cheng-Wen Wu and Xiaoqing Wen, Morgan Kaufmann Publishers, 2006.

Web Links:

- 1 <https://www.classcentral.com/course/swayam-digital-vlsi-testing-7956>.
- 2 <https://www.youtube.com/watch?v=MEaMm423t0w&list=PLZjlBaHNchvOFBWBAAtAP9exwQgYpKqsO4&index> by Prof. Santanu Chattopadhyay, IIT, Kharagpur.
- 3 <https://www.youtube.com/watch?v=AbldfSxjNM&list=PLbMVogVj5nJTClnafWQ9FK2nt3cGG8kCF> by Dr. Santosh Biswas and Dr. Jatindra Kumar Deka, IIT, Guwahati.

RADAR ENGINEERING
(Professional Elective –V)

VII Semester	L	T	P	C
Course Code: 231EC7E06	3	0	0	3

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

- CO1:** Model the radar's range equation.
- CO2:** Make use of the range equation in analytical problems.
- CO3:** Explain the different types of radars and its applications.
- CO4:** Classify the different tracking techniques
- CO5:** Explain the radar sub-systems of the radar receiver

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Basics of Radar: Introduction, Maximum Unambiguous Range, simple Radar Range Equation, Radar Block Diagram and Operation, Radar Frequencies and Applications. Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise, Illustrative Problems.

Radar Equation: Modified Radar Range Equation, SNR, probability of detection, probability of False Alarm, Integration of Radar Pulses, Radar Cross Section of Targets (simple targets - sphere, cone-sphere), Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment), Illustrative Problems

Unit – II

CW and Frequency Modulated Radar: Doppler Effect, CW Radar – Block Diagram, Isolation between Transmitter and Receiver, Non-zero IF Receiver, Receiver Bandwidth Requirements, Applications of CW radar. Illustrative Problems.

FM-CW Radar: Range and Doppler Measurement, Block Diagram and Characteristics, FM-CW altimeter, Multiple Frequency CW Radar.

Unit – III

MTI and Pulse Doppler Radar: Introduction, Principle, MTI Radar with - Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancellers – Filter Characteristics, Blind Speeds, Double Cancellation, Range Gated Doppler Filters, Limitations to MTI Performance, MTI versus Pulse Doppler Radar

Unit – IV

Tracking Radar: Tracking with Radar, Sequential Lobing, Conical Scan, Mono pulse Tracking Radar – Amplitude Comparison Mono pulse (one- and two- coordinates), Phase Comparison Mono pulse, Tracking in Range, Acquisition and Scanning Patterns, Comparison of Trackers

Unit – V

Radar Receivers: Displays – types. Duplexers – Branch type and Balanced type, Circulators as Duplexers. Introduction to Phased Array Antennas – Basic Concepts, Radiation Pattern, Beam Steering and Beam Width changes, Series versus parallel feeds, Applications, Advantages and Limitations, Radomes

Text Books:

1. Introduction to Radar Systems, Merrill I. Skolnik, TMH Special Indian Edition, 2nd Edition, 2007.
2. Radar Engineering and Fundamentals of Navigational Aids, GSN Raju, IK International Publishers, 1st Edition, 2017

Reference Books:

1. Radar: Principles, Technology, Applications, Pearson Education, Byron Edde, 2004.
2. Radar Principles – Peebles, Jr., P.Z., Wiley, New York, 1998
3. Microwave and Radar Engineering, G Sasi Bhusana Rao, Pearson Publications, 1st Edition, 2014

Web Links:

1. Principles and Techniques of Modern Radar Systems Dr. Amitabha Bhattacharya, IIT Kharagpur- NPTEL course
Weblink: <https://archive.nptel.ac.in/courses/108/105/108105154/>
2. MIT open course on Introduction to radar systems :
Weblink: <https://www.ll.mit.edu/outreach/online-course-radar-introduction-radar-systems>

DIGITAL IMAGE PROCESSING
(Professional Elective – V)

VII Semester

Course Code: 231EC7E07

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Interpret the concepts of digital image processing and image transforms.
CO2: Apply filtering operations on images both in spatial and frequency domain.
CO3: Utilize spatial and frequency domain filters for image restoration.
CO4: Apply coding and multi-resolution techniques for image compression and analysis.
CO5: Make use of segmentation techniques and color models in image processing.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	1	-	-	-	-	-	-	-	-	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:

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

Unit – I

Introduction: Introduction to Image Processing, Examples of fields that use Digital Image Processing, Fundamental steps in digital image processing, components of an image processing system, Elements of Visual Perception, Light and the Electromagnetic Spectrum. Image sensing and acquisition, image sampling and quantization, some basic relationships between pixels, introduction to the mathematical tools used in digital image processing.

Image Transforms: Need for image transforms, Image transforms, Fourier Transform, 2D Discrete Fourier Transform and its properties, Walsh Transform, Hadamard transform, Haar Transform, Discrete Cosine transform, KL Transform, Singular Value Decomposition.

Unit – II

Intensity Transformations and Spatial Filtering: Background, some basic intensity transformation functions, histogram processing, fundamentals of spatial filtering, smoothing spatial filters, and sharpening spatial filters.

Filtering in the Frequency Domain: The Basics of filtering in the frequency domain, image smoothing using frequency domain filters, Image Sharpening using frequency domain filters, Selective filtering

Unit – III

Image Restoration and Reconstruction: A model of the image degradation/ Restoration process, Noise models, restoration in the presence of noise only Spatial Filtering, Periodic Noise Reduction by frequency domain filtering, Linear, Position –Invariant Degradations, Estimating the degradation function, Inverse filtering, Minimum mean square error (Wiener) filtering, constrained least squares filtering, geometric mean filter.

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.

Wavelets and Multi resolution Processing: Image pyramids, sub band coding, Multi resolution expansions, wavelet transforms in one dimensions & two dimensions, introduction to Wavelet packets.

Unit – V

Image segmentation: Fundamentals, point, line, edge detection, thresholding, region – based segmentation.

Color image processing: Color fundamentals, color models, pseudo color image processing, basics of full color image processing, color transformations, smoothing and sharpening. Image segmentation based on color, noise in color images, color image compression.

Text Books:

1. Digital Image Processing, R. C. Gonzalez and R. E. Woods, Prentice Hall, 4th edition, 2018.
2. Digital Image Processing, Jayaraman, S. Esakkirajan, and T. Veerakumar, Tata McGraw-Hill Education, 1st edition, 2011.

Reference Books:

1. Fundamentals of Digital Image Processing, Anil K.Jain, Prentice Hall of India, 9th Edition, 2002.
2. Digital Image Processing, S Sridhar, Oxford higher education publication, 2014.
3. Digital Image Processing using MATLAB, R. C. Gonzalez and R. E. Woods, Prentice Hall, 3rd Edition, 2020.

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>

**INTERNET OF THINGS
(Professional Elective – V)**

VII Semester

Course Code: 231EC7E08

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Explain the architecture, design principles, networking fundamentals.
- CO2:** Describe the architecture and functioning of IoT hardware platforms such as Arduino, Raspberry Pi, and ARM Cortex processors.
- CO3:** Interpret the interfacing of I/O devices, sensors & communication modules.
- CO4:** Explain the IoT solution framework including device integration, data acquisition, cloud computing, and data storage mechanisms.
- CO5:** Discuss the IoT security requirements, vulnerabilities and Real time IoT Based Applications.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	-	-	-	-	-	-	-	-	-	1
CO2	3	2	1	-	-	-	-	-	-	-	-	1
CO3	3	2	1	-	-	-	-	-	-	-	-	1
CO4	3	2	1	-	-	-	-	-	-	-	-	1
CO5	3	2	1	-	-	-	-	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Introduction to IoT:

Introduction to IoT, Architectural Overview, Design principles and needed capabilities, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT.

Unit – II

Elements of IoT Hardware Components:

Computing- Arduino, Raspberry Pi, ARM Cortex-A class processor, Embedded Devices – ARM Cortex-M class processor, Arm Cortex-M0 Processor Architecture, Block Diagram, Instruction Set- ARM and Thumb Instruction Set.

Unit – III**IoT Application Development Communication:**

IoT Applications, Sensing, Actuation, I/O interfaces. Communication Protocols-MQTT, ZigBee, CoAP, UDP, TCP, Bluetooth, Bluetooth Low Energy (BLE) Protocol.

Unit – IV**Solution framework for IoT applications:**

Implementation of Device integration, Data acquisition and integration, Device data storage Unstructured data storage on cloud/local server. Introduction to cloud computing, Difference between Cloud Computing and Fog Computing, Role of Cloud Computing in IoT, Connecting IoT to cloud.

Unit – V**IoT Privacy, Security and Vulnerabilities Solution:**

Introduction, vulnerabilities, security requirements and threat analysis, use cases and misuse cases, IoT security tomography and layered attacker model, identity management, and establishment, access control and secure message communication, security models, profiles and protocols for IoT.

IoT Case Studies: Agriculture, Healthcare.

Text Books:

1. Internet of Things: Architecture and Design Principles by Raj Kamal, 1st Edition, McGraw Hill Education, ISBN: 978-9390727384.
2. The Definitive Guide to the ARM Cortex-M0 by Joseph Yiu, ISBN: 978-0128032770

Reference Books:

1. Internet of Things - A Hands-on Approach by Arshdeep Bahga and Vijay Madisetti, Universities Press, ISBN: 9788173719547.
2. Cypress Semiconductor/PSoC4 BLE (Bluetooth Low Energy) Product Training Modules.
3. The Internet of Things: Enabling Technologies, Platforms, and Use Cases by Pethuru Raj and Anupama C. Raman, CRC Press, ISBN: 978-1351981934

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_cs96/preview
2. <https://archive.nptel.ac.in/courses/108/108/108108098/>

INDUSTRIAL WASTE WATER MANAGEMENT (Open Elective-III)

VII Semester
Course Code: 231CE7001

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO 1	PSO2
CO1	-	-
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:

1. Wastewater Treatment by M.N. Rao and A.K. Dutta, Oxford & IBH, New Delhi, 2016
2. Industrial Wastewater Treatment by KVSG Murali Krishna.

Reference Books:

1. Industrial Water Pollution Control by W. Wesley Eckenfelder, Mc- GrawHill, Third Edition, 2015
2. Wastewater Treatment- Concepts and Design Approach by G.L. Karia & R.A. Christian, Prentice Hall of India

Web Links:

1. <https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce32/>
2. <https://www.un-ihe.org/online-course-industrial-effluent-treatment>

**BASICS OF RS&GIS
(Open Elective-III)**

VII Semester
Course Code: 231CE7002

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

History and Basic Concept of Remote Sensing:

Introduction to remote sensing: Evolution of Remote Sensing- use of hot air balloons, pigeons and platforms of remote sensing, low-medium-high altitude imaging.

Basic concepts of remote sensing: Electromagnetic spectrum and its interaction with atmosphere, energy interaction with the earth surfaces characteristics of remote sensing systems.

Unit – II

Photogrammetry; Aerial and Terrestrial; photo interpretation. Sensors; Radar imaging; colour scanners; thematic mapper. Introduction to space agencies - IRS, Landsat, SPOT, Cartosat, Ikonos, Envisat etc. sensors, sensor resolutions (spatial, spectral, radiometric and temporal).

