PROGRAM STRUCTURE AND SYLLABUS

(I to VIII Semesters)

PETROLEUM TECHNOLOGY

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 excel in petroleum education and research to meet the needs of industry and society.

MISSION

M1: Impart quality education in Petroleum Technology using modern tools.
M2: Establish effective industry and innovational collaboration to serve the society.
M3: Inculcate professional ethics, personality development skills for lifelong learning.

****

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of the Program will

PEO 1	Engage in ongoing and professional development through self-study, continuing
PEO 2	Apply their engineering skills, exhibiting critical thinking and problem-solving skills to tackle societal, technical, and business challenges.
PEO 3	Demonstrate research skills, team spirit or leadership qualities.

PROGRAM OUTCOMES (POs)

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

PO 1	**Engineering Knowledge:** Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem Analysis:** Identify, formulate, research literature and analyze complex engineering problems, reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
PO 4	**Conduct Investigations of Complex Problems:** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
PO 6	**The Engineer and Society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
PO 7	**Environment and Sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
PO 9	**Individual and Teamwork:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project Management and Finance:** Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member and leader in a team and to manage projects in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

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

PSO 1	Solve petroleum technology problems using analytical methods, modern tools, and techniques.
PSO 2	Design, operate, maintain, and troubleshoot petroleum process equipment.

Mission of the department – PEOs mapping

PEOs Statements		**M1**	**M2**	**M3**
PEO 1:	Engage in ongoing and professional development through self-study, continuing education in Petroleum Technology and also in other allied fields.	2	3	1
PEO 2:	Apply their engineering skills, exhibiting critical thinking and problem-solving skills to tackle societal, technical, and business challenges.	2	1	3
PEO 3:	Demonstrate research skills, team spirit or leadership qualities.	1	2	3

Note:

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

INDUCTION PROGRAMME

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

PROGRAM STRUCTURE

I Semester

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

II Semester

S. No.	Course Code	Course Title	Course Component	L	T	P	Credits
1	231BS2T04	Engineering Chemistry	BSC	3	0	0	3
2	231BS2T03	Differential Equations & Vector Calculus	BSC	3	0	0	3
3	231ES2T01	Basic Electrical and Electronics Engineering	ESC	3	0	0	3
4	231ES2T02	Introduction to Programming	ESC	3	0	0	3
5	231PT2T01	Introduction To Petroleum Engineering	PCC	3	0	0	3
6	231BS2L03	Engineering Chemistry Lab	BSC	0	0	2	1
7	231ES2L01	Electrical and Electronics Engineering Lab	ESC	0	0	3	1.5
8	231ES2L02	Computer Programming Lab	ESC	0	0	3	1.5
9	231PT2L01	Petroleum Technology Lab	PCC	0	0	3	1.5
10	231HS2L03	NSS/NCC/Scouts & Guides/Community Service	HSMC	0	0	1	0.5
11	231MC2T01	Constitution of India	MC	2	0	0	0
12	231MC2T02	Cognitive English for Engineers – I	MC	0	0	2	0
						Total	**21**

III SEMESTER								
Course Code	**Course Title**	**Course Component**	**Course Type**	**Total Number of contact hours**				**Credits (C)**
				Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
231BS3T03	Numerical Methods and Transformation Techniques	BSC	Theory	3	0	0	3	3
231HS3T02	Universal Human Values	BSC	Theory	2	1	0	3	3
231PT3T01	Principles of Geology for Petroleum Engineers	PCC	Theory	3	0	0	3	3
231PT3T02	Material and Energy Balances	PCC	Theory	3	0	0	3	3
231PT3T03	Fluid Mechanics for Petroleum Engineers	PCC	Theory	3	0	0	3	3
231PT3L01	Principles of Geology for Petroleum Engineers lab	PCC	Lab	0	0	3	3	1.5
231PT3L02	Fluid Mechanics for Petroleum Engineers Lab	PCC	Lab	0	0	3	3	1.5
231CS3S01	**Skill oriented course I** Python Programming	SC	Lab	0	1	2	2	2
231PT3P01	Community Service Project	PROJ	Project	0	0	4	0	0
231MC3T03	Cognitive English for Engineers - II	MC	Lab	0	0	2	2	0
			Total	**14**	**1**	**14**	**24**	**20**

IV SEMESTER								
Course Code	**Course Title**	**Course Component**	**Course Type**	**Total Number of contact hours**				**Credits (C)**
				Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
231BS4T01	Complex Variables, Probability & Statistics	BSC	Theory	3	0	0	3	3
231HS4T01	Managerial Economics and Financial Analysis	HSMC	Theory	2	0	0	2	2
231PT4T01	Thermodynamics for Petroleum Engineers	PCC	Theory	3	0	0	3	3
231PT4T02	Heat Transfer Operations	PCC	Theory	3	0	0	3	3
231PT4T03	Petroleum Geology	PCC	Theory	3	0	0	3	3
231PT4L01	Petroleum Geology Lab	PCC	Lab	0	0	3	3	1.5
231PT4L02	Heat Transfer Operations Lab	PCC	Lab	0	0	3	3	1.5
231PT4S01	**Skill oriented course-II** Mathematical Methods Using Numerical Lab	SC	Lab	0	1	2	3	2
231ES4T04	Design Thinking & Innovation	ESC	Theory	1	0	2	3	2
231MC4T01	Essence of Indian Traditional Knowledge	MC	Theory	2	0	0	2	0
			Total	**17**	**2**	**10**	**29**	**21**

V SEMESTER								
Course Code	**Course Title**	**Course Component**	**Course Type**	**Total Number of contact hours**				**Credits (C)**
				Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
231PT5T01	Well Logging & Formation Evaluation	PCC	Theory	3	0	0	3	3
231PT5T02	Instrumentation, Process Dynamics and Control	PCC	Theory	3	0	0	3	3
231PT5T03	Drilling Technology	PCC	Theory	3	0	0	3	3
-	**Professional Elective – I**	PEC	Theory	3	0	0	3	3
-	**Open Elective – I**	OEC	Theory	3	0	0	3	3
231PT5L01	Drilling Fluids Lab	PCC	Lab	0	0	3	3	1.5
231PT5L02	Instrumentation, Process Dynamics and Control Lab	PCC	Lab	0	0	3	3	1.5
231PT5S01	**Skill Oriented Course III** MATLAB for Petroleum Engineers	SC	Lab	0	0	3	3	2
231PT5L03	Tinkering Lab for Petroleum Engineers	PCC	Lab	0	0	2	2	1
231PT5P01	Summer Internship-I	PROJ	Project	0	0	2	2	2
231MC5T01	Professional Ethics and Human Values	MC	Theory	2	0	0	2	0
			Total	**17**	**0**	**13**	**30**	**23**

VI SEMESTER								
Course Code	**Course Title**	**Course Compon ent**	**Course Type**	**Total Number of contact hours**				**Credits (C)**
				Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
231PT6T01	Petroleum Reservoir Engineering	PCC	Theory	3	0	0	3	3
231PT6T02	Petroleum Refinery & Petrochemical Engineering	PCC	Theory	3	0	0	3	3
231PT6T03	Petroleum Production Engineering	PCC	Theory	3	0	0	3	3
-	**Professional Elective - II**	PEC	Theory	3	0	0	3	3
-	**Professional Elective -III**	PEC	Theory	3	0	0	3	3
-	**Open Elective - II**	OEC	Theory	3	0	0	3	3
231PT6L01	Petroleum Analysis Lab	PCC	Lab	0	0	3	3	1.5
231PT6L02	Petroleum Reservoir Simulation and Engineering Lab	PCC	Lab	0	0	3	3	1.5
231PT6S01	**Skill Oriented Course-IV** Drilling Simulation Lab	SC	Lab	0	0	3	3	2
231MC6T01	Technical Paper Writing & IPR	MC	Theory	2	0	0	2	0
231MC6T03	Soft Skills	MC	Theory	2	0	0	2	0
			Total	**22**	**0**	**9**	**31**	**23**
Mandatory Industry Internship of 08 weeks duration during summer vacation								

VII SEMESTER								
Course Code	Course Title	Course Component	Course Type	Total Number of contact hours				Credits (C)
				Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
231PT7T01	Enhanced Oil Recovery Techniques	PCC	Theory	3	0	0	3	3
231HS7T02	Management and Organizational Behaviour	HSMC	Theory	2	0	0	2	2
-	**Professional Elective – IV**	PEC	Theory	3	0	0	3	3
-	**Professional Elective -V**	PEC	Theory	3	0	0	3	3
-	**Open Elective - III**	OEC	Theory	3	0	0	3	3
-	**Open Elective - IV**	OEC	Theory	3	0	0	3	3
231PT7S01	**Skill Oriented Course-V** Petroleum Equipment Design & Simulation Lab	SC	Lab	0	0	3	3	2
231MC7T03	Research Methodology	MC	Theory	2	0	0	2	0
231PT7P01	Summer Internship - II	PROJ	Project	0	0	2	2	2
			Total	**19**	**0**	**5**	**24**	**21**

VIII Semester								
Course Code	Course Title	Course Component	Course Type	Total Number of contact hours				Credits (C)
				Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
231PT8P01	Project (Full Semester Internship)	PROJ	Project	0	0	24	24	12
			Total	**0**	**0**	**24**	**24**	**12**

BSC: Basic Sciences Courses;

HSMC: Humanities and Social Sciences including Management Courses;

ESC: Engineering Sciences Courses;

PCC: Professional Core Courses;

PEC: Professional Elective Courses;

OEC: Open Elective Courses;

MC: Mandatory Courses;

PROJ: Project.

PROFESSIONAL ELECTIVES

Professional Elective – I (V Semester)		
S. No.	**Course Code**	**Name of the Course**
1	231PT5E01	Offshore Drilling, Production and Management
2	231PT5E02	CBM Reservoir Engineering
3	231PT5E03	Statistics for Petroleum Engineers
4		MOOCS-NPTEL/SWAYAM

Professional Elective – II (VI Semester)		
S. No.	**Course Code**	**Name of the Course**
1	231PT6E01	Subsea Engineering
2	231PT6E02	Flow Assurance
3	231PT6E03	Natural Gas Hydrates
4		MOOCS-NPTEL/SWAYAM

Professional Elective – III (VI Semester)		
S. No.	**Course Code**	**Name of the Course**
1	231PT6E04	Horizontal Well Technology
2	231PT6E05	Well Completions, Testing and Servicing
3	231PT6E06	Reservoir Modelling and Simulation
4		MOOCS-NPTEL/SWAYAM

Professional Elective – IV (VII Semester)		
S. No.	**Course Code**	**Name of the Course**
1	231PT7E01	HSE in Petroleum Industry
2	231PT7E02	Oil Filed Chemicals
3	231PT7E03	Advanced Natural Gas Engineering
4		MOOCS-NPTEL/SWAYAM

Professional Elective – V (VII Semester)		
S. No.	**Course Code**	**Name of the Course**
1	231PT7E04	Petroleum Economics, Policies and Regulations
2	231PT7E05	Asset Management
3	231PT7E06	Surface Production Operations
4		MOOCS-NPTEL/SWAYAM

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

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

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

OPEN ELECTIVE - III (VII Semester)			
S. No.	**Course Code**	**Course Name**	**Offered By Department**
1.	231CE7O01	Industrial 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

ENGINEERING PHYSICS

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

	L	T	P	C
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 H231all 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 Uncertainity Principle – interpretation of wave function – Schröedinger 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. "ATextbook of Engineering Physics"by M N Avadhanulu,P G Kshirsagar & T.V.S.ArunMurthy S Chand & Company Ltd, 11thedition

Reference Books:

1. "Engineering Physics"by M.R.Srinivasan, NewAge International publishers.
2. "Engineering Physics"by D.K.Bhattacharyaand PoonamTandon,Oxfordpress.
3. "Engineering Physics"by R.K Gaur.and S.LGupta.,-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)

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

Reference Books:

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

Web Links:

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

PART B: BASIC MECHANICAL ENGINEERING

UNIT I

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

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

UNIT II

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

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

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

UNIT III

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

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

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

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

Text Books:

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

Reference Books:

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

Web Links:

1. https://www.youtube.com/playlist?list=PL8tFFpsLHxMRZsJljPLGVGthqSEJV11DZ
2. https://sedyono.files.wordpress.com/2015/10/ch-02.pdf
3. https://www.cedengineering.com/userfiles/Mechanical%20Power%20Transmission%20Fundamentals-R1.pdf
4. https://ccsuniversity.ac.in/bridge-library/pdf/Lecture-3-Engine.pdf
5. https://www.sathyabama.ac.in/sites/default/files/course-material/2020-10/UNIT 5_14.pdf
6. https://www.youtube.com/watch?v=q79bl99rWFM

ENGINEERING GRAPHICS

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

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

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

CO 1: Apply the principles of engineering drawing, to construct engineering curves and orthographic projection of points.

CO 2: Construct projections of Lines and planes in various positions in first quadrant.

CO 3: Construct projections of solids in various positions in first quadrant.

CO 4: Develop surfaces of the regular solids.

CO 5: Construct isometric and orthographic views of simple solids.

Mapping of course outcomes with program outcomes:

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

UNIT I

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

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

UNIT II

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

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

UNIT III

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

UNIT IV

Projections of Solids: Types of solids: Polyhedra and Solids of revolution. Projections of solids in simple positions: Axis perpendicular to horizontal plane, Axis perpendicular to vertical planeand 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 linedevelopment. Development of a cube, prism, cylinder, pyramid and cone simple cases.

UNIT V

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

Textbook:

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

Reference Books:

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

Web Links:

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

COMMUNICATIVE ENGLISH
(Common to all branches)

	L	T	P	C
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 andusage (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.

Mapping of Course Outcomes with Program Outcomes:

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. Chand Publishers.
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 byDr.Y.Aparna, Dr.K.Venkateswara Rao, VGS Techno series.

Web Links

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

IT WORKSHOP
(Common to all branches of Engineering)

I Semester **L T P C**
Course Code: 231ES1L01 **0 0 2 1**

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

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

Mapping of Course Outcomes with Program Outcomes:

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

List of Experiments:

Week 1: Identification of peripherals of a computer

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

Week 2: System Assembling and Disassembling

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

Week 3: Virtual Machine setup

a. Setting up and configuring a new virtual machine.

Week 4: Installation of software

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

Week 5: Networking and Internet

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

Week 6: Text Editors

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

Week 7: Word

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

Week 8: Excel

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

Week 9: Power Point

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

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

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

Week 11: LaTeX

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

Week 12: Internet & World Wide Web (WWW)

a. Web Browsers, Surfing the Web: Students customize their web browsers with the LAN proxy settings, bookmarks, search toolbars and pop up blockers. Also, plug-ins like Macromedia Flash and JRE for applets should be configured.

b. Cyber Hygiene: Students would be exposed to the various threats on the internet and would be asked to configure their computer to be safe on the internet. They need to customize their browsers to block pop ups, block active downloads to avoid viruses and/or worms.

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

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

Reference Books:

1. Comdex Information Technology course tool kit, Vikas Gupta, WILEY Dream tech, 2003.
2. The Complete Computer upgrade and repair book, Cheryl A Schmidt, WILEY Dream tech, 2013, 3rd edition.
3. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education, 2012, 2nd edition.
4. PC Hardware - A Handbook, Kate J. Chase, PHI (Microsoft).
5. LaTeX Companion, Leslie Lamport, PHI/Pearson.
6. Essential Computer and IT Fundamentals for Engineering and Science Students, Dr.N.B.Vekateswarlu, S.Chand.