Unit – III

Geographic Information System:

Introduction to GIS; Components of a GIS, Geospatial Data: Spatial Data and Attribute data, Joining Spatial and Attribute data.

Image interpretation:

Introduction, elements of visual image interpretations, digital image processing- image pre-processing, image enhancement, image classification, supervised classification, unsupervised classification using GIS Environs.

Unit – IV

Data Models: Vector data model: Representation of simple features – Topology and its importance; coverage and its data structure, Shape file; Relational Database, Raster Data Model: Elements of the Raster data model, Types of Raster Data, Raster Data Structure, Data conversion

Unit – V

Coordinate Systems:

Geographic Coordinate System: Approximation of the Earth, Datum; Map Projections: Types of Map Projections-Map projection parameters, commonly used Map Projections. Global positioning system and various navigation applications.

Text Books:

1. Textbook of Remote Sensing and Geographical Information Systems, by Anji M. Reddy · 2018, BS Publications.
2. Remote Sensing and GIS, Basudev Bhatta, Oxford Publishers 2015

Reference Books:

1. Basics of Remote sensing & GIS by S. Kumar, Laxmi Publications.
2. Introduction to Geographic Information System, Kang-Tsung Chang, McGraw- Hill 2015.

Web Links:

1. http://geology.wlu.edu/harbor/geol260/lecture_notes/notes.html
2. <https://lecturenotes.in/subject/572/remote-sensing-and-gis-rsg>

SAFETY ENGINEERING
(Open Elective-III)

VII Semester
Course Code: 231CE7003

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 safe guard workers in construction of high risk Buildings.
- CO3:** Ensure safety while operating construction machinery.
- CO4:** Outline safety plans for demolition of buildings.
- CO5:** Prepare fire safety plans for a given building.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Accidents Causes and Management Systems:

Problems impeding safety in construction industry- causes of fatal accidents, types and causes of accidents related to various construction activities, human factors associated with these accident – construction regulations, contractual clauses – Pre contract activates, preconstruction meeting - design aids for safe construction – permits to work – quality assurance in construction - compensation – Recording of accidents and safety measures – Education and training.

Unit – II

Hazards of Construction and Prevention:

Excavations, basement and wide excavation, trenches, shafts – scaffolding , types, causes of accidents, scaffold inspection checklist – false work – erection of structural frame work, dismantling – tunneling – blasting, pre blast and post blast inspection – confined spaces – working on contaminated sites – work over water – road works – power plant constructions – construction.

Unit – III**Working At Heights:**

Fall protection in construction OSHA 3146 – OSHA requirement for working at heights, Safe access and egress – safe use of ladders- Scaffoldings , requirement for safe work platforms, stairways, gangways and ramps – fall prevention and fall protection , safety belts, safety nets, fall arrestors, controlled access zones, safety monitoring systems – working on fragile roofs, work permit systems, height pass – accident case studies.

Unit – IV**Construction Machinery:**

Selection, operation, inspection and testing of hoisting cranes, mobile cranes, tower cranes, crane inspection checklist - builder's hoist, winches, chain pulley blocks – use of conveyors – concrete mixers, concrete vibrators – safety in earth moving equipment, excavators, dozers, loaders, dumpers, motor grader, concrete pumps, welding machines, use of portable electrical tools, drills, grinding tools, manual handling scaffolding, hoisting cranes – use of conveyors and mobile cranes – manual handling.

Unit – V**Safety in Demolition Work:**

Safety in demolition work, manual, mechanical, using explosive - keys to safe demolition, pre survey inspection, method statement, site supervision, safe clearance zone, health hazards from demolition - Indian standard - trusses, girders and beams – first aid – fire hazards and preventing methods – interesting experiences at the construction site against the fire accidents.

Fire Safety:

Fire –fire load-control and institutional fire protection systems, Fire Hydrant and extinguishers, Electrical Hazards, protection and interlock- Discharge rod and earthing device, safety in the use of portable tools. Emergency planning and preparedness. Marking of Route Fire Exist.

Text Books:

1. 'Safety in the Build Environment' by Jnathea D.Sime, London, 2010
2. 'Reliability Maintenance and Safety Engineering, by Gupta A K, Laxmi Publications, New Delhi.

Reference Books:

1. 'Construction hazard and Safety Hand book' by Hudson, R., Butter Worth's, 1985.
2. 'Construction Safety Hand Book'by V.J.Davies and K.Thomasin,Thomas Telford Ltd., London, 1990.

Web Links:

1. nptel.ac.in/courses/105103093/
2. nptel.ac.in/courses/105103093/22

BATTERY MANAGEMENT SYSTEMS AND CHARGING STATIONS (OPEN ELECTIVE-III)

VII Semester	L	T	P	C
Course Code: 231EE7001	3	0	0	3

Course Outcomes:

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

- CO1** Describe the construction and operation of different batteries for EV applications
- CO2** Describe charging algorithms of different batteries and balancing methods of battery packs
- CO3** Describe the different kinds of infrastructure needed in the charging stations
- CO4** Describe the requirements of battery management and their maintenance.
- CO5** Explain the modelling of batteries

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

EV Batteries

Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel. Lead Acid Batteries: Lead acid battery basics, special characteristics of lead acid batteries, battery life and maintenance, Li-ion batteries. Nickel-based Batteries: Nickel cadmium, Nickel metal hydride batteries. Sodium-Based Batteries:

Introduction, sodium sulphur batteries, sodium metal chloride (Zebra) batteries. Lithium Batteries: Introduction, the lithium polymer battery, lithium ion battery

UNIT – II

Battery Charging Strategies

Charging algorithms for a single battery: Basic terms for charging performance evaluation and characterization, CC charging for NiCd/NiMH batteries, CV charging for lead acid batteries, CC/CV charging for lead acid and Li-ion batteries, MSCC charging for lead acid, NiMH and Li-ion batteries, TSCC/CV charging for Li-ion batteries, CVCC/CV charging for Li-ion batteries, Pulse charging for lead acid, NiCd/NiMH and Li-ion batteries, Charging termination techniques, Comparisons of charging

algorithms and new development; Balancing methods for battery pack charging: Battery sorting, Overcharge for balancing, Passive balancing, Active balancing.

UNIT – III

Charging Infrastructure

Domestic Charging Infrastructure, Public charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

UNIT – IV

Battery-Management-System Requirements

Battery-pack topology, BMS design requirements, Voltage sense, Temperature sense, Current sense, Contactor control, Isolation sense, Thermal control, Protection, Charger control, Communication via CAN bus, Log book, SOC estimation, Energy estimation, Power estimation, Diagnostics.

UNIT – V

Battery Modelling

General approach to modelling batteries, simulation model of rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of NiCd battery model, Simulation examples.

Text Books:

- 1 Energy Systems for Electric and Hybrid Vehicles by K.T. Chau, IET Publications, First edition, 2016.
- 2 Battery Management Systems Vol. – II Equivalent Circuits and Methods, by Gregory L.Plett, Artech House publisher, First edition 2016.

Reference Books:

- 1 Electric and hybrid vehicles: design fundamentals, 2nd edition, husain iqbal, crc press
- 2 Lithium-Ion Batteries: Fundamentals and Applications (Electrochemical Energy Storage and Conversion) 1st Edition by Yuping Wu
- 3 The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles Paperback – Illustrated, June 7, 2011 by Mark Warner

Web Links:

- 1 <https://www.hydroquebec.com/data/electrification-transport/pdf/technical-guide.pdf>
- 2 <https://www.youtube.com/watch?v=eQX-iobIYmw>

**CONCEPT OF SMART GRID TECHNOLOGY
(OPEN ELECTIVE-III)**

VII Semester	L	T	P	C
Course Code: 231EE7O02	3	0	0	3

Course Outcomes:

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

- CO1** Explain the concepts of smart grid and its issues in interconnection.
- CO2** Explain various smart grid technologies and its usage in smart applications.
- CO3** Describe the concepts of smart substations.
- CO4** Analyze micro grids and distributed generation systems.
- CO5** Describe the different technologies in smart grid.

Mapping of Course Outcomes with Program Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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:

1. Integration of Green and Renewable Energy in Electric Power Systems - by Ali Keyhani – Mohammad N. Marwali - Min Dai Wiley - 2009.
2. The Smart Grid: Enabling Energy Efficiency and Demand Response - by Clark W.Gellings – Fairmont Press - 2009.

Reference Books:

1. The Advanced Smart Grid: Edge Power Driving Sustainability:1 by Andres Carvallo - John Cooper - Artech House Publishers July 2011
2. Smart Grid: Technology and Applications - by Janaka B. Ekanayake - Nick Jenkins - Kithsiri Liyanage - Jianzhong Wu - Akihiko Yokoyama -Wiley publishers - 2012.

Web Links:

1. <https://nptel.ac.in/courses/108104052/>
2. <https://nptel.ac.in/downloads/108101040/>
3. <https://nptel.ac.in/courses/108101040/>

**FINITE ELEMENT METHODS
(OPEN ELECTIVE-III)**

VII Semester

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
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.

Analysis of Trusses: Finite element modeling, coordinates and shape functions, assembly of global stiffness matrix and load vector, finite element equations, treatment of boundary conditions, stress, strain and support reaction calculations.

Unit - III

Analysis of Beams: Element stiffness matrix for Hermite beam element, derivation of load vector for concentrated and UDL, simple problems on beams.

Unit - IV

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions, formulation of axisymmetric problems. Higher order and iso-parametric elements: One dimensional, quadratic and cubic elements in natural coordinates, two dimensional four node iso-parametric elements and numerical integration.

Unit – V

Steady state heat transfer analysis: one dimensional analysis of a fin.

Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of eigen values and eigen vectors, free vibration analysis

Text Books:

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

Reference Books:

- 1 An Introduction to the Finite Element Method, J.N. Reddy, McGraw Hill Education, 4th Edition, 2020.
- 2 Concepts and Applications of Finite Element Analysis, Cook et al, Wiley Publications, 4th edition, 2007.
- 3 Engineering Thermodynamics, P. Chattopadhyay, Oxford University Press, 1st edition, 2011.
- 4 Refrigeration and Air-conditioning, CP Arora, , McGraw Hill, 4th edition 2021.

Weblinks:

- 1 <https://nptel.ac.in/courses/112/104/112104193/>
- 2 <https://nptel.ac.in/courses/112/104/112104205/>

INTRODUCTION TO MECHATRONICS (open Elective-III)

VII Semester	L	T	P	C
Course Code: 231ME7002	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:

- 1 Mechatronics Integrated Mechanical Electronics Systems/KP Ramachandran & G K Vijaya Raghavan/WILEY India Edition/2008
- 2 Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005

Reference Books:

- 1 Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
- 2 Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
- 3 Mechatronics System Design / Devdas Shetty/Richard/Thomson.
- 4 Mechatronics/M. D. Singh/J. G. Joshi/PHI.

Weblinks:

- 1 <https://www.electronicshub.org/different-types-sensors/>
- 2 https://en.wikipedia.org/wiki/Solid-state_electronics
- 3 <http://www.htl-worldwide.com/the-difference-between-pneumatic-hydraulic-and-electrical-actuators/>
- 4 <https://www.worldscientific.com/worldscibooks/10.1142/10193>

PRODUCT DESIGN AND DEVELOPMENT
(open elective-III)

VII Semester	L	T	P	C
Course Code: 231ME7003	3	0	0	3

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

CO1: Apply creative thinking skills for idea generation

CO2: Translate conceptual ideas into clear sketches.

CO3: Able to identify causes of failure through fault free analysis and perform failure analysis

CO4: Test a product under thermal, vibration, electrical and combined environments.

CO5: Know how to design for manufacturability

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
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, Behavioural 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:

- 1 Engineering Design, George E. Dieter, McGraw-Hill
- 2 Product Integrity and Reliability in Design, John W. Evans and Jillian Y. Evans, Springer Verlag.

Reference Books:

- 1 The Product Management Handbook, Richard S. Handscombe, McGraw-Hill
- 2 New Product Design, Ulrich Eppinger
- 3 Product Design, Kevin Otto.

Weblinks:

- 1 https://onlinecourses.nptel.ac.in/noc21_me83/preview
- 2 <https://www.youtube.com/watch?v=HN9GtL21rb4&t=6s>

ADVANCED MATERIALS (open elective-III)

VII Semester	L	T	P	C
Course Code: 231ME7004	3	0	0	3

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

- CO1:** Explain the materials science and engineering concepts of varied materials to understand the correlations between structure and properties.
- CO2:** Apply the concept of strengthening mechanisms to assess the properties of special metallic materials and alloys.
- CO3:** Apply the concept of strengthening mechanisms to assess the properties of polymers and composite materials.
- CO4:** Analyze the role of functional & smart materials in the contemporary applications covered in diverse fields of engineering and technology.
- CO5:** Explain advances in nanomaterials applications in varied fields with a special focus on safety, sustainability, and environmental considerations.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
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:

- 1 R. Balasubramaniam, "Callister's Materials Science and Engineering," 2nd Edition, Wiley, 2009.
- G. E. Dieter, "Mechanical Behavior of Materials," 3rd Edition, McGraw-Hill, 1986.
- 2

Reference Books:

- 1 L. M. Nieckele, "Advanced Materials: Properties, Processing, and Applications," CRC Press, 2019.
- 2 R. W. Cahn and P. Haasen (Eds.), "Physical Metallurgy," 4th Edition, Elsevier, 1996.
- 3 S. C. Sharma, "Advanced Materials and Their Applications," Dhanpat Rai Publishing Company, 2018.
- 4 V. Raghavan, "Materials Science and Engineering," PHI Learning, 2014.

Weblinks:

- 1 <https://ocw.mit.edu/courses/3-051j-materials-for-biomedical-applications-spring-2006/>
- 2 https://www.youtube.com/playlist?list=PLbRMhDVUMngdzwQyMgoUgdaGBqi_p4nVM
- 3 <https://www.coursera.org/specializations/materials-science-for-advanced-technological-applications>

SMART MANUFACTURING (open elective-III)

VII Semester	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:

- 1 Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008
- 2 Tom M. Mitchell, Machine Learning, McGraw Hill, 2013
- 3 Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.
- 4 Aurélien Géron, Hands on Machine Learning with Scikit-Learn and TensorFlow [Concepts, Tools, and Techniques to Build Intelligent Systems], Published by O’Reilly Media, 2017
- 5 S. Kaushik, Artificial Intelligence, Cengage Learning India,

Reference Books:

- 1 Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
- 2 Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012.
- 3 M.C. Trivedi, A Classical Approach to Artificial Intelligence, Khanna Publishing House, New Delhi, 2018.
- 4 Artificial Intelligence and Machine Learning, Principles and applications by Vinod Chandra S.S., Anand Hareendran S., PHI 2011.

Web links:

- 1 https://onlinecourses.nptel.ac.in/noc25_cs91/preview
- 2 https://onlinecourses.nptel.ac.in/noc25_cs147/preview
- 3 https://onlinecourses.nptel.ac.in/noc25_cs146/preview

DISCRETE TIME SIGNAL PROCESSING
(Open Elective-III)

VII Semester
Course Code: 231EC7001

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

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

- CO1** Summarize Discrete Time Signals and Systems.
- CO2** Apply DFS and DFT techniques to compute discrete-time signals
- CO3** Make use of FFT Algorithms for DFT computation.
- CO4** Interpret the basic structures of FIR and IIR digital filters.
- CO5** 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	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 to Digital Signal Processing:

Discrete time signals & sequences, linear shift invariant systems, stability, and causality. Linear constant coefficient difference equations. Frequency domain representation of discrete time signals and systems.

Unit – II

Discrete Fourier Series & Fourier Transforms:

Properties of discrete Fourier series, DFS representation of periodic sequences, Discrete Fourier transforms: Properties of DFT, linear convolution of sequences using DFT, Computation of DFT.

Unit – III**Fast Fourier Transforms:**

Fast Fourier Transforms (FFT) - Radix-2 Decimation-in-Time and Decimation-in-Frequency FFT Algorithms, Inverse FFT.

Unit – IV**Realization Of Digital Filters:**

Review of Z-transforms, Applications of Z-transforms, solution of difference equations - digital filters, Block diagram representation of linear constant-coefficient difference equations, Basic structures of IIR systems, Transposed forms, Basic structures of FIR systems, System function.

Unit – V**Multirate Digital Signal Processing:**

Decimation, Interpolation, Sampling rate conversion, Implementation of sampling rate conversion.

Text Books:

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G. Manolakis, 4th Edition, Pearson Education, 2007.
2. Discrete Time Signal Processing, A. V. Oppenheim and R. W. Schaffer, 3rd Edition, Pearson Education, 2014.

Reference Books:

1. Fundamentals of Digital Signal Processing using MATLAB, Robert J. Schilling, Sandra L. Harris, Thomson Learning, 2007.
2. Digital Signal Processing, P. Ramesh Babu, 6th Edition, SciTech Publications, 2014.
3. Digital Signal Processing, Tarun Kumar Rawat, 1st Edition, Oxford University Press, 2015.

Web Links:

1. https://www.tutorialspoint.com/digital_signal_processing/index.htm
2. <https://nptel.ac.in/courses/108106151>
3. <http://www.dspguide.com/pdfbook.htm>

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Introduction to Integrated Circuits: Integrated Circuits Types, Classification, Package Types, Temperature ranges and Power supplies. Differential Amplifier-DC And AC analysis of differential amplifier configurations, circuits for improving CMRR, Necessity of swamping resistors, Cascaded Differential Amplifier Stages and Level translator.

Unit – II

Characteristics of Op-Amps: Block Diagram of a Op-Amp, Pin diagram, symbolic representation and features of 741IC, Ideal and practical characteristics of an Op-Amp, Equivalent circuit of an Op-Amp, Define the terms input offset voltage and current, input bias current, CMRR, Slew Rate, PSRR,etc, Virtual ground concept, DC characteristics, AC characteristics and Measurement of Op-Amp parameters.

Unit – III

Linear and Non-Linear Applications of Op- Amps: Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier, AC amplifier, V to I, I to V converters, Buffers. Non-Linear Applications-Comparators, Multivibrators, Triangular and Square wave generators, Log and Anti- log Amplifier, Precision rectifiers.

Unit – IV

D-A and A-D Converters: Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, and IC 1408 DAC, Different types of ADCs parallel Comparator type ADC, counter type ADC, Successive Approximation ADC and dual slope ADC. DAC and ADC Specifications.

Active Filters: Introduction, Butter worth filters – 1st order, 2nd order LPF, HPF filters. Band pass, Band reject and All pass filters.

Unit – V

Digital Logic Families and Interfacing: Introduction to logic families, CMOS logic, CMOS steady state and dynamic electrical behavior, CMOS logic families. Bipolar logic, transistor-transistor logic, TTL families, CMOS/TTL interfacing, low voltage CMOS logic and interfacing, Emitter coupled logic.

Text Books:

1. Op Amps and Linear Integrated Circuits, Ramakant A. Gayakwad, 4th Edition, PHI, Pearson Education, 2003.
2. Linear Integrated Circuits–D. Roy Chowdhury, New Age International (p) Ltd, 2nd Edition, 2003.
3. Digital Design Principles & Practices – John F. Wakerly, PHI/ Pearson Education Asia, 4th Ed.,

Reference Books:

1. Design with Operational Amplifiers & Analog Integrated Circuits-Sergio Franco, McGrawHill, 1988
2. OPAMPS and Linear Integrated Circuits concepts and Applications, James MFiore, Cengage Learning India Ltd.
3. Operational Amplifiers & Linear Integrated Circuits–R.F. Coughlin & Fredrick Driscoll, PHI, 6th Edition.
4. Fundamentals of Digital Logic with VHDL Design- Stephen Brown, Zvonko Vranesic, McGrawHill, 3rd Edition.

Web Links:

1. <http://nptel.ac.in/courses/117108038/Prof.GunashekarM.K/IIScBangalore>
2. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-01sc-introduction-to-electrical-engineering-and-computer-science-i-spring-2011/unit-3-circuits/op-amps>

**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	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

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)**

VII Semester

Course Code: 231CS7001

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:

1. Pfleeger, C.P., Security in Computing, Prentice Hall, 5th edition.
2. Schneier, Bruce. Applied Cryptography, Second Edition, John Wiley & Sons.

Reference Books:

1. Rhodes-Ousley, Mark. Information Security: The Complete Reference, Second Edition, Information Security Management: Concepts and Practice, McGrawHill.
2. Whitman, Michael E. and Herbert J. Mattord. Roadmap to Information Security for IT and Infosec Managers. Boston, MA: Course Technology.
3. Information Security, Mark Rhodes, Ousley, 2 nd edition, MGH.

Web Links:

1. <https://www.edx.org/micromasters/ritx-cybersecurity>.
2. <https://www.coursera.org/specializations/cyber-security>.
3. <https://www.nptel.ac.in/courses/106105031/>.
4. <http://bedford-computing.co.uk/learning/wp-content/uploads/2016/08/>
5. <https://www.wileyindia.com/cyber-security-understanding-cybercrimescomputer-forensics-and-legal-perspectives.html>

BIG DATA ANALYTICS (Open Elective-III)

VII Semester

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:

1. Hadoop: The Definitive Guide, Tom White, 4th Edition, O'reilly, 2012.
2. Hadoop for Dummies, Dirkde Roos, PaulC.Zikopoulos, RomanB.Melnyk, Bruce Brown, Rafael Coss, John Wiley& Sons, 2014.
3. Anand Raja ramanand Jeffrey David Ullman, "Mining of Massive Datasets", CUP, 2012

Reference Books:

1. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley& sons, 2012.
2. Paul Zikopoulos, Dirkde Roos, Krishnan Parasuraman, Thomas Deutsch, James Giles, David Corrigan, "Harness the Power of Big Data: The IBM Big Data Platform", Tata Mc Graw Hill Publications, 2012.
3. Arshdeep Bahga and Vijay Madiseti, "Big Data Science& Analytics: A Hands On Approach", VPT, 2016.
4. Learning Spark: Lightning Fast Big Data Analysis Paper back, Holden Karau

Web Links:

1. Hadoop: <http://hadoop.apache.org/>
2. Hive: <https://cwiki.apache.org/confluence/display/Hive/Home>
3. <http://nptel.ac.in/courses/106106142/>
4. <https://hortonworks.com/tutorial/how-to-process-data-with-apache-hive/>
5. <https://databricks.com/spark/getting-started-with-apache-spark>

**INTERNET OF THINGS
(Open Elective-III)**

VII Semester
Course Code: 231IT7001

L	T	P	C
3	0	0	3

Course Outcomes (COs):