Web Links:

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

COMMUNICATIVE ENGLISH LAB

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

	L	T	P	C
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 frbetter 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 **L T P C**
Course Code: 231HS1L02 **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 andrunning.

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 manyas 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

ENGINEERING CHEMISTRY

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

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

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

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

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

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

UNIT II:
Electrochemistry and Corrosion
Electrodes –electrochemical cell, Nernst equation, cell potential calculations.
Primary cells – Zinc-air battery, Secondary cells: Nickel-Cadmium (Ni-Cd), and lithium-ion batteries- Working principle of the batteries including cell reactions; Fuel Cells: Principle and working of hydrogen-oxygen Fuel cell.
Corrosion: Introduction to corrosion, Dry corrosion (Pilling Bed worth rule) electrochemical theory of corrosion, differential aeration cell corrosion, galvanic corrosion, Factors affecting the corrosion, cathodic and anodic protection, electroplating and electroless plating (Nickel and Copper).
UNIT III:
Polymers and Fuel Chemistry
Introduction to polymers, functionality of monomers, Mechanism of chain growth (Free radical), step growth polymerization.
Thermoplastics and Thermosetting plastics-: Preparation, properties, and applications of Polystyrene, PVC, Nylon 6,6 and Bakelite.
Elastomers – Preparation, properties and applications of Buna S, Buna N, Thiokol rubbers.

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

UNIT IV:

Engineering Materials

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

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

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

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

UNIT V:

Nanomaterials and Green chemistry

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

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

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

Text Books:

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

Reference Books:

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

Web Links:

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

DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS
(Common to all branches)

II Semester	**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, generalsolution, 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'smethod. 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, 5thEdition.
4. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha ScienceInternational 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)

	L	T	P	C
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, FirstEdition
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 UniversityPress, 2017
4. Basic Electrical and Electronics Engineering, S. K. Bhatacharya, 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 INSTRUMENTTAION

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, XORand 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. Chitralekha Mahanta, IIT Guwahati.

INTRODUCTION TO PROGRAMMING

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

II Semester **L T P C**
Course Code: 231ES2T02 **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 YashwanthKanetkar, 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**.**

INTRODUCTION TO PETROLEUM ENGINEERING

		L	T	P	C
II Semester		**L**	**T**	**P**	**C**
Course Code: 231PT2T01		**3**	**0**	**0**	**3**

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

CO 1: Identify the various streams in the petroleum industry.
CO 2: Outline the onshore and offshore reservoirs.
CO 3: List out the various artificial lift techniques.
CO 4: Illustrate various attributes in mid-stream processing and storage.
CO 5: Describe the crude oil products and their 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	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT-I
What is Petroleum Engineering & Significance? Introduction Petroleum Industry- Upstream Sector-Midstream Processing-Downstream Processing-Indian and World Scenario of Petroleum and Natural Gas- Petroleum Trade- Geopolitics.

UNIT II
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. Exploration and Drilling Rigs- Rig Components-Drill and drill bits- Drilling fluids.

UNIT III
Well Completions Production System: Sketches of Well - Well head- Christmas tree and Casing and various other parts- Cementing-Safety Systems.
Artificial Lift: Principles and operation of Rod Pumps Down hole Pumps - Gas Lift - Plunger Lift-Electrical submersible pumps.

UNIT IV
Separation of Reservoir Fluids- Manifolds and Gathering - Production Separators - Gas Treatment and Compression - Oil & Gas Storage.

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
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. Havard Devold, Oil and Gas Production Handbook: An Introduction to Oil & Gas Production, ABB ATPA Oil and Gas.
2. John R. Fanchi and Christiansen, R.L. Introduction to Petroleum Engineering, John Wiley & Sons.
3. Geology of Petroleum, A. I. Levorsen. CBS Publishers & Distributors, 2nd Edition.

Reference Books:

1. Production and transport of oil and gas (part B: gathering and transport); Szilas A.P; Elsevier publications, 2nd Edition.
2. Subsea Engineering Handbook; Yong Bai., QiangBai; Gulf Professional Publishing; Elsevier
3. Fundamentals of Petroleum Chemical Technology, P Belov, Mir Publishers.

Web Links:

1. https://www.studentenergy.org
2. https://petrowiki.org/Hydrate_problems_in_production
3. https://en.wikipedia.org/wiki/Pipeline_transport
4. https://petrowiki.org/Production_system

ENGINEERING CHEMISTRY LAB

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

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

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

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

Mapping of Course Outcomes with Program Outcomes:

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

List of Experiments (Any ten experiments):

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

Augmented Experiments (Any One experiment to be conducted):

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

Reference:

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

ELECTRICAL & ELECTRONICS ENGINEERING LAB

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

	L	T	P	C
II Semester				
Course Code:231ES2L01	**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 experiments can be performed)

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

Reference Books:

1. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, FirstEdition
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 gatesusing ICs.

List of Augmented Experiments:

(Any one of the fallowing experiments can be performed)

1. Input & Output characteristics of BJT in CB configuration.
2. 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
    a. 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. Chitralekha 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

Text Books:

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

Reference Books:

1. The C Programming Language, Brian W. Kernighan and Dennis M. Ritchie, Prentice-Hall, 1988
2. Computing fundamentals and C Programming, Balagurusamy, E., McGraw-Hill Education, 2008.
3. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.

4. Let Us C YashwanthKanetkar, Eighth edition, BPB Publications.
5. Programming in C A-Practial 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 + ½ 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→1+2+3=6).
27. Display a given number in reverse order (Eg: 123 → 321).
28. Display a given number is a Palindrome or not.
29. Find the given number is Armstrong or not.
30. Find the given number is Perfect or not.
31. Find the given number is Strong or not.

32. Calculate the sum of the digits of a given number upto single digit (Lucky Number)
33. Display the Fibonacci series [Hint: 0 1 1 2 3 5 …(sum of the consecutive numbers)].
34. Display from 1 to 20 [Eg: 5 * 1 = 5 ….. 5 * 20 = 100].

35. Display following format

```
1
1   2
1   2   3
1   2   3   …..   n
```

36. Display following format (Floyd's Triangle)

```
1
2   3
4   5   6
……………………....
```

37. Display following format

```
1
1   2
1   2   3
………………………………..n
3   2   1
2   1
1
```

38. Generate pyramid structure format

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

39. Generate Pascal triangle format

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

40. Find the value of ncr [Hint : n!/r!(n-r)!].
41. Print the sum of the following series. $1 + x + x^2 + x^3 + \dots\dots\dots + x^n$
42. Print the sum of the following series. $1 + x + x^2/2 + x^3/3 + \dots\dots + x^n/n$
43. Print the sum of the following series. $1 + x + x^2/2! + x^3/3! + \dots\dots + x^n/n!$
44. Print the sum of the following series. $X + x^3/3! + \dots\dots\dots + x^n/n!$
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 = 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! .....
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

PETROLEUM TECHNOLOGY LAB

II Semester | **L T P C**
Course Code: 231PT2L01 | **0 0 3 1.5**

	L	T	P	C
II Semester				
Course Code: 231PT2L01	0	0	3	1.5

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

CO 1 Illustrate the importance of unit operations such as fluid dynamics, heat transfer and mass transfer.
CO 2 Understand the factors that influence reservoir fluid flow.
CO 3 Determine the properties of drilling fluid.
CO 4 Characterize the distillation of fuel samples.
CO 5 Study the properties of rocks and depositional environment.

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

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

List of experiments
1. Distinguish between Laminar and turbulent flows – concept of Reynolds number.
2. Determine Venturi and Orifice coefficient- Venturi meter and Orifice Meter Assembly
3. Experiment to distinguish between free and forced convective heat transfer – identification of variables affecting the heat transfer.
4. Determine overall heat transfer coefficient in double pipe heat exchanger
5. Determination of Cloud & Pour Points of petroleum products.
6. Determination of Flash & Fire points of gasoline, kerosene and other products.
7. Measurement of mud viscosity.
8. Measurement of drilling fluid density.
9. To Location of observed outcrops on the Top sheet. Geological mapping and Traversing.
10. To Measurement of the strike, dip.
11. Identification of Rocks
12. Identification of Minerals

Augmented Experiments:

13. To Measurement of apparent and true thickness of the outcrops.
14. Study the PID characteristics of Temperature control trainer.

References:

1. Process Systems Analysis and control, D.R.Coughanowr, 2nd Edition. McGraw Hill.
2. Introduction to fluid mechanics, Fox R W and A T McDonald, 5th Edition, John Wiley & Sons.
3. Petroleum Refining: Technological and Economics, J.H.Gary and G.E.Handwerk, 4th Edition, Marcel Dekkar, Inc.
4. Petroleum Engineering: Drilling and Well Completion, Carl Gatlin, PrenticeHall, Inc.
5. Text Book of Physical Geology, Mahapatra, G.B., CBS publications.

Web Links:

1. https://nptel.ac.in/courses/103/104/103104044/
2. https://nptel.ac.in/courses/105/105/105105170/

NSS/NCC/SCOUTS & GUIDES/COMMUNITY SERVICE

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

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

Mapping of Course Outcomes with Program Outcomes:

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

UNIT I Orientation

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

Activities:

i) Conducting –ice breaking sessions-expectations from the course-knowing personaltalents and skills
ii) Conducting orientations programs for the students –future plans-activities-releasingroad 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-Surveyin 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 PopulationEducation.
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)

	L	T	P	C
II Semester	**L**	**T**	**P**	**C**
Course Code:231MC2T01	**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 andPolitics.
3. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication).
4. J.C. Johari, Indian Government and PoliticsHans.

Web Links:

1. nptel.ac.in/courses/109104074/8
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 fr better listening and speaking comprehension.
CO4:	Evaluate and exhibit professionalism in participating in debates and group discussions.
CO5:	Develop the capacity to use various writing forms to achieve their professional needs.

Mapping of Course Outcomes with Program Outcomes:

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

List of Topics:

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

Suggested Software:

- Walden Infotech
- Young India Films
- Cambridge Empower

Reference Books:

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

Web Links:

Spoken English:

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

Voice & Accent:

1. https://www.youtube.com/user/letstalkaccent/videos

2.https://www.youtube.com/c/EngLanguageClub/featured

3.https://www.youtube.com/channel/UC_OskgZBoS4dAnVUgJVexc

4.www.cambridgeone.org

NUMERICAL METHODS AND TRANSFORMATION TECHNIQUES

III Semester **L T P C**
Course Code: 231BS3T03 **3 0 0 3**

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

CO 1: Evaluate the approximate roots of polynomial and transcendental equations by different algorithms. Apply Newton's forward & backward interpolation and Lagrange's formulae for equal and unequal intervals
CO 2: Evaluate the approximate roots of polynomial and transcendental equations by different algorithms. Apply Newton's forward & backward interpolation and Lagrange's formulae for equal and unequal intervals.
CO 3: Apply the Laplace transform for solving differential equations
CO 4: Find or compute the Fourier series of periodic signals
CO 5: Know and be able to apply integral expressions for the forwards and inverse Fourier transform to a range of non-periodic waveforms

Mapping of course outcomes with program outcomes:

CO/PO	PO 1	PO2	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: Iterative Methods: Introduction – Solutions of algebraic and transcendental equations: Bisection method – Secant method – Method of false position – Iteration method – Newton-Raphson method (Simultaneous Equations) Interpolation: Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula

UNIT – II: Numerical integration, Solution of ordinary differential equations with initial conditions: Trapezoidal rule– Simpson's 1/3rd and 3/8th rule– Solution of initial value problems by Taylor's series– Picard's method of successive approximations– Euler's method –Runge- Kutta method (second and fourth order) – Milne's Predictor and Corrector Method.

UNIT –III: Laplace Transforms: Definition of Laplace transform - Laplace transforms of standard functions – Properties of Laplace Transforms – Shifting theorems–Transforms of derivatives and integrals – Unit step function – Dirac's delta function – Inverse Laplace transforms – Convolution theorem (without proof). Applications: Solving ordinary differential equations (initial value problems) and integro differential equations using Laplace transforms.

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

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

Textbooks:

1. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers, 2021.
2. B. V. Ramana, Higher Engineering Mathematics, 2007 Edition, Tata Mc.Graw Hill Education.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India.
2. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineering and Science, Tata Mc. Graw Hill Education.
3. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publications.
4. Lawrence Turyn, Advanced Engineering Mathematics, CRC Press

Web Links:

1. https://www.slideshare.net/slideshow/iteration-methodsolution-of-algebraic-and-transcendental-equations/240859002
2. https://www.lkouniv.ac.in/site/writereaddata/siteContent/202004032250572068siddharth_bhatt_engg_Numerical_Solution_of_Ordinary_Differential_Equations.pdf,
3. https://people.bath.ac.uk/ensdasr/ME10305.bho/lt.notes.pdf
4. https://theengineeringmaths.com/wp-content/uploads/2017/08/fourier-1-2.pdf
5. https://www.sciencedirect.com/topics/mathematics/fourier-integral-theorem

UNIVERSAL HUMAN VALUES

III Semester **L T P C**
Course Code: 231HS3T02 **2 1 0 3**

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

CO 1: Define the terms like Natural Acceptance, Happiness and Prosperity
CO 2: Identify one's self, and one's surroundings (family, society nature)
CO 3: Apply what they have learnt to their own self in different day-to-day settings in real life
CO 4: Relate human values with human relationship and human society
CO 5: Justify the need for universal human values and harmonious existence

Mapping of course outcomes with 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	CO1	-	-	-	-	-	-	2	1	1	-	-
CO2	CO2	-	-	-	-	-	-	2	1	1	-	-
CO3	CO3	-	-	-	-	-	-	2	1	1	-	-
CO4	CO4	-	-	-	-	-	-	2	1	1	-	-
CO5	CO5	-	-	-	-	-	-	2	1	1	-	-

Mapping of course outcomes with program Specific Outcomes:

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

UNIT I:
Introduction to Value Education (6 lectures and 3 tutorials for practice session)
Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)
Lecture 2: Understanding Value Education
Tutorial 1: Practice Session PS1 Sharing about Oneself
Lecture 3: self-exploration as the Process for Value Education
Lecture4: Continuous Happiness and Prosperity – the Basic Human Aspirations
Tutorial 2: Practice Session PS2 Exploring Human Consciousness
Lecture 5: Happiness and Prosperity – Current Scenario
Lecture 6: Method to Fulfil the Basic Human Aspirations
Tutorial 3: Practice Session PS3 Exploring Natural Acceptance

UNIT II:
Harmony in the Human Being (6 lectures and 3 tutorials for practice session)
Lecture 7: Understanding Human being as the Co-existence of the self and the body.
Lecture 8: Distinguishing between the Needs of the self and the body
Tutorial 4: Practice Session PS4 Exploring the difference of Needs of self and body.
Lecture 9: The body as an Instrument of the self
Lecture 10: Understanding Harmony in the self
Tutorial 5: Practice Session PS5 Exploring Sources of Imagination in the self

Lecture 11: Harmony of the self with the body
Lecture 12: Programme to ensure self-regulation and Health
Tutorial 6: Practice Session PS6 Exploring Harmony of self with the body

UNIT III:
Harmony in the Family and Society (6 lectures and 3 tutorials for practice sessions)
Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction
Lecture 14: 'Trust' – the Foundational Value in Relationship
Tutorial 7: Practice Session PS7 Exploring the Feeling of Trust
Lecture 15: 'Respect' – as the Right Evaluation
Tutorial 8: Practice Session PS8 Exploring the Feeling of Respect
Lecture 16: Other Feelings, Justice in Human-to-Human Relationship
Lecture 17: Understanding Harmony in the Society
Lecture 18: Vision for the Universal Human Order
Tutorial 9: Practice Session PS9 Exploring Systems to fulfil Human Goal

UNIT IV:
Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session)
Lecture 19: Understanding Harmony in the Nature
Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature
Lecture 21: Realizing Existence as Co-existence at All Levels
Lecture 22: The Holistic Perception of Harmony in Existence
Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence.