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

- CO1:** Explain the fundamental concepts of internet of things.
- CO2:** Illustrate diversified layered architectures and design principles for IoT/M2M.
- CO3:** Identify appropriate network layer protocols used in IoT
- CO4:** Illustrate the scope of data organizing and business models and process.
- CO5:** Describe the role of bigdata, cloud computing and data analytics in a typical IoT system.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	-
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:

1. Internet of Things: Architecture, Design Principles And Applications, Rajkamal, McGraw Hill Higher Education.
2. Vijay Madiseti, Arshdeep Bahga, Internet of Things A Hands-On- Approach,2014

Reference Books:

1. An Introduction to Internet of Things, Connecting devices, Edge Gateway and Cloud with Applications, Rahul Dubey, Cengage, 2019. Adrian McEwen, Designing the Internet of Things, Wiley Publishers, 2013.
2. IoT Fundamentals, Networking Technologies, Protocols and Use Cases for the Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetette, rob Barton, Jerome Henry, CISCO, Pearson, 2018.
3. Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, Wiley.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_cs17/preview
2. <https://arduinomakerspace.com/iot-projects-using-arduino/>
3. <https://www.coursera.org/specializations/iot>

COMPUTER NETWORKS (Open elective-III)

VII Semester
Course Code: 231AM7001

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO1:** Identify different types of network topologies, protocols and the layers of the OSI and TCP/IP models
- CO2:** Recognize the data link layer design issues and various protocols used for data transmission
- CO3:** Describe MAC Sublayer and how a network can detect and correct transmission errors
- CO4:** Classify and compare the major routing and congestion control algorithms
- CO5:** Describe the functionality of TCP and UDP and summarize the various Application layer protocols such as http, DNS, and HTTP

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	POS1	POS2
CO1	2	-
CO2	3	-
CO3	2	-
CO4	1	-
CO5	2	-

UNIT-I

Introduction: Computer network and components, Types of Computer Networks, Network Software, Reference Models: OSI Reference Model, TCP/IP Reference Model, Comparison between OSI and TCP/IP Models; Example Networks: The ARPANET, Internet., Transmission Media, Guided and Un-guided media.

UNIT-II

Data Link Layer: Data Link Layer Design Issues: Services Provided to Network Layer, Framing, Error Control and Flow Control; Error Detection and Correction: Error Correcting Codes, Error Detecting Codes; Elementary Data Link Protocols, Sliding Window Protocols: One-Bit Sliding Window Protocol, Protocol Using Go Back N and Selective Repeat.

UNIT-III

The Medium Access Control Sublayer (MAC): Channel Allocation Problem: Static Channel Allocation, Dynamic Channel Allocation; Multiple Access Protocol: ALOHA, Carrier Sense Multiple Access Protocols, Collision-Free Protocols, Limited Contention Protocol.

UNIT-IV

The Network Layer: Network Layer Design Issues, Routing Algorithms: The Optimality Principle, Shortest Path Routing, Flooding, Distance Vector Routing, Link State Routing, Hierarchical Routing, Congestion Control Algorithms: General Principles of Congestion Control, Congestion Prevention Policies. The Network Layer in Internet-The IP Protocol, IP Address IPV4, IPV6.

UNIT – V

The Transport Layer: Services Provided to Upper Layer; Elements of Transport Protocols: Connection Establishment, Connection Release; The Internet Transport Protocols: UDP and TCP Protocol, TCP Connection Establishment, TCP Connection Release.

The Application Layer: DNS- Domain Name System, Electronic Mail: Architecture and Services, The World Wide Web: Architectural Overview; Web documents: Static Web Document, Dynamic Web Document; Hyper Text Transfer Protocol (HTTP).

Text Books:

- 1 Andrew S. Tanenbaum, Computer Networks, 5th Edition, Pearson Education, 2016.
- 2 Behrouz A Forouzan, Data Communications and Networking, 4th Edition, McGraw-Hill- 2006

Reference Books:

- 1 S Keshav, An Engineering approach to computer Networking, 2nd Edition, Pearson Education
- 2 J.F.Kurose, K.W.Ross, Computer Networking a Top-Down approach featuring the internet, 2nd Edition, Pearson Education.

Web Links:

- 1 <https://nptel.ac.in/courses/106105081>
- 2 <https://www.coursera.org/learn/fundamentals-network-communications>
- 3 nptel.ac.in/courses/106/106/106106091/

**PIPELINE ENGINEERING
(OPEN ELECTIVE-III)**

VII Semester

Course Code: 231PT7001

L	T	P	C
3	0	0	3

Course Outcomes:

- 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
- CO5:** 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 Book:

1. GPSA Engineering Data Book, Volume 2, 12 Edition, 2003.
2. Ludwig's Applied Process Design for Chemical and Petrochemical Plants, Volume 1, 4th Edition, A. Kayode Coker, Elsevier, 2007
3. Piping and Pipeline Calculations Manual, Construction, Design, Fabrication and Examination, Philips Ellenberger, Elsevier, 2010.

Reference Books:

1. Liquid pipeline hydraulics; E. Sashi Menon; Marcel Dekker Inc.; 2004.
2. Gas-pipe hydraulics; E. Sashi Menon; CRC Press-Taylor & Francis Publications; 2005.
3. Flow of fluids, Crane, 7th edition, 1988

**INTRODUCTION TO SEISMIC METHODS
(OPEN ELECTIVE-III)**

VII Semester

Course Code: 231PT7O02

L	T	P	C
3	0	0	3

Course Outcomes:

- 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:

1. Introduction to Geophysical Prospecting, Milton B. Dobrin, and Carl H. Savit, 4th Edition, McGraw Hill, 1988.
2. Outlines of Geophysical Prospecting: A Manual for Geologists, M.B. Ramachandra Rao, EBD Educational Pvt Ltd., 1993.
3. Field Geophysics, John Milsom and Asger Eriksen, 4th Edition, John Wiley, 2011.

Reference Books:

1. Elements of Geology: Oil and Gas Exploration Techniques, J. Guillemot, Technip 1991.
2. Fundamentals of Geophysics, Lowri, W., Cambridge University Press. (1997).
3. Applied Geophysics, Telford, W. M, Geldart L.P., Sheriff, R.E., Keys, D.A. (1990).

**INTRODUCTION TO ARTIFICIAL LIFT METHODS
(OPEN ELECTIVE-III)**

VII Semester

Course Code: 231PT7O03

Course Outcomes:

L T P C
3 0 0 3

- 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:

1. Petroleum Production engineering: A computer assisted approach, Boyun GUO, William C. Lyons, Ali Ghalambor, Elsevier Science and Technology books 2007.
2. Petroleum Engineering Handbook-Production Operations Engineering, Volume 4, Joe Dunn Clegg and Larry W. Lake, SPE, 2014.

Reference Books:

1. Petroleum production systems, M.J. Economides, A. Daniel Hill & C. E. Economides, Prentice-Hall, N.J-07488, 1994.
2. The Technology of Artificial Lift Method, Brown, K.E, Volume 1-4, Penn Well Books, Tulsa, Oklahoma, 1977.
3. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University, 2014.

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 Pareswaran, ISBN-90-5809-689-0

Web Links:

1. <https://www.slideshare.net/slideshow/sustainable-mining-practices-240275756/240275756>
2. https://www.terin.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. Wohlber
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. Rzhovsky
3. Opencast Mining – Unit Operations: V.V. Rzhovsky
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: 231MI7004	3	0	0	3

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

- CO1: Explain environmental management principles and global/local environmental issues affecting mining.
- CO2: Identify types of pollution, assess their impacts, and recommend control and preventive measures.
- CO3: Analyze land pollution challenges, tailing management techniques, and implement mine closure plans.
- CO4: Apply environmental management tools including EIA, audits, and economic analysis for mining operations.
- CO5: Demonstrate knowledge of key environmental legislation and regulatory compliance for mining projects.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction: Goals, strategies and tools for environmental management – systems approach to environmental management – environmental guideline – National Policies on environment with respects to mining activities – Global and Local environmental issues – resource degradation – desertification – Industrialization, Objectives of Sustainable Development.

Structure of the atmosphere – ozone layer depletion – Acid rain – Greenhouse gases and global warming Ambient Air quality and emission standards, Air quality Sampling and monitoring, Dispersion of air pollutants.

UNIT – II

Environmental Pollution – I: Environmental Pollutants due to surface – Air, Water, Noise, Sources and Classification of pollutants including dust and their effect on human health, Sources, hazards, sampling and analysis, standards, instrumentation and measurement of pollutants including dust, Air born dust modeling, Control and preventive measures for air pollution including for dust, , Water pollution standards, Noise standards – Measurement – Noise Impact Index assessment, Control and preventive measures for water, noise pollution. Pollution due to blast and equipment vibrations their monitoring, prevention and control.

UNIT – III

Environmental Pollution – II: Land pollution, land for alternation dealing with mind out land, re-vegetation, tailing management, tailing dams, method and construction, land use plan, Mine closure planning. Textural classification and properties of soil. Impact of pollution on human health, miner’s diseases and their social impact.

UNIT – IV

Environmental Management: Environmental quality objectives, Emission and ambient standards – Minimum National standards – International environmental standards – ISO 14000 – EIA Notification – Siting of Industries – Environmental management plans, Environmental impact assessment, Environmental management system audits, Environmental economics – Principles of cost benefit analysis – Valuing the Environment – Environmental Accounting, Environmental administration- training awareness and competence, Mine subsidence, its prediction and control.

UNIT – V

Environmental Legislations: Environmental laws, the Environmental (Protective) Act, 2004,

The Water Act (1974), The Air act (1981), The Forest Act 1927, The forest conservation act

1980, Power and responsibilities of regulatory agencies and occupation consent to establish and operate wild life protection act and rules, Environmental clearance procedure for a mining Project.

Text Books:

1. Manahan S.E. Environmental Science and Technology.
2. Mackenthun, K.M. Basic Concepts in Environmental Management, Lewis Publications, London, 1998.

Reference Books:

1. Noel de Nevers, Air Pollution Control Engg., McGraw Hill, New York, 1995
2. Anjaneyulu, Y. Air Pollution & Control Technologies, Allied Publishers (P) Ltd, India, 2002.
3. Nick Hanley, Jaison F. Shogren and Ben White. Environmental Economics – In Theory and Practice, Macmillan India Ltd, New Delhi, 1999.
4. Roger Perman, Yue Ma and James McGilvray. Natural Resources and Environmental Economics, Second edition, Addison Wesley Longman Ltd, Singapore, 1997

Web Links:

1. https://nptel.ac.in/courses/124/105/124105076/downloads/Lecture_Notes_Environmental_Management_Mining.pdf
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)

VII Semester
Course Code: 231AG7001

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	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

Unit - I

Water harvesting -principles, importance and uses. Water harvesting techniques – classification based on source, storage and use. Runoff harvesting – short-term and long-term techniques. Short-term harvesting techniques - contour bunds, semicircular hoop, trapezoidal bunds, graded bunds, rock catchment and ground catchment. Long term harvesting techniques- purpose and design criteria

Unit – II

Structures - farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes. Farm pond - components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction. Percolation pond - site selection, design and construction details. Design considerations of nala bunds.