UNIT V:
Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)
Lecture 23: Natural Acceptance of Human Values
Lecture 24: Definitiveness of (Ethical) Human Conduct
Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct
Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
Lecture 26: Competence in Professional Ethics
Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education
Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies
Lecture 28: Strategies for Transition towards Value-based Life and Profession
Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order
Practice Sessions for UNIT I – Introduction to Value Education PS1 Sharing about Oneself
PS2 Exploring Human Consciousness PS3 Exploring Natural Acceptance
Practice Sessions for UNIT II – Harmony in the Human Being PS4 Exploring the difference of Needs of self and body
PS5 Exploring Sources of Imagination in the self PS6 Exploring Harmony of self with the body
Practice Sessions for UNIT III – Harmony in the Family and Society PS7 Exploring the Feeling of Trust
PS8 Exploring the Feeling of Respect
PS9 Exploring Systems to fulfil Human Goal
Practice Sessions for UNIT IV – Harmony in the Nature (Existence) PS10 Exploring the Four Orders of Nature
PS11 Exploring Co-existence in Existence
Practice Sessions for UNIT V – Implications of the Holistic Understanding – a Look at Professional Ethics
PS12 Exploring Ethical Human Conduct
PS13 Exploring Humanistic Models in Education
PS14 Exploring Steps of Transition towards Universal Human Order

Textbooks:

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. R R Gaur, R Asthana, G P Bagaria,Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2.

Reference Books:

1. JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

Weblinks:

1. https://fdp-si.aicte-india.org/UHV- II%20Class%20Notes%20&%20Handouts/UHV%20Handout%201-Introduction%20to%20Value%20Education.pdf
2. https://fdp-si.aicte-india.org/UHV- II%20Class%20Notes%20&%20Handouts/UHV%20Handout%202-Harmony%20in%20the%20Human%20Being.pdf
3. https://fdp-si.aicte-india.org/UHV- II%20Class%20Notes%20&%20Handouts/UHV%20Handout%203-Harmony%20in%20the%20Family.pdf
4. https://fdp-si.aicte-india.org/UHV%201%20Teaching%20Material/D3-S2%20Respect%20July%2023.pdf
5. https://fdp-si.aicte-india.org/UHV- II%20Class%20Notes%20&%20Handouts/UHV%20Handout%205-Harmony%20in%20the%20Nature%20and%20Existence.pdf
6. https://fdp-si.aicte-india.org/download/FDPTeachingMaterial/3-days%20FDP-SI%20UHV%20Teaching%20Material/Day%203%20Handouts/UHV%203D%20D3-S2A%20Und%20Nature-Existence.pdf
7. https://fdp-si.aicte- india.org/UHV%20II%20Teaching%20Material/UHV%20II%20Lecture%2023-25%20Ethics%20v1.pdf
8. https://www.studocu.com/in/document/kiet-group-of-institutions/universal-human- values/chapter-5-holistic-understanding-of-harmony-on-professional-ethics/62490385
9. https://onlinecourses.swayam2.ac.in/aic22_ge23/preview

PRINCIPLES OF GEOLOGY FOR PETROLEUM ENGINEERS

		L	T	P	C
III Semester					
Course Code:	**231PT3T01**	**3**	**0**	**0**	**3**

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

CO 1: Explain the general facts and principles of the earth.
CO 2: Analyze the different processes for the formation of landforms.
CO 3: Analyze the different erosion cycles and their products.
CO 4: Compare and classify various kinds of rocks.
CO 5: Explain how basins and deltas are formed

Mapping of course outcomes with program outcomes:

CO/PO	PO 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	3	-	-	-	-	-	2	-	-	-	2	-
CO5	2	-	-	-	-	-	2	-	-	-	2	-

Mapping of course outcomes with program Specific Outcomes:

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

UNIT-I:
Origin and Evolution of Earth: Dimensions, origin, internal structure of the earth -- crust, mantle, core. Internal dynamic process- Plate tectonics, Continental drift, Earthquake and Volcanoes. External dynamic process – weathering-erosion-deposition. Principles of stratigraphy.

UNIT-II:
Geomorphology: Fundamental concepts in Geomorphology, geomorphic processes and distribution of landforms-drainage patterns –development, Landforms in relation to rock types, paleochannels, buried channels.

UNIT-III:
Rock Cycles and Structural Geology: Geological work of rivers, wind, ocean, glaciers, and their landforms. Study of structures: folds, faults, joints, and unconformities.

UNIT-IV:
Petrology: Origin of igneous, sedimentary, and metamorphic rocks. Sedimentology - Sedimentary structures-petrographic characters of conglomerate, sandstone, shale, and limestone.

UNIT-V:

Sedimentary Basins and Paleontology: Introduction to sedimentary basins and deltaic systems; Topographic maps, Thematic maps, and their profiles. Paleontology-Micropaleontology-Palyonology and its importance in oil exploration

Textbooks:

1. Engineering Geology, Bell, F.G., 2nd Edition, Butter worth Heimann.
2. Principles of Engineering Geology, Bangar, K.M., 2nd Edition, Standard Publishers.

Reference Books:

1. Elements of Mineralogy, Gribble, C. D., Rutley's, 27th Edition. CBS Publishers.
2. Principles of Physical Geology, David Duff, Homes, Nelson Thornes Ltd; 4th Revised edition.
3. Textbook of Physical Geology, Mahapatra, G.B., CBS Publishers.
4. Textbook of Geology, Mukherjee, P.K., The World Press Pvt. Ltd.

Web Links:

1. web.crc.losrios.edu/~jacksoh/classes/earthscience/Chapter1.pdf
2. science.jrank.org/pages/3820/Landform.html
3. www.manitoba.ca/iem/min-ed/kidsrock/origins/index.html
4. https://ocw.mit.edu/courses/earth-atmospheric-and.../12...sedimentary .../ch11. pdf
5. www.ucmp.berkeley.edu/fosrec/ONeill.html

MATERIAL AND ENERGY BALANCES

III Semester		**L**	**T**	**P**	**C**
Course Code:	**231PT3T02**	**3**	**0**	**0**	**3**

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

CO 1: Apply the unit conversion fundamentals in process calculations.
CO 2: Formulate and solve elementary material balances in physical and chemical processes.
CO 3: Formulate and solve elementary energy balances in reactive and non-reactive processes.
CO 4: Impart the thermodynamics in process calculations.
CO 5: Apply the concepts and solve combustion calculations' combined material and energy balances

Mapping of course outcomes with program outcomes:

CO/PO	PO 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	2	2	-	-	-	-	2	-	-	-	2	-
CO3	3	2	-	-	-	-	2	-	-	-	2	-
CO4	3	2	-	-	-	-	2	-	-	-	2	-
CO5	2	2	-	-	-	-	2	-	-	-	2	-

Mapping of course outcomes with program Specific Outcomes:

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

UNIT-I:
Stoichiometric relations: Basis of calculations, Methods of expressing compositions of mixtures and solutions, density and specific gravity, Baume and API gravity scales, Units and interconversions
Behavior of Ideal gases: Kinetic theory of gases, Application of ideal gas law, Gaseous mixtures, Gases in chemical reactions.

UNIT-II:
Vapor Pressure and Vapor Liquid Equilibrium: Liquefaction and liquid state, vaporization, boiling point, Effect of temperature on vapor pressure, Antoine equation, Vapor pressure plots (ternary), Estimation of critical properties, Vapor pressure of immiscible liquids and ideal solutions, Raoult's law, Non-volatile solutes.
Humidity and Saturation: Relative and percentage saturation or dew point, wet bulb and dry bulb temperature, Use of humidity charts for engineering calculations

UNIT-III:
Material balances: Tie components, Yield, Material Balance with and without reaction, Conversion. Material balance calculations in simple drying, dissolution and crystallization processes. Processes involving chemical reactions. Processes involving recycles, bypass, purge and other complexities. Calculations using MS EXCEL/MATLAB.

UNIT-IV:

Energy Balances: Energy, energy balances, the Heat capacity of gases, liquid and mixture solutions. Kopp's rule, Latent heat, Heat of fusion and Heat of vaporization, Trouton's rule, Kistyakowsky equation for nonpolar liquids enthalpy and its evaluation. Calculation and applications of heat of reaction, combustion, formation and neutralization, Kirchoff's equation, enthalpy concentration change, calculation of theoretical and actual flame temperatures. Calculations using MS EXCEL/MATLAB.

UNIT-V:

Combustion Calculations: Introduction to fuels, Calorific value of fuels, coal, liquid fuels, Gaseous fuels, air requirement and flue gases, Combustion calculations, incomplete combustion, Material and energy balances, Thermal efficiency calculations using MS EXCEL/MATLAB.

Textbooks:

1. Chemical Process Principles, Part -I, Material and Energy Balances, Hougen O A, Watson K. M. and Ragatz R.A., 2nd Edition, CBS Publishers & distributors, New Delhi.
2. Basic Principles and Calculations in Chemical Engineering, D.H. Himmelblau, 7th Edition. PHI, New Delhi.

Reference Books:

1. Elementary Principles of Chemical Processes, R. M. Felder and R. W. Rousseau, 3rd Ed., Wiley.
2. Handbook Chemical Engineering Calculations, N. Chopey, 3rd Edition, Mc-Graw Hill.
3. Stoichiometry, Bhatt, B. I., Thakore S. B., 5th Ed., Tata Mc-Graw Hill Education.
4. Stoichiometry and Process Calculations, K. V. Narayanana and B. Lakshmikutty, PHI Learning Private Ltd.
5. Principles of Chemical Engineering processes: Material and Energy balances, Nayef Ghasem and R. Henda, 2nd Edition, CRC Press.

Web Links:

1. https://www.docsity.com/en/introduction-chemical-process-principles-and-calculations-lecture-notes/394277/
2. https://chem.libretexts.org/LibreTexts/University_of_Missouri/UM%3A_Chem_1320_(Keller)/10%3AGases/10.9%3A_Real_Gases_Deviations_from_Ideal_Behavior
3. http://chem-guide.blogspot.in/2010/03/ideal-and-real-gases.html
4. http://www.sanfoundry.com/chemical-engineering-questions-answers-material-balances-involving-combustion/
5. https://www.ohio.edu/mechanical/thermo/Applied/Chapt.7_11/Chapter11.html

FLUID MECHANICS FOR PETROLUM ENGINEERS

III Semester		**L**	**T**	**P**	**C**
Course Code:	**231PT3T03**	**3**	**0**	**0**	**3**

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

CO 1: Apply the concept of dimensional analysis for fluid flow and estimate fluid properties
CO 2: Apply continuity, momentum and energy equations for fluid flow systems and perform calculations involving Bernoulli's equation.
CO 3: Carryout calculations associated with the estimation of friction factor and pressure drop in the circular and non-circular conduits as well as the flow past solids
CO 4: Apply basic concepts of fluidization and to estimate pressure drop in packed and fluidized beds.
CO 5: Design and selection of pumps, fans & blowers and calculate, and analyze the performance of flow measuring devices.

Mapping of course outcomes with program outcomes:

CO/PO	PO 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	2	2	-	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-

Mapping of course outcomes with program Specific Outcomes:

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

UNIT-I:
Basic concepts of dimensional analysis, nature of fluids, hydrostatic equilibrium, applications of fluid statics. Fluid flow phenomena-laminar flow, shear rate, shear stress, rheological properties of fluids. Difference between flow through pipes and porous media.

UNIT-II:
Basic equation of fluid flow –mass balance in a flowing fluid; continuity, differential momentum balance; equations of motion, macroscopic momentum balances, mechanical energy equations. Incompressible Newtonian/non-Newtonian flow in pipes and channels- shear stress and skin friction in pipes, laminar flow in pipes and channels, turbulent flow in pipes and channels, friction from changes in velocity or direction, losses in pipes.

UNIT-III:
Flow past immersed bodies, drag and drag coefficient, flow through beds of solids, motion of particles through fluids. Fluidization, conditions for fluidization, minimum fluidization velocity, types of fluidizations, expansion of fluidized bed, applications of fluidization, continuous fluidization, slurry and pneumatic transport.

UNIT-IV:

Transportation and metering of fluids- pipes, fittings and valves, pumps: positive displacement and centrifugal pumps. Measurement of flowing fluids: full bore meters, insertion meters; venturi meter, rotameter, orifice meter, hot wire anemometer, Pitot tube, and other flow metering devices.

UNIT-V:

Flow of compressible fluids- definitions and basic equations, processes of compressible flow, isentropic flow through nozzles, adiabatic frictional flow, and isothermal frictional flow. Compressors, fans, blowers, steam ejectors and jets. Flow through porous media and application of Darcy's law.

Textbooks:

1. Unit Operations of Chemical Engineering, McCabe,W.L., J.C.Smith& Peter Harriot McGraw-Hill, 7th Edition.
2. Fluid mechanics for Petroleum Engineers, Elemer Bobok, Elsevier.

Reference Books:

1. Introduction to Fluid Mechanics, Fox, R.W. and A. T. McDonald, 5th Edition, John Wiley& Sons.
2. Transport Processes and Unit Operations, Christie J. Geankoplis, PHI,
3. Chemical Engineering, Vol-1: Fluid flow, Heat Transfer and Mass Transfer, J. M. Coulson and J. F. Richardson, Pergamon Press, 4th Edition.
4. Fluid Mechanics for Chemical Engineers, Noel De Nevers, Tata McGraw-Hill.
5. Fluid Flow for Chemical and Process Engineers, Bragg R and F. A. Holland, 2nd Edition, Hodder Stoughton Educational.
6. Fluid Flow for the Practicing Chemical Engineer, Patrick Abulencia, J and Louis Theodore, John wiley and Sons.

Web Links:

1. www.mhhe.com/engcs/chemical/mccabe/graphics/toc.pdf
2. www.unimasr.net/ums/.../UniMasr.com_919e27ecea47b46d74dd7e268097b653.pdf
3. home.zcu.cz/~kovarikp/MT/freestudy/FLUID.../FLUID_MECHANICS_D203.pdf
4. https://www.coursehero.com
5. www.qzu.zj.cn/hgx/jpkc/hgyl/kj/huagongyuanli/syjx/801.html

PRINCIPLES OF GEOLOGY FOR PETROLEUM ENGINEEERS LAB

III Semester **L T P C**
Course Code: 231PT3L01 **0 0 3 1.5**

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

CO 1: Preparation of geological maps using litho-stratigraphic columns
CO 2: Find out strike and dip in different geological locations.
CO 3: Calculate the thickness of beds.
CO 4: Make use of the maps to study the reservoir area and find out the oil-water contact.
CO 5: Identify different types of rocks.

Mapping of course outcomes with program outcomes:

CO/PO	PO 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	-	-	-	-	-	3
CO2	3	-	-	-	2	2	-	-	-	-	-	3
CO3	2	-	-	-	2	2	-	-	-	-	-	3
CO4	3	-	-	-	2	2	-	-	-	-	-	3
CO5	2	-	-	-	2	2	-	-	-	-	-	3

Mapping of course outcomes with program Specific Outcomes:

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

List of Experiments:
1. Location of observed outcrops on the Toposheet.
2. Preparation of geological map of the area.
3. Measurement of the strike.
4. Measurement of dip.
5. Measurement of apparent and true thickness of the outcrops.
6. Preparation of geological contour map and its profile.
7. Study of important rock-forming minerals.
8. Study of igneous rocks.
9. Study of sedimentary rocks.
10. Study of metamorphic rocks.