Unit – III

Soil erosion control structures - introduction, classification and functional requirements. Design of Gabion structures. Permanent structures for soil conservation and gully control – check dams, drop, chute and drop inlet spillways - design requirements, planning for design, design procedures - hydrologic, hydraulic and structural design and stability analysis.

Unit – IV

Hydraulic jump and its application. Drop spillway - applicability, types - straight drop, box-type inlet spillways - description, functional use, advantages and disadvantages, straight apron and stilling basin outlet, structural components and functions.

Chute spillway - description, components, energy dissipaters, design criteria of Saint Antony Falls (SAF) stilling basin and its limitations. Drop inlet spillway - description, functional use and design criteria.

Unit – V

Loads on head wall, variables affecting equivalent fluid pressure, triangular load diagram for various flow conditions, creep line theory, uplift pressure estimation, safety against sliding, overturning, crushing and tension.

Text Books:

1. Michael, A.M. and T.P. Ojha. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
2. Singh Gurmel, C. Venkataraman, G. Sastry and B.P. Joshi. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

Reference Books:

1. Murthy, V.V.N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
2. Schwab, G.O., D.D. Fangmeier, W.J. Elliot, R.K. Frevert. 1993. Soil and Water Conservation Engineering. 4th Edition, John Wiley and Sons Inc. New York.

Web Links:

1. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=125071>
2. <http://ecoursesonline.iasri.res.in/course/view.php?id=54>
3. <https://nptel.ac.in/courses/126/105/126105012/>
4. <https://www.fao.org/land-water/water/water-management/water-storage/en/>

**BASICS OF SOIL MECHANICS
(Open Elective-IV)**

VII Semester
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 physical properties of soil and its determination
- CO2:** Determine the various index properties and the classification of soil
- CO3:** Assess the stress developed due to various loads and soil conditions
- CO4:** Explain the various compaction methods and the determination of permeability
- CO5:** Explain the concept of consolidation, compressibility and settlement calculation

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Physical Properties of Soil:

Three phase system - phase diagram - physical properties Functional Relationships between physical properties-determination of water content, specific gravity, In-situ density-Relative density

Unit – II

Plasticity Characteristics of soil: Consistency, Atterberg's limits and their determination liquid limit, plastic limit, shrinkage limit - Index Properties-Activity-Free swell index. Soil Classification: Soil classification- need and criteria for soil classification-IS Particle size classification-Classification tests-grain size analysis - hydrometer analysis- grain size distribution curve - Unified Soil Classification- Indian Standard Soil classification- Coarse grained soils- Fine grained soils-Plasticity chart.

Unit – III

Effective stress: Stresses due to self-weight-total, neutral and effective stresses – Pressure diagrams under different soil conditions. Stresses due to applied loads: Boussinesq theory-Concentrated load-Strip footing- circular footing- Rectangular footing-Newmark’s influence chart - Pressure bulb-Significant depth Westergaard’s theory - 2:1 distribution method

Unit – IV

Compaction: Principle of compaction, OMC and MDD, Lab tests-IS light weight and heavy weight compaction tests, Factors affecting compaction - zero air void line-Effect of compaction on engineering

properties of soils - Field compaction control – Proctor’s Needle.

Permeability and Seepage: types of soil water, Permeability-Darcy’s law-Factors effecting permeability- laboratory tests-Average permeability of stratified soils. Seepage pressure critical hydraulic gradient -quick sand condition.

Unit – V

Consolidation: Definition and significance-mechanism-Terzaghi’s soil-spring analogy -lab consolidation test

– e-log p curve-Coefficient of compressibility-coefficient of volume change-compression index- determination of consolidation settlement – Terzaghi’s theory of 1D consolidation-Time-settlement calculations. Determination of coefficient of consolidation-time fitting methods – Pre-consolidation pressure- normally consolidated and over consolidated clays-secondary consolidation.

Text Books:

1. Arora, K.R. (2019), “Soil Mechanics and Foundation Engineering”, Standard Publishers, Delhi
2. Gopal Ranjan and Rao, A.S.R., “Basic and Applied Soil Mechanics”, New Age Ltd. International Publisher New Delhi (India) 2016

Reference Books:

1. Craig, R.F. (2019), “Soil Mechanics”, McGraw hill, New Delhi
2. Narasinga Rao, B.N.D. (2015), Soil Mechanics and Foundation Engineering, Wiley Publishers

Web Links:

1. <http://nptel.ac.in/courses/105103097/>

CONSTRUCTION MATERIALS AND EQUIPMENTS (Open Elective-IV)

VII Semester
Course Code: 231CE7O05

L	T	P	C
3	0	0	3

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

- CO1:** Explain the tests on stones, cement and aggregates.
- CO2:** Explain the concepts of strength and durability testing on mortar and concrete.
- CO3:** Compare the properties of most common and advanced building materials.
- CO4:** Selection of Automation techniques in construction industry.
- CO5:** Analyze benefits of robotics versus conventional construction equipment.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO 1	PSO 2
CO1	-	-
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:

1. Varghese.P.C, "Building Materials", PHI Learning Pvt. Ltd, New Delhi, 2018.
2. Rajput.R.K., "Engineering Materials", S.ChandandCompanyLtd.,2018.

Reference Books:

1. Jagadish.K.S, "AlternativeBuildingMaterialsTechnology", NewAgeInternational,2017.
2. Gambhir.M.L.,&NehaJamwal., "BuildingMaterials,products,propertiesandsystems", TataMcGrawHillEducationsPvt.Ltd,NewDelhi,2019.

Web Links:

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

NATURAL DISASTER MANAGEMENT & MITIGATION
(Open Elective-IV)

VII Semester

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit – I

Introduction Concept of Disaster Management. Types of Disasters. Disaster mitigating agencies and their organizational structure at different levels.

Unit – II

Overview of Disaster Situations in India Vulnerability of profile of India and Vulnerability mapping including disaster – prone areas, communities, places. Disaster preparedness – ways and means; skills and strategies; rescue, relief reconstruction. Case Studies: Lessons and Experiences from Various Important Disasters in India and Biological disasters – SARS-spread and transmissions -pandemic, endemic and epidemic.

Unit – III

Flood and Drought Disaster Raising flood damage, assessing flood risk, flood hazard assessment, flood impact assessment, flood risk reduction options. Drought and development, relief management and prevention, drought mitigation and management- integrating technology and people.

Unit – IV

Landslide and Earthquake Disaster Land slide hazards zonation mapping and geo environmental problems associated with the occurrence of landslides. The use of electrical resistivity method in the study of landslide. Causes and effects of earthquakes. Secondary effects. Criteria for earthquake resistant design.

Unit – V

Cyclone and Fire Disaster Cyclone occurrence and hazards. Cyclone resistant house for coastal areas. Disaster resistant construction role of insurance sector. Types of fire. Fire safety and firefighting method, fire detectors, fire extinguishers. Rehabilitation: Rehabilitation programmes, Management of Relief Camp.

Text Books:

1. Disaster Management, RB Singh (Ed), Rawat Publications, 2000.
2. Disaster Management Future Challenges and Opportunities, Jagbir Singh, I.K International publishing house

Reference Books:

1. Natural Hazards in the Urban habitat by Iyengar, CBRI, Tata McGraw Hill
2. Natural Disaster management, Jon Ingleton (Ed), Tular Rose, 1999

Web Links:

1. <https://www.youtube.com/watch?v=2v7N5a3tLgE>
2. <https://www.youtube.com/watch?v=5KtVocJfVGw>

**CONCEPTS OF POWER QUALITY
(OPEN ELECTIVE-IV)**

VII Semester	L	T	P	C
Course Code: 231EE7003	3	0	0	3

Course Outcomes:

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

- CO1** Differentiate between different types of power quality problems and sources of voltage sag, voltage swell.
- CO2** Explain about the sources of transient over voltages in a power system.
- CO3** Explain about the Long – Duration Voltage Variations and Flickering.
- CO4** Analyse the Harmonic distortion and solutions and their indices.
- CO5** Explain the concepts of distributed generation technologies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 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:

- 1 Electrical Power Systems Quality - Dugan R C - McGranaghan M F – Santoso S - and Beaty H W - Second Edition - McGraw–Hill - 2012 - 3rd edition.
- 2 Electric power quality problems – M.H.J.Bollen IEEE series-Wiley india publications – 2011.
- 3 Power Quality Primer - Kennedy B W - First Edition - McGraw–Hill - 2000.

Reference Books:

- 1 Understanding Power Quality Problems: Voltage Sags and Interruptions - Bollen M HJ - First Edition - IEEE Press; 2000.
- 2 G. T, Heydt, "Electric Power Quality", Stars in a Circle Publications, 1991 Power System Harmonics - Arrillaga J and Watson N R - Second Edition - John Wiley & Sons - 2003.
- 3 Electric Power Quality control Techniques - W. E. Kazibwe and M. H. Sendaula – Van Nostrad Reinhold - New York.
- 4 Harmonics and Power Systems –Franciso C.DE LA Rosa–CRC Press (Taylor & Francis).

Web Links:

- 1 <https://nptel.ac.in/courses/108107157>
- 2 https://onlinecourses.nptel.ac.in/noc21_ee103/preview

QUANTUM SCIENCE AND TECHNOLOGY
Open Elective-IV

VII Semester	L	T	P	C
Course Code: 231EE7004	3	0	0	3

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

- CO1: Explain core principles of quantum mechanics and their technological implications.
- CO2: Analyze quantum phenomena like superposition and entanglement.
- CO3: Apply mathematical tools to model and solve quantum systems.
- CO4: Demonstrate understanding of quantum algorithms and quantum circuits.
- 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	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

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)

VII Semester

Course Code: 231ME7O06

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

Unit - I

Classical Optimization Techniques: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions, merits and demerits of classical optimization techniques.

Unit -II

Numerical Methods for Optimization: Nelder Mead’s Simplex search method, Gradient of a function, Steepest descent method, Newton’s method, Pattern search methods, conjugate method, types of penalty methods for handling constraints, advantages of numerical methods

Unit - III

Genetic Algorithm (GA) : Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different

reproduction and crossover operators, GA for constrained optimization, draw backs of GA,

Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

Multi-Objective GA: Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems

Unit – IV

Applications Of Optimization In Design And Manufacturing Systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

Unit – V

Reliability: Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, hazard analysis.

Text Books:

- 1 Engineering Optimization by S.S.Rao, 3rd edition, New Age Publishers,2013, ISBN13 978-8122427233
- 2 Reliability Engineering by L.S.Srinath, East west publishers,2005, ISBN13 978-8176710480

Reference Books:

- 1 Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
- 2 Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers
- 3 Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers
- 4 An Introduction to Reliability and Maintainability Engineering by CE Ebeling, Waveland Printers Inc., 2009

Weblinks:

- 1 https://onlinecourses.nptel.ac.in/noc21_me10/preview
- 2 <https://www.coursera.org/learn/operations-research-modeling>

**ADVANCED MANUFACTURING PROCESSES
(OPEN ELECTIVE-IV)**

VII Semester

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: Understand various surface treatment techniques and processing of ceramics.

CO4: Gain the knowledge on advanced coating processes.