Reference Books:
1. Elements of Mineralogy, Gribble, C. D., Rutley's, 27th Edition. CBS Publishers.
2. Principles of Physical Geology, David Duff, Homes, Nelson Thornes Ltd; 4thRevised edition.
3. Textbook of Physical Geology, Mahapatra, G.B., CBS Publishers.
4. Principles of Engineering Geology, Bangar, K.M., 2nd Edition, Standard Publishers.

Web Links:
1. science.jrank.org/pages/3820/Landform.html
2. www.manitoba.ca/iem/min-ed/kidsrock/origins/index.html
3. https://ocw.mit.edu/courses/earth-atmospheric-and.../ 12...sedimentary .../ch11. Pdf

FLUID MECHANICS FOR PETROLUM ENGINEERS LAB

III Semester **L T P C**
Course Code: 231PT3L02 **0 0 3 1.5**

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

CO 1: Determine the discharge coefficients of orifice and venturi metres as well as notches.
CO 2: Measure the point velocity using pitot tube
CO 3: Estimate the skin and form frictional losses in pipes and fittings
CO 4: Estimate the mechanical efficiency of centrifugal pump.
CO 5: Determination of terminal velocity of a particle using Stoke's law

Mapping of course outcomes with program outcomes:

CO/PO	PO 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	2	-	-	-	-	-	-	-	2	2	-	2
CO3	3	-	-	-	-	-	-	-	2	2	-	2
CO4	3	-	-	-	-	-	-	-	2	2	-	2
CO5	3	-	-	-	-	-	-	-	2	2	-	2

Mapping of course outcomes with program Specific Outcomes:

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

List of Experiments:

1. Identification of laminar and turbulent flows; Major equipment – Reynolds apparatus

2. Measurement of point velocities; Major equipment - Pitot tube setup

3. Verification of Bernoulli's equation; Major equipment – Bernoulli's Apparatus

4. Calibration of Rotameter; Major equipment – Rotameter Assembly

5. Variation of Orifice coefficient with Reynolds Number; Major equipment -Orifice meter Assembly.

6. Determination of Venturi coefficient; Major equipment – Venturi meter Assembly

7. Friction losses in Fluid flow in pipes; Major equipment - Pipe Assembly with provision for Pressure measurement

8. Pressure drop in a packed bed for different fluid velocities; Major equipment - Packed bed with Pressure drop measurement

9. Pressure drop and void fraction in a fluidized bed; Major equipment -Fluidized bed with Pressure drop measurement

10.Studying the coefficient of contraction for a given open orifice; Major equipment - Open Orifice Assembly

11.Studying the coefficient of discharge in a V-notch; Major equipment - V-notch Assembly

12.Studying the Characteristics of a centrifugal pump; Major equipment -Centrifugal Pump

13.Viscosity determination using Stoke's law; Major equipment – Terminal Velocity determination column.

Reference Books:

1. Introduction to Fluid Mechanics, Fox, R.W. and A.T.Mc.Donald, 5th Edition, John Wiley & Sons.
2. Chemical Engineering, Vol-1: Fluid flow, Heat Transfer and Mass Transfer, J.M.Coulson and J.F.Richardson, Pergamon Press, 4th Edition.
3. Fluid Mechanics for Chemical Engineers, Noel De Nevers, Tata McGraw-Hill.
4. Fluid Flow for Chemical and Process Engineers, Bragg R and F. A. Holland, 2nd Edition, Hodder Stoughton Educational.
5. Fluid Flow for the Practicing Chemical Engineer, Patrick Abulencia, J and Louis Theodore, John Wiley and Sons.

Web Links:

1. www.mhhe.com/engcs/chemical/mccabe/graphics/toc.pdf
2. www.unimasr.net/ums/.../UniMasr.com_919e27ecea47b46d74dd7e268097b653.pdf
3. home.zcu.cz/~kovarikp/MT/freestudy/FLUID.../FLUID_MECHANICS_D203.pdf
4. https://www.coursehero.com
5. www.qzu.zj.cn/hgx/jpkc/hgyl/kj/huagongyuanli/syjx/801.htm

PYTHON PROGRAMMING
(Skill Oriented Course-I)

III Semester **L T P C**
Course Code: 231CS3S01 **0 1 2 2**

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

CO1: Develop programs using fundamental concepts in python
CO2: Develop programs using Functions & Strings.
CO3: Develop programs using Dictionaries
CO4: Apply Object Oriented Programming concepts and files to Develop real time applications
CO5: Develop DS programs using Python

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

List of Experiments:
1. Basic Programs
1.1) Write a program that asks the user for a weight in kilograms and converts it to pounds. There are 2.2 pounds in a kilogram.
1.2) Write a program that asks the user to enter three numbers (use three separate input statements). Create variables called total and average that hold the sum and average of the three numbers and print out the values of total and average.
1.3) Write a program that asks the user for two numbers and prints Close if the numbers are within .001 of each other and Not close otherwise.

2. Control Flow
2.1) Write a program that uses a for loop to print the numbers 8, 11, 14, 17, 20, . . .83, 86, 89.
2.2) Write a program that asks the user for their name and how many times to print it. The program should print out the user's name the specified number of times
2.3) Write a program to find the given number is Armstrong number or not.

3. Control Flow Continued
3.1) Use a for loop to print a triangle like the one below. Allow the user to specify how high the triangle should be.

*
**
***
****
3.2) Generate a random number between 1 and 10. Ask the user to guess the number and print a message based on whether they get it right or not.
3.3) Write a program to convert a given number into a given base.
Note: Convert the given number into a string in the given base. Valid base is 2<=base<=36 Raise exceptions similar to how int ("XX", YY) does (play in the console to find what errors it raises). Handle negative numbers just like bin and oct do.

4. Strings
4.1) Write a program that asks the user to enter a word and prints out whether that word contains any vowels.
4.2) Write a program that asks the user to enter two strings. The program should then check to see if the strings are of the same length. If they are not, the program should print an appropriate message and exit. If they are of the same length, the program should alternate the characters of the two strings and print the strings character-wise alternatively. For example, if the user enters abcde and ABCDE the program should print out AaBbCcDdEe
4.3) Write a program that asks the user for a large integer and inserts commas into it according to the standard American convention for commas in large numbers. For instance, if the user enters 1000000, the output should be 1,000,000.

5. Data structure
5.1) Write a program that generates a list of 20 random numbers between 1 and 100.
(a) Print the list.
(b) Print the average of the elements in the list.
(c) Print the largest and smallest values in the list.
(d) Print the second largest and second smallest entries in the list
(e) Print how many even numbers are in the list.
5.2) Write a program that asks the user for an integer and creates a list that consists of the factors of that integer.
5.3) Write a program that generates 100 random integers that are either 0 or 1. Then find the longest run of zeros, the largest number of zeros in a row. For instance, the longest run of zeros in [1,0,1,1,0,0,0,0,1,0,0] is 4.

6. Data Structure-Continued
6.1) Write a program that removes any repeated items from a list so that each item appears at most once. For instance, the list [1,1,2,3,4,3,0,0] would become [1,2,3,4,0].
6.2) Write a python script to perform following operations:
i) Create a matrix and print it
ii) Perform Addition of 2 matrices
iii) Perform multiplication of 2 matrices
6.3) Write a program to sort given list of strings in the order of their vowel counts.

7. Functions
7.1) Write a function called sum_digits that is given an integer num and returns the sum of the digits of num.
7.2) Write a function called first_diff that is given two strings and returns the first location in which the strings differ. If the strings are identical, it should return -1.
7.3) Write a function called number_of_factors that takes an integer and returns how many factors the number has.
7.4) Write a function called is_sorted that is given a list and returns True if the list is sorted and False otherwise.

8. Functions-Continued
8.1) Write a function called root that is given a number x and an integer n and returns x1/n . In the function definition, set the default value of n to 2.
8.2) Write a function called primes that is given a number n and returns a list of the first n primes. Let the default value of n be 100.

8.3) Write a function called merge that takes two already sorted lists of possibly different lengths, and merges them into a single sorted list.
(a) Do this using the sort method.
(b) Do this without using the sort method
8.4) Write a program that asks the user for a word and finds all the smaller words that can be made from the letters of that word. The number of occurrences of a letter in a smaller word can't exceed the number of occurrences of the letter in the user's word.

9. Files
9.1) Write a program that reads a file consisting of email addresses, each on its own line. Your program should print out a string consisting of those email addresses separated by semicolons.
9.2) Write a program that reads a list of temperatures from a file called temps.txt, converts those temperatures to Fahrenheit, and writes the results to a file called ftemps.txt.
9.3) Write a program to count frequency of characters in a given file.

10. OOP
10.1) Write a class called Product. The class should have fields called name, amount, and price, holding the product's name, the number of items of that product in stock, and the regular price of the product. There should be a method get_price that receives the number of items to be bought and returns a the cost of buying that many items, where the regular price is charged for orders of less than 10 items, a 10% discount is applied for orders of between 10 and 99 items, and a 20% discount is applied for orders of 100 or more items. There should also be a method called make_purchase that receives the number of items to be bought and decreases amount by that much.
10.2) Write a class called Time whose only field is a time in seconds. It should have a method called convert_to_minutes that returns a string of minutes and seconds formatted as in the following example: if seconds is 230, the method should return '5:50'. It should also have a method called convert_to_hours that returns a string of hours, minutes, and seconds formatted analogously to the previous method.
10.3) Write a class called Converter. The user will pass a length and a unit when declaring an object from the class—for example, c = Converter (9,'inches'). The possible units are inches, feet, yards, miles, kilo meters, meters, centi meters, and milli meters. For each of these units there should be a method that returns the length converted into those units. For example, using the Converter object created above, the user could call c. feet() and should get 0.75 as the result.

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

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://www.hackerrank.com/

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:
- Cambridge Empower
- Young India Films
- Walden Infotech

Textbooks:

1. Cambridge Empower – Second Edition B2 Level

Reference Books:

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

Web Links:

Spoken English:

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

Voice & Accent:

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

COMPLEX VARIABLES, PROBABILITY & STATISTICS

		L	T	P	C
IV Semester		**L**	**T**	**P**	**C**
Course Code:	**231BS4T01**	**3**	**0**	**0**	**3**

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

CO 1: Apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic and find the differentiation and integration of complex functions used in engineering problems.
CO 2: Make use of the Cauchy residue theorem to evaluate certain integrals.
CO 3: Apply discrete and continuous probability distributions.
CO 4: Design the components of a classical hypothesis test.
CO 5: Infer the statistical inferential methods based on small and large sampling 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	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/PSO	PSO 1	PSO 2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

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

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

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

UNIT – IV:

Sampling Theory: Introduction – Population and Samples – Sampling distribution of Means and Variance (definition only) – Central limit theorem (without proof) – Representation of the normal theory distributions – Introduction to t, χ^2 and F-distributions – Point and Interval estimations – Maximum error of estimate.

UNIT – V:

Tests of Hypothesis: Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors – Level of significance – One tail and two-tail tests – Test of significance for large samples: Single and two means – Single and two proportions – Student's t- distribution: Significance test of a sample mean – Significance test of difference between sample means.

Text Books:

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

Reference Books:

1. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 9th edition, Mc-Graw Hill.
2. S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications.
3. Jay l. Devore, Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage.
4. Shron L. Myers, Keying Ye, Ronald E Walpole, Probability and Statistics Engineers and the Scientists, 8th Edition, Pearson 2007.
5. Sheldon, M. Ross, Introduction to probability and statistics Engineers and the Scientists, 4th Edition, Academic Foundation, 2011

Web Links:

1. https://en.wikipedia.org/wiki/Complex_analysis
2. http://www.nptel.ac.in/courses/111103070/
3. https://en.wikipedia.org/wiki/Probability_and_statistics
4. http://nptel.ac.in/courses/111105041/1

MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS

		L	T	P	C
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:

CO 1: Define the concepts related to Managerial Economics, financial accounting and management.
CO 2: Apply the Concept of Production cost and revenues for effective Business decision
CO 3: Analyze how to invest their capital and maximize returns
CO 4: Evaluate the capital budgeting techniques
CO 5: Develop the accounting statements and evaluate the financial performance of business entity.

Mapping of course outcomes with program outcomes:

CO/PO	PO 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: 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 Isocosts, MRTS -Cobb-Douglas Production Function - Laws of Returns - Internal and External Economies of scale. Cost & Break-Even Analysis - Cost concepts and Cost behaviour-Break-Even Analysis (BEA)-Determination of Break- Even Point (Simple Problems)-Managerial significance and limitations of Break- Even Analysis.
UNIT-III: Business Organizations and Markets:
Introduction–Nature, meaning, significance, functions and advantages. 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, functions and advantages. 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 Return (ARR) Net Present Value (NPV), Internal Rate Return (IRR), Method (sample problems).

UNIT-V Financial Accounting and Analysis:

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

Textbooks:

1. Varshney &Maheswari: Managerial Economics, Sultan Chand.

Reference Books:

1. Managerial Economics: Principles and Worldwide Applications, 9E (Adaptation) by Dominick Salvatore and Siddhartha Rastogi
2. Managerial Economics: Principles and Worldwide Applications by Dominick Salvatore.

Web Links:

1. www.managementstudyguide.com
2. www.tutorialspoint.com
3. https://www.indeed.com/career-advice/career-development/business-market
4. https://www.investopedia.com/terms/c/capitalbudgeting.asp#:~:text=Capital%20budgeting%20is%20used%20by,return%20meets%20a%20set%20benchmark.
5. https://onlinecourses.swayam2.ac.in/imb23_mg35/preview

THERMODYNAMICS FOR PETROLEUM ENGINEERS

		L	T	P	C
IV Semester					
Course Code:	**231PT4T01**	**3**	**0**	**0**	**3**

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

CO 1: Apply the laws of thermodynamics and their application to petroleum engineering systems.
CO 2: Apply the volumetric properties, thermodynamic property relations and equations of states to the pure substances.
CO 3: Apply the second law of thermodynamics and their application to petroleum engineering systems.
CO 4: Assess the requirement of properties of pure fluids and their mixtures to the analysis of petroleum systems.
CO 5: Apply the concepts of Vapor Liquid–Liquid Equilibrium (VLLE), Solid-Liquid Equilibrium (SLE), Solid-Vapor Equilibrium (SVE) and equilibrium adsorption of gases on solids to petroleum 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	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/PSO	PSO 1	PSO 2
CO1	2	-
CO2	2	-
CO3	2	-
CO4	2	-
CO5	2	-

UNIT-I:
Introduction: The scope of thermodynamics, defined quantities; temperature, volume, pressure, work, energy, heat, Joules experiments, SI units.
The first law and other basic concepts: The first law of thermodynamics, thermodynamic state and state functions, enthalpy, The steady-state steady flow process, equilibrium, the reversible process, constant-V and constant- P processes, heat capacity.

UNIT-II:
Volumetric properties of pure fluids: The PVT behavior of pure substances, virial equations, the ideal gas, the applications of the virial equations, cubic equations of state, generalized correlations for gases. Estimation of compressibility factors for Natural Gas.