CO5: Describe various fabrication methods for microelectronic devices.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
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:

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

Reference Books:

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

Weblinks:

- 1 <https://archive.nptel.ac.in/courses/112/107/112107077/> .
- 2 <https://archive.nptel.ac.in/courses/112/103/112103306/>
- 3 <https://archive.nptel.ac.in/courses/112/105/112105053/>
- 4 <https://home.iitk.ac.in/~mohite/ae681.html>
- 5 <https://archive.nptel.ac.in/courses/113/104/113104102/>
- 6 <https://archive.nptel.ac.in/courses/103/106/103106075/>

**TOTAL QUALITY MANAGEMENT
(OPEN ELECTIVE-IV)**

VII Semester	L	T	P	C
Course Code: 231ME7008	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	3	1	3	3	2	2	3	2	3	1	1
CO2	3	2	3	2	2	1	2	1	3	2	2	2
CO3	3	3	2	1	3	2	3	1	1	1	2	2
CO4	3	2	2	2	1	3	2	2	2	1	3	1
CO5	3	1	2	1	2	2	2	2	2	2	2	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I

Introduction: Definition of Quality, Factors effecting quality, Quality management, Quality Dimensions, four phases of quality, Total Quality, Salient features of Total Quality Management (TQM)-definition of TQM, Elements of TQM, Principles of TQM, Pillars of TQM, Traditional Approach and TQM Approach. Characteristics of TQM: TQM Enablers, Approaches, relevance, Barriers to TQM Implementation

Unit -II

Quality costs: Cost classification, Basic cost of quality. Applications and Importance of quality cost. Quality leadership: Quality of leadership, Quality of successful leader, leadership for TQM, Deming Philosophy, Contributions of Gurus of TQM

Unit - III

Customer Focus: Customer Complaints and suggestions, panels, Customer satisfaction, Customer Perception of Quality, Customer driven quality circles, Customer focus and activities, needs and expectations, Organizations action from the customer point of view.

Continuous Quality Improvement - Juran Trilogy, PDCA Cycle, Kaizen- kaizen suggestion's,

program introduction at workplace, principles of kaizen. Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development

Unit - IV

TQM Tools: Bench marking - Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) - House of Quality, QFD Process, Benefits. Taguchi Quality Loss Function.

Total Productive Maintenance (TPM) - Concept, Improvement Needs, FMEA -Stages of FMEA, the seven tools of quality, Process Capability- Concept, Methods of calculating process capability, Process capability index, Concept of six sigma.

Unit – V

Need for ISO9000-ISO9001-2008 Quality System- Elements, documentation Quality Auditing– QS9000-ISO14000-Concepts, Requirements and Benefits–TQM, Implementation in manufacturing and service sectors.

Text Books:

- 1 Total Quality Management, Dale HB ester field, Pearson,4th Edition 2015
- 2 Total Quality Management,K.C.Arora,S.K.Kataria&sons,NewDelhi,2016
- 3 Total Quality Management, Subburaj Ramaswamy, Tata Mcgraw Hill Publishing Company Ltd., 2005

Reference Books:

- 1 Management Quality-Concepts and Tasks, Narayana V and Sreenivasan N.S.,New age publishers;1st edition(1January2005).
- 2 Statistical Quality Control, SeventhEdition, RichardS.Leavenworth & Eugene LodewickGrant,7th Edition,TataMcgrawHill,2015
- 3 Total QualityManagement, Subburaj Ramasamy, TataMcGrawHill Publishing CompanyLtd., NewDelhi, 2005.

Web links:

- 1 <https://nptel.ac.in/courses/110/105/110105039/>
- 2 <https://nptel.ac.in/courses/110/104/110104085/>
- 3 <https://nptel.ac.in/courses/110/104/110104080/#>

OPERATIONS MANAGEMENT
(open elective-IV)

VII Semester

Course Code: 231ME7O09

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/PO	PO1	PO2	PO3	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:

CO/PSO	PSO1	PSO 2
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

RELIABILITY: Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, hazard analysis

Text Books:

1. Operations Research-An Introduction/Hamdy A Taha/Pearson publishers
2. Operations Research –Theory & publications / S.D.Sharma Kedarnath/McMillan publishers India Ltd

References:

1. Introduction to O.R/Hiller & Libermann/TMH
2. Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.
3. Operations Research: Methods & Problems / Maurice Saseini, Arthur Yaspan & Lawrence Friedman/Wiley
4. Operations Research / R.Pannerselvam/ PHI Publications.
5. Operations Research / Wagner/ PHI Publications.

Web Links:

1. <https://nptel.ac.in/courses/110/106/110106062/>
2. <https://ocw.mit.edu/courses/sloan-school-of-management/15-760a-operations-management-summer-2002/>

ENERGY AUDITING (OPEN ELECTIVE-IV)

VII Semester

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

- 1 General Aspects of Energy Management & Energy Audit,, National Certificate Examination for Energy Managers and Energy Auditors, National Productivity Council of India
- 2 Energy Performance Assessment for Equipment and Utility systems, National Certificate Examination for Energy Managers and Energy Auditors, National Productivity Council of India

Reference Books:

- 1 Murphy, W.R. , Mckay, G. (1982) 'Energy Management ', London: Butterworth-Heinemann
- 2 K. Smith, C.B. (Ed. 4) (1981). 'Energy Management Principles : applications, benefits, savings', Amsterdam : Pergamon Press
- 3 Witte, L. C. (1988), ' Industrial energy management and utilization ', Washington: Hemisphere Pub. Corp

Web links:

- 1 <https://sustainabilityeducationacademy.com/free-online-energy-audit-course/>
- 2 <https://coursevania.com/courses/introduction-to-energy-auditing/>
- 3 <https://www.cdgtraining.com/courses/Certified-Energy-Auditor-CEA-Course-66f78d2e6560e62a1e6ef941>

FUNDAMENTALS OF IMAGE PROCESSING (Open Elective-IV)

VII Semester
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)

VII Semester **L** **T** **P** **C**
Course Code: 231CS7002 **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:

1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Publications, 2019
2. Data Science and Machine Learning Mathematical and Statistical Methods, Dirk P. Kroese, Zdravko I. Botev, Thomas Taimre, Radislav Vaisman, 25th November 2020

Reference Books:

1. Machine Learning Probabilistic Approach, Kevin P. Murphy, MIT Press, 2012.
2. Stephen Marsland, "Machine Learning -An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
3. Andreas C. Müller and Sarah Guido "Introduction to Machine Learning with Python: A Guide for Data Scientists", O'Reilly

Web Links:

1. <https://www.deeplearning.ai/machine-learningyearning/>
2. <https://www.cse.huji.ac.il/~shais/UnderstandingMachineLearning/index.html>
3. https://onlinecourses.nptel.ac.in/noc21_cs24/preview
4. <https://www.udemy.com/course/machinelearning/>

**DATA VISUALIZATION
(OPEN ELECTIVE-IV)**

VII Semester	L	T	P	C
Course Code: 231DS7002	3	0	0	3

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

- CO1:** Identify and recognize visual perception and representation of data.
- CO2:** Illustrate about projections of different views of objects.
- CO3:** Apply various Interaction and visualization techniques.
- CO4:** Analyze various groups for visualization.
- CO5:** Apply visualizations for volumetric data to present them graphically.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit– I

Introduction To Data Visualizations And Perception: Introduction of visual perception, visual representation of data, Gestalt principles, Information over load.

Unit– II

Visual Representations: Creating visual representations, visualization reference model, visual mapping, visual analytics, Design of visualization applications.

Unit–III

Classification Of Visualization Systems: Classification of visualization systems, Interaction and visualization techniques mis leading, Visualization of one, two and multi-dimensional data, text and text documents.

Unit– IV

Visualization Of Groups: Visualization of groups, trees, graphs, clusters, networks, software, Meta phorical visualization. Various visualization techniques, data structures used in data visualization.

Unit– V

Visualization of Volumetric Data And Evaluation of Visualizations: Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geo graphic information, GIS systems, collaborative visualizations, evaluating visualizations

Text Books:

1. Ward, Grinstein, Keim, Interactive Data Visualization: Foundations, Techniques, and Applications. Natick, 2nd edition, AK Peters, Ltd 2015.

Reference Books:

1. Tamara Munzner, Visualization Analysis & Design, 1st edition, AK Peters Visualization Series 2014
2. Scott Murray, Interactive Data Visualization for the Web, 2nd Edition, 2017

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_mg67/preview
2. https://onlinecourses.nptel.ac.in/noc22_mg67/preview
3. <https://www.coursera.org/learn/datavisualization>
4. <https://www.udemy.com/course/data-visualization-foundations/>
5. <https://www.udemy.com/course/masteringd3js/>

CLOUD COMPUTING (Open Elective-IV)

VII Semester
Course Code: 231IT7002

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

Course Outcomes:

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

- CO1:** Explain cloud computing concepts, service models (IaaS, PaaS, SaaS), and deployment models (public, private, hybrid).
- CO2:** Analyze cloud-enabling technologies including distributed computing, virtualization, and SOA.
- CO3:** Evaluate virtualization technologies and container platforms such as Docker and Kubernetes.
- CO4:** Assess the major challenges in cloud computing, including security, interoperability, and fault tolerance.
- CO5:** Describe advanced cloud topics like serverless computing, IoT integration, and DevOps practices.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction to Cloud Computing Fundamentals

Cloud computing at a glance, defining a cloud, cloud computing reference model, types of services (IaaS, PaaS, SaaS), cloud deployment models (public, private, hybrid), utility computing, cloud computing characteristics and benefits, cloud service providers (Amazon Web Services, Microsoft Azure, Google App Engine).

UNIT – II

Cloud Enabling Technologies

Ubiquitous Internet, parallel and distributed computing, elements of parallel computing, hardware architectures for parallel computing (SISD, SIMD, MISD, MIMD), elements of distributed computing, Inter-process communication, technologies for distributed computing, remote procedure calls (RPC), service-oriented architecture (SOA), Web services, virtualization.

UNIT – III**Virtualization and Containers**

Characteristics of virtualized environments, taxonomy of virtualization techniques, virtualization and cloud Computing, pros and cons of virtualization, technology examples (XEN, VMware), building blocks of containers, container platforms (LXC, Docker), container orchestration, Docker Swarm and Kubernetes, public cloud VM (e.g. Amazon EC2) and container (e.g. Amazon Elastic Container Service) offerings.

UNIT-IV**Cloud computing challenges**

Economics of the cloud, cloud interoperability and standards, scalability and fault tolerance, energy efficiency in clouds, federated clouds, cloud computing security, fundamentals of computer security, cloud security architecture, cloud shared responsibility model, security in cloud deployment models.

UNIT –V**Advanced concepts in cloud computing**

Serverless computing, Function-as-a-Service, serverless computing architecture, public cloud (e.g. AWS Lambda) and open-source (e.g. OpenFaaS) serverless platforms, Internet of Things (IoT), applications, cloud-centric IoT and layers, edge and fog computing, DevOps, infrastructure-as-code, quantum cloud computing.

Text Books:

1. Mastering Cloud Computing, 2nd edition, Rajkumar Buyya, Christian Vecchiola, Thamarai Selvi, Shivananda Poojara, Satish N. Srirama, Mc Graw Hill, 2024.
2. Distributed and Cloud Computing, Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra, Elsevier, 2012.