UNIT-III:
The second law of thermodynamics: Statements of the second law, heat engines, thermodynamic temperature scales, thermodynamic temperature and the ideal-gas scale, entropy, entropy changes of an ideal gas, mathematical statement of the second law, the third law of thermodynamics, calculation of ideal work and lost work, examples on thermodynamic behavior of oil and natural gas under reservoir conditions.

UNIT-IV:

Thermodynamic properties of fluids: Property relations for homogeneous phases, residual properties, two phase systems, thermodynamic diagrams, tables of thermodynamic properties, generalized property correlations for gases. Viscosity of petroleum fluids.

Thermodynamics of flow processes: Principles of conservation of mass and energy for flow systems, analysis of expansion processes; turbines, throttling, compression processes, compressors and pumps.

UNIT-V:

Solution thermodynamics: Basic concepts of chemical potential, phase equilibria, partial properties, fugacity coefficient, residual and excess Gibbs free energy, correlations for the estimation of fugacity coefficient, residual and excess Gibbs energy in vapor liquid equilibria.

Phase Equilibria: Gamma/Phi formulation of VLE, VLE from Virial Equations of State and cubic equations of state, introduction to Vapor- Liquid–Liquid Equilibrium (VLLE), Solid- Liquid Equilibrium (SLE) and Solid-Vapor Equilibrium (SVE), Equilibrium adsorption of gases on solids. Flash Vapourization.

Textbooks:

1. Introduction to Chemical Engineering Thermodynamics, Smith, J. M., H. C. Van Ness and M.M. Abbott, 6th Edition, 8th reprint, McGraw Hill.

Reference Books:

1. Characterization and Properties of Petroleum Fractions, M. R. Riaze, ASTM, International.
2. Equation of State and PVT analysis, Tarek Ahmed, Gulf publishing company.
3. Engineering and Chemical Thermodynamics, Koretsky, M. D., John Wiley & Sons.
4. Introductory Chemical Engineering Thermodynamics, Richard Elliott, J. and Carl T. Lira, 2nd Edition, Prentice Hall.

Web Links:

1. http://achemes.weebly.com/uploads/9/0/7/4/9074935/unit_1_the_first_law_and_otherbasic_concepts.pdf
2. http://nptel.ac.in/courses/103101004/
3. http://www.msubbu.in/ln/td/Thermo-II-Lecture-2-SolutionThermo.pdf
4. https://ceng.tu.edu.iq/ched/images/lectures/chem-lec/st3/c4/lecture%205.pdf
5. https://ceng.tu.edu.iq/ched/images/lectures/chem-lec/st3/c4/lecture%2016.pdf

HEAT TRANSFER OPERATIONS

IV Semester **L T P C**
Course Code: 231PT4T02 **3 0 0 3**

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

CO 1: Apply the fundaments of heat transfer in process Industries. Differentiate the modes of heat transfer, steady and unsteady state heat conduction
CO 2: Apply the principles of convection to heat transfer operations LMTD
CO 3: Analyze the phenomena of heat transfer by conduction, convection.
CO 4: Explain the effect of natural convection and radiation
CO 5: Carry out the detailed process design of shell and tube heat exchangers design various heat transfer equipment and evaporation

Mapping of course outcomes with program outcomes:

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

Mapping of course outcomes with program Specific Outcomes:

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

UNIT-I:
Importance of heat transfer in process Industries and Conduction: Nature of heat flow, Modes of heat transfer, Fourier's law, Thermal conductivity and its variation with temperature.
Steady state: heat conduction through plane wall, composite wall, sphere and cylinder, resistance in series.
Unsteady state heat conduction**:** Equation for one-dimensional conduction with constant surface temperature and varying surface temperature; Semi-infinite solid.

UNIT-II:
Principles of heat flow in fluids: Typical heat exchange equipment, counter current and parallel current flows, energy balances, rate of heat transfer, overall heat transfer coefficient, electrical analogy, critical radius of insulation, logarithmic mean temperature difference. Variable overall coefficient, multi-pass in exchangers, individual heat transfer coefficients, resistance form of overall coefficient, fouling factors, classification of individual heat transfer coefficients, magnitudes of heat transfer coefficients, effective coefficients for unsteady-state heat transfer

UNIT-III:
Heat Transfer to Fluids without Phase change: Regimes of heat transfer in fluids, thermal boundary layer, heat transfer by forced convection in laminar flow, heat transfer by forced convection in turbulent flow, the transfer of heat by turbulent eddies. Analogy between transfer of momentum and heat, heat transfer to liquid metals, heating and cooling of fluids in forced convection outside tubes.
Heat transfer to fluids with phase change: Heat transfer from condensing vapors, heat transfer to boiling liquids.

UNIT-IV:

Natural convection: Natural convection to air from vertical shapes and horizontal planes, effect of natural convection in laminar flow heat transfer.

Radiation: Properties and definitions, black body radiation, real surfaces, and the grey body. Absorption of radiation by opaque solids, radiation between surfaces, radiation and shielding, combined heat transfer by conduction, convection and radiation.

UNIT-V:

Heat Exchange Equipment: General design of heat exchange equipment, heat exchangers, condensers, boilers and extended surface equipment, heat transfer in agitated vessels, scraped surface heat exchangers, heat transfer in packed beds, heat exchanger effectiveness (NTU method).

Evaporators: Types of evaporators, performance of tubular evaporator. Capacity and economy, methods of feeding, multiple effect evaporators, vapour recompression.

Textbooks:

1. Unit Operations of Chemical Engineering, McCabe, W.L., J.C Smith and Peter Harriott, 7th Edition, McGraw-Hill.
2. Process Heat Transfer, D.Q. Kern, Tata- McGraw-Hill.
3. Heat Transfer, Holman, J.P., 9th Edition, Tata McGraw-Hill.

Reference Books:

1. Heat Transfer, Y.V.C. Rao, Universities Press (India) Pvt. Ltd.
2. Schaum's Outline of Heat Transfer, Donald Pitts and L. E. Sisson, 2nd Edition, McGraw-Hill.
3. A Textbook on Heat Transfer, Sukhatme, P., 5th Edition, Universities Press (India) Pvt. Ltd.
4. Heat Transfer: Principles and Applications, Binay Dutta, K., PHI Learning.
5. Chemical Engineering: Fluid Flow, Heat Transfer and Mass Transfer, Coulson, J.M.; Richardson, J.F.; Backhurst, J.R.; Harker, J.H., Vol.1, 6th Edition, Reed Elsevier India.

Web Links:

1 http://nptel.ac.in/courses/103103032/9
2 http://www.srmuniv.ac.in/sites/default/files/downloads/unit_II_convective_heat_transfer.pdf
3 http://pages.mtu.edu/~fmorriso/cm310/lectures/2015heatlecture09.pdf
4 https://file.scirp.org/pdf/EPE20090200004_95602315.pdf

PETROLEUM GEOLOGY

IV Semester **L T P C**
Course Code: 231PT4T03 **3 0 0 3**

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

CO 1: Outline different source rocks and identify better one for oil formation.
CO 2: Analyze the different factors for the mechanism of oil migration.
CO 3: Apply the petrophysical properties of reservoir and cap rocks for oil retention.
CO 4: Build a geological model for ideal petroleum system.
CO 5: Explain the different types of sedimentary basins.

Mapping of course outcomes with program outcomes:

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

Mapping of course outcomes with program Specific Outcomes:

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

UNIT-I:
Source Rocks: Definition of source rock, Nature and type of source rocks - Claystone / shale, The process of Diagenesis, Catagenesis and Metagenesis in the formation of source rocks, Evaluation of petroleum source rock potential, Subsurface pressure temperature conditions for the generation of oil and gas from the source sediments, Oil window.

UNIT-II:
Hydrocarbon Migration: Geological framework of migration and accumulation, mechanism of primary and secondary oil migration, Free-path ways for migration, Short distance and long-distance migration, Evidence for migration, Oil and gas seepages.

UNIT-III:
Reservoir Rocks and Cap Rocks: Characteristics of Reservoir rocks. Reservoir pore space and its properties. Classification and nomenclature: Clastic Reservoir Rocks, Carbonate Reservoir Rocks, Marine and non-marine reservoir rocks, unconventional, fractured reservoir rocks, and the concept of Shale oil. Cap rocks: Definition and characteristics of cap rocks.

UNIT-IV:
Entrapment of Hydrocarbons: Classification and types of traps: Structural, stratigraphic and combination type of traps, Traps associated with salt domes. Petroleum System and its analysis.

UNIT-V:
Sedimentary Basins: Sedimentary basins -origin and classification, Types of basins and their relationship to hydrocarbon prospects. Tectonic classification, stratigraphic evolution, and hydrocarbon accumulations of the following basins: Krishna-Godavari basin, Cambay basin and Mumbai off-shore.

Text Books:

1. Geology of Petroleum, A.I. Levorsen,2nd Edition. CBS, Publishers.
2. Geology for petroleum exploration, drilling and production, Hyne, N.J.

Reference Books:

1. Elements of Petroleum Geology, Richard, C. Selley,Elsevier.

Web Links:

1. web.crc.losrios.edu/~jacksoh/classes/earthscience/Chapter1.pdf
2. science.jrank.org/pages/3820/Landform.html
3. www.manitoba.ca/iem/min-ed/kidsrock/origins/index.html
4. https://ocw.mit.edu/courses/earth-atmospheric-and.../12... sedimentary... /ch11. pdf

PETROLEUM GEOLOGY LAB

IV Semester **L T P C**
Course Code: 231PT4L01 **0 0 3 1.5**

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

CO 1: Identify source, reservoir, cap rocks and distinction between clastic and non-clastic reservoir rocks
CO 2: Measure the porosity and permeability of reservoir rocks.
CO 3: Identify different types of hydrocarbon traps and find out the oil-water contact.
CO 4: Make use of the maps to study the reservoir area.
CO 5: Construct geological model of petroleum system and make use of well logs for well correlation.

Mapping of course outcomes with program outcomes:

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

Mapping of course outcomes with program Specific Outcomes:

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

List of Experiments:
1. Megascopic identification of source rocks.
2. Megascopic identification of clastic reservoir rocks.
3. Megascopic identification of carbonate reservoir rocks.
4. Megascopic identification of cap rocks.
5. Identification of hydrocarbon traps.
6. Measurement of porosity of reservoir rocks.
7. Measurement of permeability of reservoir rocks.
8. Building geological model of a petroleum system.
9. Identification of distinction between clastic and carbonate reservoir rocks
10. Preparation of structural contour map and location of oil-water contact (OWC)

Reference Books:
1. Geology of petroleum, AL Leversen, second edition.
2. Principles of Physical Geology, David Duff, Homes, Nelson Thornes Ltd; 4thRevised edition.
3. Elements of petroleum geology, Richard C. Selley, second edition, academic press.
4. Principles of Engineering Geology, Bangar, K.M., 2nd Edition, Standard Publishers.

Web Links:
1. science.jrank.org/pages/3820/Landform.html
2. www.manitoba.ca/iem/min-ed/kidsrock/origins/index.html
3. https://ocw.mit.edu/courses/earth-atmospheric-and.../ 12...sedimentary .../ch11. Pdf

HEAT TRANSFER OPERATIONS LAB

IV Semester		**L**	**T**	**P**	**C**
Course Code:	**231PT4L02**	**0**	**0**	**3**	**1.5**

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

CO 1: Experimentally determine of thermal conductivities of composite wall and metal rod.
CO 2: Calculate the natural and forced convective heat transfer coefficients (both film and overall coefficients) from experimental data.
CO 3: Estimate the experimental critical heat flux from pool boiling of water.
CO 4: Determine the temperature distribution along the length of a pin-fin under natural and forced convection conditions
CO 5: Determine the Stefan-Boltzmann constant, emissivity of a metal plate etc.

Mapping of course outcomes with program outcomes:

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

Mapping of course outcomes with program Specific Outcomes:

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

List of Experiments:

1. Determination of total thermal resistance and thermal conductivity of composite wall.
2. Determination of thermal conductivity of a metal rod.
3. Determination of natural convective heat transfer coefficient for a vertical rod.
4. Determination of critical heat flux for pool boiling of water.
5. Determination of forced convective heat transfer coefficient for air flowing through a pipe.
6. Determination of overall heat transfer coefficient in double pipe heat exchanger.
7. Study of the temperature distribution along the length of a pin-fin under natural and forced convection conditions.
8. Estimation of un-steady state film heat transfer coefficient between the medium in which the body is cooled.
9. Determination of Stefan – Boltzmann constant.
10. Determination of emissivity of a given plate at various temperatures.

Reference Books:
1. Heat Transfer, Y.V.C. Rao, Universities Press (India) Pvt. Ltd.
2. Schaum's Outline of Heat Transfer, Donald Pitts and L. E. Sisson, 2nd Edition, McGraw-Hill.
3. A Textbook on Heat Transfer, Sukhatme, P., 5th Edition, Universities Press (India) Pvt. Ltd.
4. Heat Transfer: Principles and Applications, Binay Dutta, K., PHI Learning.
5. Chemical Engineering: Fluid Flow, Heat Transfer and Mass Transfer, Coulson, J.M.; Richardson, J.F.; Backhurst, J.R.; Harker, J.H., Vol.1, 6th Edition, Reed Elsevier India.

Web Links:
1. http://nptel.ac.in/courses/103103032/9#
2. http://www.srmuniv.ac.in/sites/default/files/downloads/unit_II_convective_heat_transfer.pdf
3. http://pages.mtu.edu/~fmorriso/cm310/lectures/2015heatlecture09.pdf

MATHEMATICAL METHODS USING NUMERICAL LAB
(Skill Oriented Course-II)

IV Semester **L T P C**
Course Code: 231PT4S01 **0 1 2 2**

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

CO 1: Apply mathematical methods using software.
CO 2: Solve simultaneous linear equations.
CO 3: Solve linear and non-linear algebraic equations
CO 4: Solve differential equations.
CO 5: Apply different software tools to solve chemical engineering 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	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/PSO	PSO 1	PSO 2
CO1	2	-
CO2	2	-
CO3	2	-
CO4	2	-
CO5	2	-

UNIT – I:
Problem-solving using mathematical software packages: Efficient problem solving, From manual solving to use of mathematical software, Categorizing problems according to solution technique used, Software usage, data presentation and visualization.
Case studies in Material and Energy Balances: Overall material and energy balances, component material and energy balances, Steady state material balances using solution of simultaneous linear equations, steady state energy balances using solution of polynomial equations.

UNIT II:
Case studies in Fluid Mechanics: Different types of fluids, flow of a fluid through pipelines – laminar flow, turbulent flow, Reynolds number, friction factor, calculation of flow rate through a pipe line, calculation of average velocity of a fluid using solution of linear and non-linear algebraic equations, pipeline networks and sizing. Flow of fluids past immersed objects – drag, calculation of terminal settling velocity using solution of non-linear algebraic equations.

UNIT III:
Case studies in Thermodynamics: Volumetric properties of pure fluids – ideal fluids, real fluids, molar volume, and compressibility factor, enthalpy, calculation of properties of fluids from cubic equations of state using solution of set of explicit equation and solution of non-linear algebraic equations.

UNIT IV:

Case studies in Heat Transfer: Modes of heat transfer, LMTD calculations, unsteady state heat transfer in one dimensional using method of lines to solve a partial differential equation that involves solution of simultaneous ordinary differential equations and explicit algebraic equations.

UNIT V:

Case studies in Chemical kinetics and Batch distillation: Solution of stiff ordinary differential equations in chemical and biochemical kinetics using solution of simultaneous ordinary differential equations, solving differential algebraic equations by using solution of system of equations of ordinary differential and implicit algebraic equations using controlled integration technique.