Reference Books:

1. Cloud Computing, Theory and Practice, Dan C Marinescu, 2nd edition, MK Elsevier, 2018.
2. Essentials of cloud Computing, K. Chandrasekhran, CRC press, 2014.
3. Online documentation and tutorials from cloud service providers (e.g., AWS, Azure, GCP)

Weblinks:

1. <https://docs.aws.amazon.com>
2. <https://learn.microsoft.com/en-us/azure/>
3. <https://cloud.google.com/docs>
4. <https://nptel.ac.in/courses/106106129>
5. <https://nptel.ac.in/courses/106105167>

**SOFTWARE ENGINEERING
(OPEN ELECTIVE-IV)**

VII Semester	L	T	P	C
Course Code: 231AM7002	3	0	0	3

Course Outcomes:

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

- CO1:** Explain the evolution of software development and analyse life cycle models like Waterfall, RAD, Agile, and Spiral
- CO2:** Apply estimation techniques and risk management for effective project management and develop SRS
- CO3:** Design software using good design principles, structured analysis, and user interface methodologies
- CO4:** Conduct blackbox, whitebox, and integration testing to ensure software reliability and quality
- CO5:** Use CASE tools for software maintenance, reverse engineering, cost estimation, and reuse strategies

Mapping of Course Outcomes with Program Outcomes:

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

UNIT-I

Introduction: Evolution, Software development projects, Exploratory style of software developments, Emergence of software engineering, Notable changes in software development practices, Computer system engineering.

Software Life Cycle Models: Basic concepts, Waterfall model and its extensions, Rapid application development, Agile development model, Spiral model.

UNIT-II

Software Project Management: Software project management complexities, Responsibilities of a software project manager, Metrics for project size estimation, Project estimation techniques, Empirical Estimation techniques, COCOMO, Halstead's software science, risk management.

Requirements Analysis and Specification: Requirements gathering and analysis,

Software Requirements Specification (SRS), Formal system specification, Axiomatic specification, Algebraic specification, Executable specification and 4GL.

UNIT-III

Software Design: Overview of the design process, How to characterize a good software design? Layered arrangement of modules, Cohesion and Coupling. approaches to software design.

Agility: Agility and the Cost of Change, Agile Process, Extreme Programming (XP), Other Agile Process Models, Tool Set for the Agile Process (Text Book 2)

Function-Oriented Software Design: Overview of SA/SD methodology, Structured analysis, Developing the DFD model of a system, Structured design, Detailed design, and Design Review.

User Interface Design: Characteristics of a good user interface, Basic concepts, Types of user interfaces, Fundamentals of component-based GUI development, and user interface design methodology.

UNIT-IV

Coding And Testing: Coding, Code review, Software documentation, Testing, Black-box testing, White-Box testing, Debugging, Program analysis tools, Integration testing, testing object-oriented programs, Smoke testing, and some general issues associated with testing. Software Reliability and Quality Management: Software reliability. Statistical testing, Software quality, Software quality management system, ISO9000. SEI Capability maturity model. Few other important quality standards, and Six Sigma.

UNIT – V

Computer-Aided Software Engineering (Case): CASE and its scope, CASE environment, CASE support in the software life cycle, other characteristics of CASE tools, Towards second generation CASE Tool, and Architecture of a CASE Environment.

Software Maintenance: Characteristics of software maintenance, Software reverse engineering, Software maintenance process models and Estimation of maintenance cost.

Software Reuse: Reuse-definition, Introduction, Reason behind no reuses of ar, Basic issues in any reuse program, A reuse approach, and Reuse at organization level.

Text Books:

- 1 Fundamentals of Software Engineering, Rajib Mall, 5th Edition, PHI.
- 2 Software Engineering A Practitioner's Approach, Roger S. Pressman, 9th Edition, McGraw Hill International Edition.

Reference Books:

- 1 Software Engineering, Ian Sommerville, 10th Edition, Pearson
- 2 Software Engineering, Principles and Practices, Deepak Jain, Oxford University Press.

Web Links:

- 1 <https://nptel.ac.in/courses/106105087>
- 2 <https://nptel.ac.in/courses/106101061>
- 3 <https://www.coursera.org/specializations/software-design-architecture>

DEEPWATER TECHNOLOGY (OPEN ELECTIVE-IV)

VII Semester
Course Code: 231PT7004

L T P C
3 0 0 3

Course Outcomes:

- CO1:** Analysis of waves and fluid-induced forces on offshore structures, Current and wind forces.
- CO2:** Understand the Deepwater exploration and Deepwater drilling techniques.
- CO3:** Apply the concepts of fixed platforms, compliant towers, subsea systems, extended reach wells and floating production systems.
- CO4:** Extend innovative subsea completion, installation and associated problem.
- CO5:** 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 geohazards, gas hydrate etc., Deep water drilling with emphasis on the additional inputs to normal offshore Drilling operation.

UNIT –III

Deep-water Production System: Fixed Platforms, Compliant Towers, Subsea systems, Extended Reach Wells, Floating production systems like FPSO, FPSS, TLPS, Spar platform and FSO.

UNIT-IV

Deep-water applications of Subsea Technology: Subsea completion, X-mas tree, Control systems, Manifolds, Templates, ROV, Deepwater installation vessels with DP system and associated problems – Offshore mobile units, station- keeping methods like mooring and dynamic positioning system.

UNIT-V**Deep-water pipelines, Umbilical's & emerging Deep-water Technologies:**

Issues in Deep-water pipeline design, Rigid and Flexible flow lines, pipe-in-pipe, Deep-water Risers and their configurations, Pipeline installation methods, Umbilical's-functions, configurations and installation, Flow assurance strategies, Innovative floating production concepts, subsea processing, subsea separation and any new innovations.

Text Books:

1. Subsea Engineering Handbook, Yong bai and Qiangbai, Gulf Professional Publishing, 2010.
2. Offshore Petroleum Drilling and Production, By Sukumar Laik, 1st Edition, Published June 30, 2020 by CRC Press.
3. Deepwater Petroleum Exploration & Production by [William L. Leffler](#), [Richard Pattarozzi](#), [Gordon Sterling](#) Penn Well Books, 2003.

Reference Books:

1. Floating Drilling: Equipment and Its Use, by Riley Sheffield Volume 2 of Floating Drilling and Volume 2 of Practical drilling technology-1980
2. Handbook On Nondestructive Testing of Concrete By V.M. Malhotra And N.J. Carino, Second Edition Crc Press-2004
3. Offshore Handbook Vol.1 to 5: Gulf Pub. Co.
4. Offshore Pipeline Design, Analysis, and Methods by A. H. Mousselli, Publisher, Penn Well Books, 1981.
5. Drilling and Producing Offshore, by R. Stewart Hall, Publisher, Pennwell Corp- 1984.

INTRODUCTION TO ACIDIZING AND HYDRO-FRACTURING (OPEN ELECTIVE-IV)

VII Semester
Course Code: 231PT7O05

L	T	P	C
3	0	0	3

Course Outcomes:

- CO1:** Apply the modelling of hydraulic fractures for different reservoirs.
- CO2:** Assess fracturing fluid properties and their usage.
- CO3:** Analyze the fracturing fluid proppant characteristics.
- CO4:** Apply the methods of matrix acidization and fracture acidization.
- CO5:** Apply the concepts of hydraulic fracturing and its design

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

CO /PSO	PSO 1	PSO 2
CO1	-	-
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 Book:

1. Reservoir Stimulation, Michael. J. Economides, Kenneth G. Nolte, 2nd Edition, Prentice Hall, 1989.

Reference Books:

1. Oil Well Stimulation, Robert S. Schechter, Prentice Hall, 1992.
2. Modern Fracturing Enhancing Natural Gas Production, Michael J. Economides, Tony Martin, ET Publishing, 2007.

**INTRODUCTION TO RESERVOIR ENGINEERING
(OPEN ELECTIVE-IV)**

VII Semester**Course Code: 231PT7O06****Course Outcomes:**

L	T	P	C
3	0	0	3

- 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:

1. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science, 1978 (17th Impression 1998).
2. Reservoir Engineering Handbook, Tarek Ahmed, 3rd Edition, Gulf Professional Publishing, 2006.
3. B. C. Craft – M. Hawkins, Ronald E. Terry & J. Brandon Rogers, 3rd revised Edition, Prentice Hall, New York, 2014.

Reference Books:

1. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman Inc. 1986.
2. Reservoir Engineering Handbook, Tarek Ahmed, 3rd Edition, Gulf Professional Publishing, 2006.

INTRODUCTION TO RESERVOIR ENGINEERING (Open Elective-IV)

VII Semester

Course Code: 231PT7O06

L	T	P	C
3	0	0	3

Course Outcomes:

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

- CO 1: Apply the basic concepts in reservoir engineering.
- CO 2: Perform basic PVT analysis of various types of fluids for wells.
- CO 3: Carry out the calculations in material balance and estimate the reserves of various sands of the reservoir from well data.
- CO 4: Apply the Darcy's Law and derive deliverability equations for various types of reservoirs.
- CO5: Learn about water Influx methods

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	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:

1. Fundamentals of Reservoir Engineering, L.P. Dake, Elsevier Science, 1978 (17th Impression 1998).
2. Reservoir Engineering Handbook, Tarek Ahmed, 3rd Edition, Gulf Professional Publishing, 2006.
3. B. C. Craft – M. Hawkins, Ronald E. Terry & J. Brandon Rogers, 3rd revised Edition, Prentice Hall, New York, 2014.

Reference Books:

1. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman Inc. 1986.
2. Reservoir Engineering Handbook, Tarek Ahmed, 3rd Edition, Gulf Professional Publishing, 2006.

Web Links:

1. <https://www.scribd.com/document/636059075/Untitled>
2. https://www.academia.edu/15328765/3_FLUID_SAMPLING_AND_ANALYSIS_OF_LABORATORY_DATA_3_1_Introduction
3. https://www.academia.edu/8462037/OIL_RECOVERY_MECHANISMS_AND_THE_MATERIAL_BALANCE_EQUATION
4. <https://byjus.com/physics/darcys-law/>
5. https://petrowiki.spe.org/Water_influx_models

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 setting 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, Inclinometers.

UNIT – II

Pressure Measurements and Flow Measurements: Unit of Pressure – Manometers Different types, - Elastic type pressure gauges and sensors– Bourdon tube – Bellows – Diaphragm – Elastic elements with LVDT and strain gauge, deformation gauge – Capacitive type pressure gauge – Measurement of vacuum – McLeod gauge – Thermal conductivity gauge – Ionisation gauge. Piezometer, Flow meters – Variable head type flow meter – Orifice plate – Venturi tube – Positive displacement flow meter: Nutating disc, Reciprocating piston, oval gear and helix type flow meter – Rotameter – Mass flow meters.

UNIT – III

Vibration, Humidity, Velocity and Level Measurements: Mechanical type vibration measuring instruments – Seismic instruments as an accelerometer – Vibrometers – Geophones. Humidity – Hot wire electro type hygrometer – Dew cell – Electrolysis type hygrometer. Anemometer, Velometer, Pitot static tube, Sound level meter, microphone, Lux meter; Level measurements: – Float gauges - Displacer type – D/P methods -Bubbler system Load cell – Electrical types – Conductivity sensors – Capacitive sensors – Nucleonic gauge - Ultrasonic gauge – Boiler drum level measurement – Differential pressure method and Hydrastep method -Solid level measurement...