Textbook:

1. Problem Solving in Chemical Engineering and Biochemical Engineering with POLYMATH, Excel, and MATLAB, Michael B. Cutlip and Mordechai Shacham, Second edition, Prentice Hall International Series.

Reference Books:

1. Chemical Process Principles: Part-I Material and Energy Balances, O. A. Hougen, K. M. Watson and R. A. Ragatz, 2nd edition, CBS Publishers & distributors, New Delhi.
2. Unit Operations of Chemical Engineering, McCabe W. L., J. C. Smith and Peter Harriot, McGraw-Hill, 7th edition.
3. Introduction to Chemical Engineering Thermodynamics, J. M. Smith and H. C. Van Ness, M. M. Abbott, 7th edition, McGraw Hill.

Weblinks:

1. https://ptgmedia.pearsoncmg.com/images/9780131482043/samplechapter/0131482041_CH01.pdf
2. https://www.vapourtec.com/flow-chemistry/laminar-turbulent/
3. http://achemes.weebly.com/uploads/9/0/7/4/9074935/unit_3_-_volumetric_properties_of_pure_fluids.pdf
4. https://www.scribd.com/document/247231680/Unsteady-State-Heat-Transfer
5. https://portal.tpu.ru/SHARED/b/BELINSKAYA/UchWork/PPAYAmaster/rasmuson_a_andersson_b_olsson_l_andersson_r_mathematical.pdf

DESIGN THINKING & INNOVATION

IV Semester		**L**	**T**	**P**	**C**
Course Code:	**231ES4T04**	**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	-	-

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

ESSENCE OF INDIAN TRADITIONALKNOWLEDGE

IV Semester **L T P C**
Course Code: 231MC4T03 **2 0 0 0**

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

CO 1: Identify the concept of Traditional knowledge and its importance.
CO 2: Explain the need for and importance of protecting traditional knowledge.
CO 3: Illustrate the various enactments related to the protection of traditionalknowledge.
CO 4: Interpret the concepts of Intellectual property to protect the traditional knowledge.
CO 5: Explain the importance of Traditional knowledge in Agriculture and Medicine.

Mapping of course outcomes with program outcomes:

CO/PO	PO 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
CO2	-	-	-	-	-	3	2	3	2	2	-	1
CO3	-	-	-	-	-	3	2	3	2	2	-	1
CO4	-	-	-	-	-	3	2	3	2	2	-	1
CO5	-	-	-	-	-	3	2	3	2	2	-	1

Mapping of course outcomes with program Specific Outcomes:

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

UNIT-I:
Introduction to Traditional Knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge vs western knowledge traditional knowledge.

UNIT-II:
Protection of Traditional Knowledge: The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

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

UNIT-IV:
Traditional Knowledge and Intellectual Property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge.

UNIT-V:

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

Textbooks:
1. Traditional Knowledge System in India, Amit Jha.

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

Web Links:
1. https://www.youtube.com/watch?v=LZP1StpYEPM
2. http://nptel.ac.in/courses/121106003/
3. https://www.researchgate.net/publication/331221999
4. https://www.wipo.int/edocs/pubdocs/en/wipo_pub_tk_1.pdf
5. https://en.wikipedia.org/wiki/Traditional_knowledge#:~:text=Traditional%20knowledge%20includes%20types%20of,ethnoastronomy%2C%20climate%2C%20and%20others

WELL LOGGING & FORMATION EVALUATION

V Semester **L T P C**
Course Code: 231PT5T01 **3 0 0 3**

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

CO 1:	Apply the basic concepts of logging and preparation of litho logs.
CO 2:	Determine the formation lithology and depositional environment through logs.
CO 3:	Differentiate the principles and its application of various logging tools
CO 4:	Determine the fluid saturation behind casing and Solving production problems with the help of logging tools.
CO 5:	Interpret the log data with the help of different logging tools.

Mapping of course outcomes with program outcomes:

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

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

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.

Direct Methods: Mud logging- preparation of litho logs - coring – conventional and sidewall coring - core analysis.

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

Gamma Ray Log: principle of radioactivity - uses of gamma ray log- determination of shaliness of formation- API counts- calibration of gamma ray tool - statistical fluctuation- time constant.

Natural Spectral Gamma ray log: Principle and application.

Caliper Log: Principle and application of caliper tool.

Density Log: Principle of density tool- environmental corrections - porosity determination - tool calibration, litho density log.

Neutron Log: Principle and application of neutron tool, porosity determination.

Sonic Log: Principle and application of sonic log - bore hole compensation - determination of primary and secondary porosity, determination of mechanical properties of rock, elastic constants, fractures etc.,

UNIT-IV

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 - free point locater - casing inspection logs.

Production Logging: Solving production problems with the help of fluid density log - temperature log and flow meter logs.

UNIT-V

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)- Image logs, Calculating the dip of the formations, collection of fluid samples from wells for confirmation of log interpretation, and also recording resistivity in cased holes. LWD (Logging While Drilling)- MWD (Measuring While Drilling).

Interpretation: Quick look interpretation - cross plots. Neutron - density, sonic - density, sonic - neutron cross plots - Hingle plot - mid plot – correlation - hydrocarbon reserve estimate. Discussion of case studies and trouble shooting.

Text Books:

1. Formation Evaluation, Edward J. Lynch, Harper & Row, 1962.
2. Well Logging and Formation Evaluation, Toby Darling, Elsevier, New York, 2005.

Reference Books:

1. Basic Well Logging and Formation Evaluation, Prof. Dr. Jurgen Schon, First Edition, Bookboon publishers, 2015.
2. Hydrocarbon well logging recommended practice, Society of professional well log analysts.

Weblinks:

1. https://petrosmartt.blogspot.com/2024/10/cased-hole-logging-in petroleum.html?utm
2. https://onepetro.org/pages/petrowiki
3. https://www.epa.gov/environmental-geophysics/logging-techniques-and-tools-nuclear-logging?utm
4. https://www.askawayblog.com/2025/02/the-vital-role-of-cased-hole-logging-in.html?utm
5. https://en.wikipedia.org/wiki/Logging_while_drilling?utm

INSTRUMENTATION, PROCESS DYNAMICS & CONTROL

V Semester **L T P C**
Course Code: 231PT5T02 **3 0 0 3**

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

CO 1: Analyze the basic elements of an instrument and its characteristics.
CO 2: Measure the various process variables using the appropriate types of instruments process variables
CO 3: Differentiate the response of First Order Systems and Second Order Systems.
CO 4: Identify the stability limits of a system and concept on gain and phase margins.
CO 5: Apply the advance control strategies and tune the process controllers.

Mapping of course outcomes with program outcomes:

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

Mapping of course outcomes with program Specific Outcomes:

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

UNIT-I:
Fundamentals: Elements of instruments, static and dynamic characteristics of instruments.
Industrial Thermometers: Mercury in glass thermometer - Bimetallic thermometer - Pressure Spring thermometer, Thermo-electricity – types of thermocouples – Thermocouple lead wires. Resistance-thermometers: RTD and bridge circuits (2 wire, 3 wire and 4 wire - method) -Radiation receiving elements-pyrometers.

UNIT-II:
Pressure, vacuum and head: Liquid column manometers - Measuring elements for gauge pressure and vacuum-indicating elements for pressure gauges - Measurement of absolute pressure - Measuring pressure in corrosive liquids - Static accuracy and response of pressure gauges.
Density and specific gravity measurements- Direct measurement of liquid level - Pressure measurement in open vessels - Level measurements in pressure vessels - Measurement of interface level - Density measurement and level of dry materials.

UNIT-III:
Introduction to process dynamics and control, Response of First Order Systems, Physical examples of first order systems.

Response of first order systems in series, higher order systems: Second order and transportation lag. Control systems Controllers and final control elements.

UNIT-IV:
Closed loop transfer functions, Transient response of simple control systems.
Stability: Stability Criterion, Routh Test, Root locus, Introduction to frequency response, Bode stability criterion, concept on gain and phase margins

UNIT-V:
Advanced control strategies: Cascade control, Feed forward control, ratio control, dead time compensation, internal model control. Controller tuning and process identification. Control valves.

Text Book:
1. Industrial Instrumentation, Donald P. Eckman, CBS, 2004.
2. Process Systems Analysis and Control, D.R. Coughanowr, 3rd Ed. McGraw Hill

Reference Books:
1. Chemical Process Control, G. Stephanopoulos, Prentice Hall, 1984.
2. Coulson and Richardson's Chemical Engineering, Volume-3, 3rd Edition: Chemical and Biochemical Reactors and Process Control, Richardson J. F. et.al, Elsevier India, 2006.
3. Automatic Process Control, Donald P. Eckman, John wiley, Reprint 2011.
4. Instrumentation and Control Systems, K. Padmaraju, Y.J. Reddy, McGraw Hill Education, 2016.
5. Process Dynamics and Control, Dale Seaborg, Thomas F. Edgar, Duncan Mellichamp, 2nd Edition, Wiley India Pvt. Ltd., 2006.

Web Links:
1. https://instrumentationtools.com/static-and-dynamic-characteristics-of-an-instrument/
2. https://www.slideshare.net/slideshow/pressure-measurement-part-i/66054865
3. https://www.tutorialspoint.com/control_systems/control_systems_response_first_order.htm
4. https://eng.libretexts.org/Bookshelves/Industrial_and_Systems_Engineering/Introduction_to_Control_Systems_(Iqbal)/04%3A_Control_System_Design_Objectives/4.01%3A_Stability_of_the_Closed-Loop_System
5. https://www.slideshare.net/slideshow/class-33-advanced-control-strategies-cascade-control/54289816

DRILLING TECHNOLOGY

V Semester **L T P C**
Course Code: 231PT5T03 **3 0 0 3**

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

CO 1: Explain the basics of drill string and rotary drilling technology.
CO 2: Apply the concept of pore pressure and its measurement in for safe drilling.
CO 3: Apply concepts of drilling fluid properties and drilling hydraulics in practice.
CO 4: Design proper casing and cementing jobs for sustainable drilling practice.
CO 5: Apply the concept of directional drilling to solve problems in different geological environments.

Mapping of course outcomes with Program Outcomes:

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

Mapping of course outcomes with Program Specific Outcomes:

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

UNIT-I:
Overview of drilling: Types of drilling -Types of Rigs and equipment. Types of wells-Well Control Equipment-Basics of drill String and BHA. GTO - Types of bits-IADC Classification of bits-Rotary Bit technology. Various types of down hole equipment.
Formation Pressure: Hydrostatic pressure, Pore pressure, Causes of abnormal pore pressure, abnormal pore pressure evaluation-Direct measurements of pore pressure -Formation integrity tests – Fracture gradient determination.

UNIT-II:
Basics of drilling fluids: Functions, types, compositions, properties of mud. Drilling fluid Rheology, annular hydraulics, filtration and volume calculation. Mud calculations, hydrostatic pressure, volume, weight related calculations during drilling
Drilling Hydraulics: Steady Flow of Drilling Fluids, Laminar and Turbulent Flow in Pipes and Annuli, Steady State Pressures in Wellbore, Swab & Surge-pressures- Mud hydraulics analysis report- Lost circulation, Disposing of the drilling fluids waste and drill cuttings waste.

UNIT-III:
Casing and Drill Pipes: Functions of casing – Types of casing –Casing connections. Drill pipes, Drill Collars, Bit Optimization -Casing Policy and Design Basics.
Cementation: Introduction cement slurries- Cementing Nomenclature-Cement additives – Cementation of liners.

UNIT-IV:

Directional drilling: Applications- Well planning- Down-hole motors- Deflection tools and techniques- Face orientation- Direction control with rotary assemblies-. Horizontal wells–Well profile design considerations– Extended reach well design – Multilateral wells

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. Types of fishing tools, Case studies of blow out control

Text Books:

1. Well Engineering and Construction, Hussain Rabia, Entrac Consulting, 2002.
2. Oil Well Drilling Engineering: Principles and Practice, H. Rabia, Graham & Trotman, 1985.
3. Drilling Engineering, J.J. Azar and G. Robello Samuel, Pennwell Books, 2007.
4. Fundamentals of Drilling Engineering, Robert F Mitchell, Stefan Z Miska, SPE Text Book Series, Volume 12.

Reference Books:

1. Petroleum Engineering: Drilling and Well Completion, Carl Gatlin, Prentice-Hall, Inc., 1960.
2. Drilling Engineering: A Complete Well Planning Approach, Neal Adams, Tommie Charrier Pennwell, 1985.
3. Working Guide to Drilling Equipment and Operations, William Lyons, Gulf Publishing, 2009.
4. Applied Drilling Engineering, Adam T. Bourgoyne Jr., Keith K. Millheim, Martine E. Chenevert and F. S. Young Jr., Society of Petroleum Engineers, 1991.
5. Fundamentals of Sustainable Drilling Engineering, M.E. Hossain, A.A.Al-Mejed, Scrivener Publishing, WILEY, 2015.

Web Links:

1. www.slb.com/-/media/Files/resources/oilfield_review/.../Defining-Drilling.pdf?la=en..
2. https://www.spgindia.org/10_biennial_form/P414.pd
3. blog.sciencenet.cn/home.php?mod=attachment&id=3216
4. petrowiki.org/Strength_of_casing_and_tubing
5. petrowiki.org/Directional_drilling

OFFSHORE DRILLING, PRODUCTION AND MANAGEMENT
(Professional Elective-I)

V Semester **L T P C**
Course Code: 231PT5E01 **3 0 0 3**

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

CO 1: Apply the concepts of offshore oil and gas operations.
CO 2: Implement the design aspects of offshore fixed platforms and mobile units.
CO 3: Apply the concepts of offshore drilling and well completions.
CO 4: Assess the requirements of advanced drilling techniques
CO 5: Implement HSE aspects of offshore and deep-water drilling.

Mapping of course outcomes with Program Outcomes:

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

Mapping of course outcomes with Program Specific Outcomes:

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

Unit -I
Introduction to offshore oil and gas operations:
Introduction to offshore oil and gas operations-Sea states and weather: Introduction to Meteorology, Oceanography, Ice, Sea bed oil-Buoyancy and stability.

Unit -II
Offshore fixed platforms and mobile units:
Offshore fixed platforms: Types, descriptions and operations- Offshore mobile units: Types description and installation, Station keeping methods like conventional mooring and dynamic positioning system.

Unit -III
Offshore drilling, well completions and Production Systems:
Difference in drilling from land, from fixed platform, Jackup, ships and semi submersibles. Use of conductors, risers and Umbilicals. Deep sea drilling, Platforms and subsea completions, Deep water applications off subsea technology. SPM and SBM, Transportation and Utilities.

Unit IV
Advanced Drilling Techniques:
Direction drilling-Applications, Horizontal wells, MWD, LWD and ERD wells drilling techniques and tools.

Unit V

Deep water technology, Divers and Safety:

Introduction, Definition and prospects- Deep water regions, Deep water drilling rig- Selection and deployment, Deep water production system, Emerging deep-water technologies- special equipment and system, Remote operation vessels (ROV), Principles of diving, Use of decompression chambers, life boats-Offshore environmental pollution and remedial measures. Management of Offshore Drilling and Production Operations.

Text books:

1. Sukumar Laik, Offshore Petroleum Drilling and Production, CRC Press.1st Edition, 2020.
2. DRIL-QUIP Inc., Offshore Drilling and completions Training, 1996.