UNIT – IV

Analyzers: Dissolved Analyzer: Conductivity meter – pH meter – Dissolved oxygen analyzer
 – Sodium analyzer – Silica analyzer – Turbidity meter – Gas analyzer – 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: 231MI7007	3	0	0	3

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

- CO1: Demonstrate knowledge of historical safety practices and major global mining disasters.
- CO2: Apply risk assessment techniques and HIRA methodology in identifying and controlling mining hazards.
- CO3: Utilize advanced risk analysis methods such as FMEA, HAZOP, FTA, and Markov Models.
- CO4: Analyze mine accidents using safety engineering theories, ANN, and SEM tools.
- CO5: Evaluate and implement ergonomic principles to improve safety and productivity in mining environments.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction: Historical Developments of Mine Safety in India and Abroad; Need for Improving, Safety Engineering Approach in Mining, Industry; Engineering Safety Goals; Mine Safety Facts and Figures; Worldwide Major Mine Disasters.

UNIT – II

Risk Management: Risk Management Related Terms and Definitions; Basic Concept of Risk, Reliability and Hazard Potential; Risk Components and Types; Risk Management Objectives; Risk Management Process; Functions of a Risk Manager; Common Errors in Risk Management; Risk Estimates for Selective, Events; Hazards Identification and Risk Assessment (HIRA) Methodology; Implementation of HIRA and its Controls & Review; Advantages of Risk Management

UNIT – III

Statistical Methods of Risk analysis: Basic Risk Analysis Methods based on Frequency Rates and Severity of Accidents Appraisal of advanced techniques - Preliminary Hazards Analysis (PHA); Hazards and Operability Analysis (HAZOP); Failure Mode and Effect Analysis (FMEA); Failure Mode Effect and Critical Analysis (FMECA); Job Safety Analysis (JSA); Fault Tree Analysis (FTA); Markov Model (MM) – An Important Risk analysis Tool.

UNIT – IV

Analyzers: Dissolved Analyzer: Conductivity meter – pH meter – Dissolved oxygen analyzer
System Safety Engineering Concept in Mine Safety: An Introduction to Systems Safety Engineering; Different School of Thoughts in Accident Causations - Domino Model; Behavioral Accident Model based on the human perception; Epidemiological Accident Models, Normal Accident Theory; The Swiss Cheese Model; Systems-Theoretic Accident

Modeling and Process (STAMP); In-depth Study of Accidents Due to Various Causes; Application of Structural Equation Modelling (SEM) and Artificial Neural Network (ANN) in Determining the Accident Causation in Mines. Safety audits and control: Objectives of safety audit in mines; Different steps in safety audit; Risk control procedures.

UNIT – V

Mine Ergonomics: Domain, Philosophy and Objective of Mine Ergonomics; Ergonomics/human, Factors fundamentals; Work physiology, and stress; Human body- structure and, function, anthropometrics; Posture and movement; Posture and Job Relation – Work Posture
Analysis using OWAS, Method; Oxygen Consumption and Workload Analysis of Mine Workers..

Text Books:

1. Engineering Safety: Fundamentals, Techniques and Applications by B. S. Dhillon; World Scientific Publisher.
2. Mine Health and Safety Management – Edited by Michael Karmis.
3. Kejriwal, B. K., Safety in mines, Lovely Prakashan.

Reference Books:

1. Dhillon, B. S. (2008). Mining equipment reliability, maintainability, and safety (Springer Series in Reliability Engineering). Springer.
2. Dhillon, B. S. (2010). Mine safety: A modern approach (Springer Series in Reliability Engineering). Springer..

Web Links:

1. https://www.dgms.gov.in/writereaddata/UploadFile/History_of_Mine_Safety_in_India.pdf
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)

VII Semester
Course Code: 231AG7002

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 green house.

CO5: Plan fertilizer scheduling, rate of application of fertilizers and methods of application.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO 1	PSO 2
CO1	1	2
CO2	-	2
CO3	2	-
CO4	3	-
CO5	3	-

Unit - I

Planning and layout of farmstead. Scope, importance and need for environmental control, physiological reaction of livestock environmental factors, environmental control systems and their design, control of temperature, humidity and other air constituents by ventilation and other methods.

Unit – II

Livestock production facilities, BIS Standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc

Unit – III

Storage of grains and Causes of spoilage. Water activity for low and high moisture food grains and its limits for storage, Moisture and temperature changes in grain bins; Traditional storage structures and their improvements, Improved storage structures (CAP, hermetic storage, Pusa bin, RCC ring bins). Design consideration for grain storage

godowns, Bag storage structures, Shallow and Deep bin, Calculation of pressure in bins and Storage of seeds

Unit – IV

Protected cultivation: Introduction, History, origin, development, national and International Scenario, components of green house, perspective, Types of green houses, polyhouses /shed nets, Cladding materials, Plant environment interactions – principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment. Design and construction of greenhouses – site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment, Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators, evaporative cooling, different shading material fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care etc.

Unit – V

Planting techniques in green house cultivation. Irrigation in greenhouse and net house – Water quality, types of irrigation system, components, design, installation and material requirement. Fogging system for greenhouses and net houses – introduction, benefits, design, installation and material requirement. Fertilization – nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application. Greenhouse climate measurement, control and management.

Text Books:

1. Pandey, P.H. Principles and practices of Agricultural Structures and Environmental Control, Kalyani Publishers, Ludhiana.
2. Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag, New Delhi.

Reference Books:

1. Venugopal Rao, P. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi.
2. Sahay, K.M. and Singh, K.K. Unit Operations of Agricultural Processing, Vikas publishing pvt. Ltd, Noida.
3. Singh Brahma and Balraj Singh. 2014. Advances in protected cultivation, New India Publishing Company.
4. Sharma P. 2007. Precision Farming. Daya Publishing House New Delhi.

Web Links:

1. <https://nptel.ac.in/courses/104103020/3>
2. <http://ecoursesonline.iasri.res.in/mod/page/view.php?id=618>

DIGITAL SIGNAL AND IMAGE PROCESSING LAB

VII Semester	L	T	P	C
Course Code: 231EC7S01	0	0	4	2

Course Outcomes:

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

- CO1:** Compare the performance of various digital filters.
- CO2:** Analyze the effect of sampling and multirate processing in both time and frequency domains.
- CO3:** Apply enhancement, segmentation and compression techniques for image processing applications.
- CO4:** Apply restoration and watermarking techniques for image processing applications.
- CO5:** Demonstrate video processing operations using hardware.

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

List of Experiments:

1. Design the IIR Low Pass and High pass Butterworth and Chebyshev filters.
2. Design the FIR Low Pass Filter using Window techniques.
3. Perform Sampling Rate Conversion of a Discrete-Time Signal by a Rational Factor (L/M) with Spectral Analysis.
4. Perform Audio Compression Using Down sampling and Reconstruction.
5. Generate the Histogram and Histogram Equalization of a digital image.
6. Partition a given image into two (foreground and background) regions using histogram-based thresholding and region growing techniques.
7. Compare the normalized cross correlation to the addition of noise and removal of noise using filters to an image.
8. Compute the edge of an image using Linear spatial filters.
9. Perform the image motion blur and calculate PSNR of original and degraded image.
10. Demonstrate video loop back, video color bar and mirror the input video signal using DM6437 LCDK Processor.

List of Augmented Experiments (Any two can be performed):

11. Obtain Frequency response of FIR Low Pass Filter using Triangular Window.

12. Demonstrate Voice Activity detection in Speech.
13. Embed and extract a watermark image/ binary watermark into a host image/an audio signal using the Least Significant Bit (LSB) technique.
14. Perform image compression using Discrete Cosine Transform (DCT) and evaluate compression ratio and PSNR.

Software Required:

1. MATLAB R2014a or higher version/Python 3.
2. Texas Instrument's Code Composer Studio (CCS).

Hardware Equipment Required:

1. Texas Instrument's TMS320C6748DSP Development Kit (LCDK).
2. DM6437 Digital Video Development platform with NTSC/PAL Camera.

Reference Books:

1. Digital Signal and Image Processing, Tamal Bose, Wiley India Edition, 1st Edition, 2010.
2. Digital Signal Processing: Principles, Algorithms, and Applications by John G. Proakis and Dimitris Manolakis, Pearson Education India, 5th Edition, 2025.

Web Links:

1. <https://nptel.ac.in/courses/117/102/117102060/> (Digital Signal Processing by Prof. S.C.Dutta Roy, IIT Delhi).
2. <http://nptel.ac.in/courses/117105079/> (Digital Image Processing by Prof. P.K.Biswas, IIT Kharagpur).
3. <https://sisu.ut.ee/imageprocessing/avaleht>

RESEARCH METHODOLOGY

VII Semester	L	T	P	C
Course Code: 231MC7T01	2	0	0	0

Course Outcomes:

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

- CO1** Explain the characteristics and process of research.
- CO2** Select the research problem by applying problem identification techniques.
- CO3** Formulate and execute research design process.
- CO4** Report the results of research process adhering to professional ethics.
- CO5** Analyze the results of research using statistical measures of central tendency, coefficient of variation, correlation and regression

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

Meaning of Research - Function of Research - Characteristics of Research – Steps involved in Research – Research in Pure and Applied Sciences - Inter Disciplinary Research. Factors which hinder Research – Significance of Research - Research and scientific methods – Research Process– Criteria of good Research – Problems encountered by Researchers – Literature Review.

UNIT – II

Identification of Research Problem : Selecting the Research problem – Necessity of defining the problem – Goals and Criteria for identifying problems for research. Perception of Research problem – Techniques involved in defining the problem.

UNIT – III

Research Design: Formulation of Research design – Need for Research design – Features of a good design – Important concepts related to Research design

UNIT – IV

Interpretation and Report Writing: Meaning and Technique of interpretation – Precautions in interpretation – Significance of report writing – Different steps in writing a report – Layout of a Research report.

UNIT – V

Statistical Techniques and Tools: Introduction of statistics – Functions – Limitations – Measures of central tendency - Arithmetic mean – Median – Mode – Standard deviation – Co-efficient of variation (Discrete series and continuous series) – Correlation - Regression

Text Books:

- 1 Research Methodology Methods & Techniques, C.R. Kothari – New Age international Publishers, Reprint 2008
- 2 A Hand Book of Methodology of Research, Rajammall, P. Devadoss and K. Kulandaivel, RMM Vidyalaya press, 1976

Reference Books:

- 1 Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd., 1997.
- 2 Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi, 2011
- 3 Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi, 1999.

Web Links:

- 1 <https://nptel.ac.in/courses/127106227>
- 2 https://www.youtube.com/watch?v=1ZLn9_PA_4s

SUMMER INTERNSHIP - II

VII Semester	L	T	P	C
Course Code: 231EC7P01	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 IV 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.

Project (Full Semester Internship)

VIII Semester	L	T	P	C
Course Code: 231EC8P01	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 Electronics & Communication 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.

Project Outcomes:

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

- CO1** Identify a real life / engineering problem
- CO2** Perform extensive investigation with prior knowledge
- CO3** Interpret problem formulation and solution through critical thinking
- CO4** Develop the work plan, schedule and estimate the cost
- CO5** Identify the resources required to initiate project work
- CO6** Apply the domain knowledge to arrive at a framework to solve the problem
- CO7** Design solution using research-based knowledge and modern tools and interpret the results
- CO8** Assess the obtained solution in the context of engineering framework addressing the societal and environmental concerns adhering to professional ethics
- CO9** Demonstrate communication skills effectively to work as a team, for guide interaction and presentations.
- CO10** Prepare technical documentation/reports with effective written communication skills.