Reference books:

1. Offshore Oil Drilling, Nick Hunter 1st Edition, Heinemann educational books, 2012.
2. Offshore Drilling Industry and Rig Construction in the Gulf of Mexico, Mark J. Kaiser, Brian F. Snyder Springer, 2013.
3. Offshore Oil and Gas People, Amanda Barlow Createspace independent publishers, 2017.
4. Drilling and Producing Offshore, R. Stewart Hall 1st edition, Penn Well, 1983.
5. ETA Offshore seminars, Inc., The Technology of Offshore Drilling, Completion and Production, Penn Well, 1976.

Weblinks:

1. https://www.slideshare.net/slideshow/introduction-to-offshore-oil-and-gas-surface-facilities/55212125
2. https://www.slideshare.net/slideshow/offshore-fixed-platforms/92559530
3. https://www.scribd.com/document/543509357/02-Offshore-Production-System
4. https://www.sciencedirect.com/topics/engineering/directional-drilling
5. https://www.sciencedirect.com/topics/engineering/deepwater-production

CBM RESERVOIR ENGINEERING
(Professional Elective-I)

V Semester **L T P C**
Course Code: 231PT5E02 **3 0 0 3**

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

CO 1: Assess the Coal Bed Methane reservoirs in the world and India.
CO 2: Apply the basic principles of sorption and isotherms in estimating CBM per ton of coal.
CO 3: Use the methods of well logging in CBM wells and estimate the CBM reservoirs.
CO 4: Implement best practices of hydro fracturing for CBM wells.
CO 5: Practice the HSE concepts for CBM operations and disposal of produced water.

Mapping of course outcomes with Program Outcomes:

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

Mapping of course outcomes with Program Specific Outcomes:

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

UNIT-I
Introduction: Overview of coal bed methane (CBM) in India – CBM vs Conventional Reservoirs. Geological influences on cleat formation of coals – Coal chemistry – Significance of rank – Cleat system and natural fracturing.

UNIT-II
Sorption: Principles of Adsorption-The Isotherm construction-CH_4 retention by coal seams-CH_4 content determination in coal seams-The isotherm for recovery - prediction - Model of the micro-pores-coal sorption of other molecular species.
Reservoir Analysis: Coal as a reservoir - Permeability-Porosity-Gas Flow-Reserve Analysis-Well spacing and drainage area- dewatering mechanism - Enhanced recovery.

UNIT-III
Well Construction: Drilling-Cementing, Formation Evaluations, Logging: Borehole environment -Tool measurement response in coal-wire line log evaluation of CBM wells -Gas-In-Place calculations -Recovery factor -Drainage area calculations - Coal permeability/Cleating-Natural fracturing and stress orientation -Mechanical rock properties in CBM evaluation.

UNIT – IV

Completions: Open hole completions -Open hole cavitation process, Cased hole completions- Multi zone entry in cased hole.

UNIT-V

Hydraulic fracturing of coal seams: Need for fracturing coals - Unique problems in fracturing coals - Types of fracturing fluids for coal-In situ conditions - Visual observation of fractures.

Water production and disposal: Water production rates from methane wells - chemical content - environmental regulations - water disposal techniques - economics of coal bed methane recovery - CO_2 sequestrated Enhanced CBM Recovery.

Text Books:

1. Fundamentals of Coal Bed Methane Reservoir Engineering, John Seidle, Pennwell Corp., 2011.
2. Coal Bed Methane: Principles and Practice, R. E. Rogers, 3rd Edition, Prentice Hall, 1994.
3. Coal Bed Methane, Robert A. Lamarre, American Association of Petroleum Geologists, 2008.

Reference Books:

1. Coal Bed Methane, Society of Petroleum, 1992.
2. A Guide to Coal Bed Methane Operations, B. A. Hollub, Society of Petroleum, 1992.

Weblinks:

1. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/coal-bed-methane#:~:text=Coal%20Bed%20Methane%20(CBM)%20refers,various%20domestic%20and%20industrial%20purposes.
2. https://www.sciencedirect.com/science/article/abs/pii/S0166516211001200
3. https://onepetro.org/books/book/78/chapter/14396476/Coalbed-Methane
4. https://www.onepetro.org/download/conference-paper/SPE-91376-MS?id=conference-paper%2FSPE-91376-MS
5. https://pmc.ncbi.nlm.nih.gov/articles/PMC12096213/

STATISTICS FOR PETROLEUM ENGINEERS
(Professional Elective-I)

V Semester **L T P C**
Course Code: 231PT5E03 **3 0 0 3**

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

CO 1: Assess about the Statistics in Engineering and Geology.
CO 2: Learn the Functionality of Univariate Distributions.
CO 3: Analyze the concepts of Estimators and their Assessment.
CO 4: Apply the concepts of Measures of Heterogeneity and Bivariate Analysis
CO 5: Practice the Analysis of Modeling and Statistics of Reservoir media.

Mapping of course outcomes with Program Outcomes:

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

Mapping of course outcomes with Program Specific Outcomes:

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

UNIT-I

Introduction: The Role of Statistics in Engineering and Geology –The Measurements, The Medium, The Physics of Flow, Estimation and Uncertainty.

Basic Concepts: Combinations of Events, Probability- Probability Laws, Conditional Probabilities, Independence, Bayes' Theorem-Summary.

UNIT-II

Univariate Distributions: The Cumulative Distribution Function -Order Statistics, Functions of Random Variables, The Monte Carlo Method Sampling and Statistics. Features of Single-Variable Distributions-Non-Concentered Moments Centered Moments Combinations and Other Moments, Truncated Data Sets, Partitioning Data Sets.

UNIT-III

Estimators And Their Assessment: The Elements Of Estimation , Desirable Properties Of Estimators , Estimator Bias ,Estimator Efficiency, Estimator Robustness ,Assessing The Sensitivities Of Estimators to Erroneous Data Sensitivity Coefficients ,Confidence Intervals ,Computational Methods To Obtain, Confidence Intervals ,Properties Of The Sample Mean, Properties Of The Sample Variance ,Confidence Intervals For The Sample Mean ,Properties Of The Sample Median ,Properties Of The Interquartile Range ,Estimator For Non arithmetic Means ,Flow Associations For Mean Values ,Physical Interpretability In Estimation ,Weighted Estimators.

UNIT-IV

Measures of Heterogeneity: Definition of Heterogeneity, Static Measures, Dynamic Measures. Hypothesis Tests- Parametric Hypothesis Tests, Non-parametric Tests,

Bivariate Analysis Correlation: Joint Distributions, The Covariance of X And Y, The Joint Normal Distribution, The Reduced Major Axis (RMA) And Regression Lines. Bivariate Analysis- Linear Regression: The Elements of Regression, The Linear Model, The Least-Squares Method, Properties of Slope and Intercept Estimates Separately Testing the Precision of the Slope and Intercept. Bivariate Analysis: Further Linear Regression- Alternatives to the Least-Squares Lines, Variable Transfonnations, Weighted Least Squares, Reducing the Number of Variables.

UNIT-V

Analysis Of Spatial Relationships: Data Types, Nominal Variables, Measures of Autocorrelation, Estimating Autocorrelation Measures, Semi variograms In Hypothetical Media, Semi variograms In Real Media, Bias and Precision Models, The Impact of Autocorrelation Upon the Information Content of Data.

Modelling Geological Media: Statistical Point of View, Kriging, Other Kriging Types, Conditional 'Simulation, Simulated Annealing.

The Use of Statistics in Reservoir Modelling: The Importance of Geology, Analysis and Inference, Flow Modelling Results, Model Building.

Textbooks

1. L. J. Devore, Probability and Statistics for Engineering and the Sciences, 9th ed., Boston, MA, USA: Cengage Learning, 2015.
2. A. Hald, Statistical Theory with Engineering Applications, New York, NY, USA: John Wiley & Sons, 2000.

Reference Books

1. C. E. Smith, Probability and Statistics in Petroleum Engineering, Richardson, TX, USA: Society of Petroleum Engineers (SPE), 2001.
2. M. H. Jensen, Practical Geostatistics: Spatial Analysis for Petroleum Geoscientists and Engineers, Hoboken, NJ, USA: Wiley, 2022.

Weblinks:

1. https://ndl.ethernet.edu.et/bitstream/123456789/39344/1/Larry%20W.%20Lake.pdf
2. https://www.scribd.com/document/257961309/Jensen-et-al-Statistics-for-Petroleum-Engineers-and-Geoscientists-1997
3. https://www.researchgate.net/publication/46493876_Confidence_interval_estimation_for_lognormal_data_with_application_to_health_economics
4. https://www.researchgate.net/publication/46553457_One-sided_and_two-sided_nonparametric_tests_for_heterogeneity_comparisons
5. https://geofaculty.uwyo.edu/yzhang/files/geosta1.pdf

WASTE WATER MANAGEMENT
(Open Elective-I)

V Semester **L T P C**
Course Code: 231CE5O01 **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	PO12
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	PSO 1	PSO 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. Preliminaryandprimarytreatment–screens–gritchambers–greasetraps–floatation– sedimentation.

Unit – IV
Secondary Treatment:
Aerobic and anaerobic treatment process-comparison.
Aerobic units:

Activated sludge process, principles, modifications of activated sludge processes Oxidation ponds– Trickling filters–Rotating biological contactors.
Anaerobic units: UASB Reactor, principle and working.

Unit – V

Tertiary Treatment and Disposal:
Removal of Nutrients–Nitrification and Denitrification–Ion exchange–membrane processes –MF, UF, NF, RO. Disposal of sewage–Methods of disposal–Effluent Standards. Need, Scope and demand for waste water recycling

Text Books:

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

Reference Books:

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

Web Links:

1. https://web.iitd.ac.in/~arunku/files/CVL100_Y16/LecSep1220.pdf
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: 231CE5O02 **3 0 0 3**

Course Outcomes:

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

CO1: Demonstrate understanding of project planning, scheduling, and monitoring techniques using tools like bar charts, milestone charts, and CPM.

CO2: Analyze and optimize project timelines and resources using PERT, crashing methods, and project management software like Primavera.

CO3: Evaluate the working, capacity, and productivity of earthwork and hoisting equipment such as dump trucks, cranes, bulldozers, and rollers.

CO4: Understand the usage and operation of concreting equipment including batching plants, mixers, and techniques for placing and finishing concrete.

CO5: Apply modern construction techniques involving formwork, piling, fabrication, quality control, safety practices, and integrate BIM in project planning.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes

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

UNIT – I

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

UNIT – II

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

UNIT – III

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

UNIT-IV

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

UNIT-V

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

Textbooks:

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

Reference Books:

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

Web Links:

1. NPTEL: Civil Engineering - NOC: Principles of Construction Management
2. NPTEL: Civil Engineering - Construction Planning and Management

GREEN BUILDINGS
(Open Elective-I)

V Semester **L T P C**
Course Code: 231CE5O03 **3 0 0 3**

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

CO1: Understand the fundamental concepts, benefits, and sustainable features of green buildings.
CO2: Describe and analyze green building rating systems and sustainability practices in construction.
CO3: Apply principles of energy-efficient green design and evaluate renewable energy integration.
CO4: Assess HVAC design strategies and energy modeling used in green building projects.
CO5: Evaluate indoor air quality measures, sustainable material use, and occupant well-being strategies.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO11	PO12
CO1	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 – 1:
Introduction
What is Green Building, Why to go for Green Building, Benefits of Green Buildings, Green Building Materials and Equipment in India, What are key Requisites for Constructing a Green Building, Important Sustainable features for Green Building

UNIT – 2:
Green Building Concepts And Practices Indian Green Building Council, Green Building Moment in India, Benefits Experienced in Green Buildings, Launch of Green Building
Rating Systems, Residential Sector, Market Transformation; Green Building Opportunities And Benefits: Opportunities of Green Building, Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy Saving Approach in Buildings, LEED India Rating System and Energy Efficiency,

UNIT-3:

Green Building Design Introduction, Reduction in Energy Demand, Onsite Sources and Sinks, Maximize System Efficiency, Steps to Reduce Energy Demand and Use Onsite Sources and Sinks, Use of Renewable Energy Sources. Eco friendly captive power generation for factory, Building requirement,

UNIT- 4:

Air Conditioning Introduction, CII Godrej Green business centre, Design philosophy, Design interventions, Energy modeling, HVAC System design, Chiller selection, pump selection, Selection of cooling towers, Selection of air handing units, Precooling of fresh air, Interior lighting system, Key feature of the building. Eco-friendly captive power generation for factory, Building requirement

UNIT –5:

Material Conservation Handling of non-process waste, waste reduction during construction, materials with recycled content, local materials, material reuse, certified wood, Rapidly renewable building materials and furniture; Indoor Environment Quality And Occupational Health: Air conditioning, 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: 231EE5O01	**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	PO12
CO1	3	2	2	-	1	-	-	-	1	1	-	-
CO2	3	2	2	-	-	-	-	-	1	1	-	-
CO3	3	2	2	-	-	-	-	-	1	1	-	-
CO4	3	2	2	-	-	-	-	-	1	1	-	-
CO5	3	2	2	-	-	-	-	-	1	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

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

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

UNIT – III
Biomass, Hydel and Geothermal Energy
Biomass: Introduction - Biomass conversion technologies- Photosynthesis. Factors affecting Bio digestion.

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

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

UNIT – IV

Energy From oceans, Waves & Tides:

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

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

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

UNIT – V

Chemical Energy Sources:

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

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

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

Text Books:

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 Shoba Nath Singh, Non- Conventional Energy Resources, Pearson Publications, 2015.

Web Links:

1. https://archive.nptel.ac.in/courses/103/103/103103206
2. http 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: 231EE5O02	**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	Analyze the methods to improve the power factor and identify the energy instruments for various real time applications.
CO5	Evaluate the computational techniques with regard to economic aspects.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
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)

Semester: V		L	T	P	C
Semester: V		**L**	**T**	**P**	**C**
Course Code: 231ME5O01		**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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	-	-	-	-	3	-	-	-	-	-	-
CO2	2	-	-	-	-	3	-	-	-	-	-	-
CO3	2	-	-	-	-	3	-	-	-	-	-	-
CO4	2	-	-	-	-	3	-	-	-	-	-	-
CO5	2	-	-	-	-	3	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	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)

Semester: V | **L** **T** **P** **C**
Course Code: 231ME5O02 | **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	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	-	-	2	-	-	-	-	1	-
CO2	1	1	1	-	-	1	-	-	-	-	1	-
CO3	3	2	1	-	-	1	-	-	-	-	1	-
CO4	2	1	1	-	-	2	-	-	-	-	1	-
CO5	2	1	1	-	-	2	-	-	-	-	1	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	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 – poison arrivals – exponential service times – with infinite population and finite population models– multichannel – poison 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 publisher
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)

	L	T	P	C
V Semester	**L**	**T**	**P**	**C**
Course Code: 231ME5O03	**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: Analyze the tools to characterize Nano materials
CO5: Understand the applications of Nano materials

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – 1
INTRODUCTION: History and Scope, Classification of Nano structured Materials, Fascinating Nanostructures, and applications of nano-materials, challenges and future prospects.

UNIT – 2
UNIQUE PROPERTIES OF NANO MATERIALS: Microstructure and Defects in Nano crystalline Materials: Dislocations, Twins, stacking faults and voids, Grain Boundaries, triple and disclinations. Effect of Nano-dimensions on Materials Behavior: Elastic properties, Melting Point, Diffusivity, Grain growth characteristics, enhanced solid solubility. Magnetic Properties: Soft magnetic nanocrystalline alloy, Permanent magnetic nanocrystalline materials, Giant Magnetic Resonance, Electrical Properties, Optical Properties, Thermal Properties and Mechanical Properties.

UNIT – 3
SYNTHESIS ROUTES: Bottom-up approaches: Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method, Self-assembly. Top-down approaches: Mechanical alloying, Nano-lithography. Consolidation of Nano powders: Shock wave consolidation, Hot iso-static pressing and Cold iso-static pressing, Spark plasma sintering.

UNIT – 4

TOOLS TO CHARACTERIZE NANOMATERIALS: X-Ray Diffraction (XRD), Small Angle X-ray scattering, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunnelling Microscope (STM), Field Ion Microscope (FEM), Three-dimensional Atom Probe (3DAP), Nano indentation.

UNIT – 5

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

Web links:

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

THERMAL MANAGEMENT OF ELECTRONIC SYSTEMS
(Open Elective-I)

	L	T	P	C
V Semester	**L**	**T**	**P**	**C**
Course Code: 231ME5O04	**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	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	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:

CO/PSO	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

ENTREPENEURSHIP
(Open Elective-I)

	L	T	P	C
V Semester	**L**	**T**	**P**	**C**
Course Code: 231ME5O05	**3**	**0**	**0**	**3**

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

CO1: Identify the core characteristics, knowledge, and skills of successful entrepreneurs.
CO2: Explain the influence of family and societal structures on entrepreneurial initiatives.
CO3: Explain the fundamentals of international business, including schemes and policies.
CO4: Develop a comprehensive business model using the Business Model Canvas framework.
CO5: Develop a comprehensive small business plan.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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:

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

Unit - I
ENTREPRENEURAL 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
ENTREPRENEURAL ENVIRONMENT

Business Environment - Role of Family and Society - Entrepreneurship Development Training and Other Support Organizational Services

Unit - III
INDUSTRIAL POLICIES

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

Unit - IV

BUSINESS PLAN PREPARATION

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

Unit – V

LAUNCHING OF SMALL BUSINESS

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

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

Text Books:

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)

SEMESTER: V	**L**	**T**	**P**	**C**
Course Code: 231EC5O01	**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.
3. Signals and Systems – A. Anand Kumar, PHI, 4th Edition, 2017.

Reference Books:

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

Web Links:

1. https://freevideolectures.com/course/3540/signals-and-systems-i(Signals and Systems Iby 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)

	L	T	P	C
V Semester	L	T	P	C
Course Code: 231EC5O02	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 Madisetti, Universities Press, 2015, ISBN:9788173719547
2. Getting Started with RaspberryPi, Matt Richardson & Shawn Wallace, O'ReiIIy(SPD), 2014, ISBN:9789350239759.
3. Misra,S.,Mukherjee,A.,&Roy,A.(2021). Introduction to IoT. Cambridge:Cambridge University Press. doi:10.1017/9781108913560.

Reference Books:

1. Adrian McEwen, Hakim Cassimally "Designing the Internet of Things", John Wiley & Sons, 2014.
2. Peter Friess,' lnternet of Things—From Research and Innovation to Market Deployment', River Publishers, 2014

Web Links:

+++

1. https://onlinecourses.npte1.ac.in/noc2lee85/course
2. https://onlinecourses.npte1.ac.in/noc2lcs17/preview
3. https://nptel.ac.in/courses/106/105/106105166/

DIGITAL ELECTRONICS AND LOGIC DESIGN
(Open Elective-I)

V Semester	**L**	**T**	**P**	**C**
Course Code: 231EC5O03	**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'scompliments and r's compliments of signed numbers, problem solving.

Binary Codes:4 bit codes, BCD, Excess-3, 2421, 84-2-1 9's compliment code etc. Error detection & correction codes, Gray code, error detection, error correction codes.

Logic Gates: Basic logic operations: NOT,OR, AND, Universal building blocks, EXOR, EX-NOR Gates.

Unit – II

Boolean Algebra &Minimization Techniques: Boolean theorems, principle of complementation & duality, De-Morgan theorems, minimization of logic functions using Boolean theorems, minimization of switching functions using K-Map up to 4 variables, tabular minimization.

Unit – III

Combinational Logic Circuits: Design of Half adder, full adder, half sub-tractor, full sub-tractor, applications of full adders, 4-bit binary adder-sub-tractor circuit, BCD adder circuit, look-a-head adder circuit, Design of decoder, de-multiplexer, 7 segment decoder, higher order de-multiplexing, encoder, multiplexer, higher order multiplexing, realization of Boolean functions using decoders & multiplexers.

Unit – IV
Programmable Logic Devices: Introduction to PLD's: PROM, PAL, PLA-Basics structures, realization of Boolean function with PLDs, programming tables of PLDs, merits & demerits of PROM, PAL, PLA comparison, realization of Boolean functions using PROM, PAL, PLA, programming tables of PROM, PAL, PLA.

Unit – V
Sequential Circuits: Classification of sequential circuits (synchronous and asynchronous) basic flip-flops, truth tables and excitation tables (NAND RS latch, NOR RS latch, RS flip-flop, JK flip-flop, T-flip-flop, D-flip-flop with reset and clear terminals). Conversion from one flip-flop to another flip-flop.

Text Books:

1. Digital Design, Morris Mano, Pearson, 3rd Edition, 2002.
2. Fundamentals of Logic Design, Charles H. Roth Jr., Jaico Publishers, 2004.
3. Switching Theory and Logic Design, A. Anand Kumar, Pearson, 3rdEdition, 2013.

Reference Books:

1. Modern Digital Electronics, RP Jain, Tata Mc Graw Hill, 4th Edition, 2010.
2. Introduction to Switching Theory and Logic Design, Fredriac J. Hill, Gerald R. Peterson, 3rd Edition, John Wiley & Sons Inc., 1982.
3. Switching and Finite Automata Theory, ZviKohavi&NirajK.Jha, 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 | | **L** | **T** | **P** | **C**
Course Code: 231CS5O01 | | **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 **L T P C**
Course Code: 231DS5O01 **3 0 0 3**

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

CO1: Develop programs using fundamentals of python

CO2: Make use of control statements and strings for developing applications

CO3: Develop applications using data structures and functions

CO4: Apply OOPs concepts and files for developing programs

CO5: Illustrate Exception Handling to handle runtime errors.

CO6: Build applications using GUI.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	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

Mapping Course Outcomes with Program Specific Outcomes:

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

Unit - I
Programming: Introduction to Programming Concepts with Scratch Introduction: Introduction to Python, Program Development Cycle, Input, Processing, and Output, Displaying Output with the Print Function, Comments, Variables, Reading Input from the Keyboard, Performing Calculations, Operators. Type conversions, Expressions, more about Data Output. Data Types Expression: Strings Assignment, and Comment, Numeric Data Types and Character Sets, Using functions and Modules. Decision Structures and Boolean Logic: if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators, Boolean Variables. Repetition Structures: Introduction, while loop, for loop, Calculating a Running Total, Input Validation Loops, Nested 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)

	L	T	P	C
V Semester	**L**	**T**	**P**	**C**
Course Code: 231IT5O01	**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, ZvonkoVranesic, SafwatZaky, 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)

	L	T	P	C
V Semester	**L**	**T**	**P**	**C**
Course Code: 231AM5O01	**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:

CO/PO	PO 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:

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

UNIT – I

Object Oriented Programming: Basic concepts, Principles, Program Structure in Java: Introduction, Writing Simple Java Programs, Elements or Tokens in Java Programs, Java Statements, Command Line Arguments, User Input to Programs, Escape Sequences Comments, Programming Style.

Data Types, Variables, and Operators : Introduction, Data Types in Java, Declaration of Variables, Data Types, Type Casting, Scope of Variable Identifier, Literal Constants, Symbolic Constants, Formatted Output with printf() Method, Static Variables and Methods, Attribute Final, Introduction to Operators, Precedence and Associativity of Operators, Assignment Operator, Basic Arithmetic Operators, Increment and Decrement Operators, Ternary Operator, Relational Operators, Boolean Logical Operators, Bitwise Logical Operators.

Control Statements: Introduction, if Expression, Nested if Expressions, if–else Expressions, Ternary Operator, Switch Statement, Iteration Statements, while Expression, do–while Loop, for Loop, Nested for Loop, For–Each for Loop, Break Statement, Continue Statement.

UNIT – II

Classes and Objects: Introduction, Class Declaration and Modifiers, Class Members, Declaration of Class Objects, Assigning One Object to Another, Access Control for Class Members, Accessing Private Members of Class, Constructor Methods for Class, Overloaded Constructor Methods, Nested Classes, Final Class and Methods, Passing Arguments by Value and by Reference, Keyword this.

Methods: Introduction, Defining Methods, Overloaded Methods, Overloaded Constructor Methods, Class Objects as Parameters in Methods, Access Control, Recursive Methods, Nesting of Methods, Overriding Methods, Attributes Final and Static

UNIT – III

Arrays: Introduction, Declaration and Initialization of Arrays, Storage of Array in Computer Memory, Accessing Elements of Arrays, Operations on Array Elements, Assigning Array to Another Array, Dynamic Change of Array Size, Sorting of Arrays, Search for Values in Arrays, Class Arrays, Twodimensional Arrays, Arrays of Varying Lengths, Three dimensional Arrays, Arrays as Vectors.

Inheritance: Introduction, Process of Inheritance, Types of Inheritances, Universal Super ClassObject Class, Inhibiting Inheritance of Class Using Final, Access Control and Inheritance, Multilevel Inheritance, Application of Keyword Super, Constructor Method and Inheritance, Method Overriding, Dynamic Method Dispatch, Abstract Classes, Interfaces and Inheritance.

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

UNIT – IV

Packages and Java Library:

Introduction, Defining Package, Importing Packages and Classes into Programs, Path and Class Path, Access Control, Packages in Java SE, Java.lang Package and its Classes, Class Object, Enumeration, class Math, Wrapper Classes, Auto boxing and Autounboxing, Java util Classes and Interfaces, Formatter Class, Random Class, Time Package, Class Instant (java.time.Instant), Formatting for Date/Time in Java, Temporal Adjusters Class, Temporal Adjusters Class.

Exception Handling: Introduction, Hierarchy of Standard Exception Classes, Keywords throws and throw, try, catch, and finally Blocks, Multiple Catch Clauses, Class Throwable, Unchecked Exceptions, Checked Exceptions.

Java I/O and File: Java I/O API, standard I/O streams, types, Byte streams, Character streams, Scanner class, Files in Java(Text Book 2)

UNIT – V

String Handling in Java: Introduction, Interface Char Sequence, Class String, Methods for Extracting Characters from Strings, Comparison, Modifying, Searching; Class String Buffer.

Multithreaded Programming: Introduction, Need for Multiple Threads Multithreaded Programming for Multicore Processor, Thread Class, Main ThreadCreation of New Threads, Thread States, Thread PrioritySynchronization, Deadlock and Race Situations, Interthread Communication Suspending, Resuming, and Stopping of Threads.

Java Database Connectivity: Introduction, JDBC Architecture, Installing MySQL and MySQL Connector/J, JDBC Environment Setup, Establishing JDBC Database Connections, ResultSet Interface

Java FX GUI: Java FX Scene Builder, Java FX App Window Structure, displaying text and image, event handling, laying out nodes in scene graph, mouse events

Tex 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, 11thedition, 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_012880464547618
816347_shared/overview

INTRODUCTION TO PETROLEUM ENGINEERING
(Open Elective-I)

V Semester	**L**	**T**	**P**	**C**
Course Code: 231PT5O01	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO 1: Differentiate between Upstream, Mid-stream and Downstream processes
CO 2: Explain the concept of Hydrocarbon Phase diagrams and Reservoir Drives
CO 3: Demonstrate the production system and subsea wells
CO 4: Explain about production separators and transportation process.
CO5: Discuss about refinery products and safety in refinery operations.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	2	-	2
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.

Weblinks:

1. http://182.72.188.194:8080/jspui/bitstream/123456789/1493/1/Introduction%20to%20Petroleum%20Engineering%20by%20John%20R.%20Fanchi.pdf
2. https://guides.loc.gov/oil-and-gas-industry/upstream
3. https://www.slideshare.net/slideshow/fundamentals-of-petroleum-engineering-module-4/68976696
4. https://www.slideshare.net/slideshow/an-introduction-to-oil-and-gas-production/92982115
5. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCH1308.pdf

INTRODUCTION TO PETROLEUM GEOLOGY
(Open Elective-I)

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

Course Outcomes:

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

CO 1: Apply the concepts of igneous, sedimentary, metamorphic rocks to evaluate drilling operations
CO 2: Identify different source rocks from which hydrocarbons are generated.
CO 3: Classify the sources of reservoir rocks, pore space, porosity and permeability
CO 4: Classify and evaluate the sedimentary basins in India.
CO5: Gain knowledge of fluid hydrocarbons migration

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

CO / PSO	PSO 1	PSO 2
CO1	-	-
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, 2^{nd} Edition, ButterworthHeimann,2007.
2. Mukharje, P.K., Text book of Geology, P.K The World Press PvtLtd., 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.

Web Links:

1. https://www.intechopen.com/chapters/68134
2. https://www.slideshare.net/SohailNawab2/source-rock-225744009
3. https://www.slideshare.net/Thomaschinnappan/reservoir-rock-in-fuel-geology
4. https://www.slideshare.net/slideshow/properties-of-reservoir-rocks/15829800
5. https://www.slideshare.net/slideshow/hydrocarbon-generation-migration/38904584

INTRODUCTION TO WELL LOGGING
(Open Elective-I)

V Semester **L T P C**
Course Code: 231PT5O03 **3 0 0 3**

Course Outcomes:

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

CO 1: Discuss about Classification of well logging methods.
CO 2: Identify different types of logging methods.
CO 3: Different ion between cased hole logging and production logging.
CO 4: List out the various advances in well logging.
CO5: Estimate the hydrocarbon reserves with the help of well logging tools.

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	2	-	2
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 locater 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.

Web Links:

1. https://www.slideshare.net/slideshow/well-log-the-bore-hole-image/86438073
2. https://homepages.see.leeds.ac.uk/~earpwjg/PG_EN/CD%20Contents/GGL-66565%20Petrophysics%20English/Chapter%2018.PDF
3. https://www.academia.edu/10349436/Cased_Hole_Wireline_Services_4_1_Cased_Hole_Wireline_Services_Cased_Hole_Wireline_Services_Formation_Evaluation_TMD_L_Thermal_Multigate_Decay_Lithology_Logging_Tool
4. https://www.academia.edu/332061/Well_Logging
5. https://esd.halliburton.com/support/LSM/GGT/PetroWorks/PetroWorks/5000/5000_0/Help/CrossPlot.interface.pdf?searchid=1405196362286

INTRODUCTION TO UNDERGROUND MINING
(Open Elective – I)

V Semester **L T P C**
Course Code: 231MI5O01 **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.

Text Books:

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.

Reference Books:

1. Underground 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 Minning technology-D. JDeshmukhVol.1
4. Modern Coal mining Technology: SamirkumarDas
5. Underground 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)

		L	T	P	C
V Semester		**L**	**T**	**P**	**C**
Course Code:	231MI5O02	**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 boxcut.

UNIT-II:
Open Pit Layout and Design: Planning the layout and open pit mine with special reference to large mechanized mines. Optimum dimensions of open pit mines. Removal of over burden and disposal, open cast bench-number, height, width and slope angle of the bench. Factors affecting the stability of the slope. Various types of slope failures, problems on slope failures. Ground water control.

UNIT-III:
Drilling and Blasting: Drill ability, mechanics of drilling, major types of drilling machines, basics of mechanics of blasting, principles of fragmentation.
Design of blasting: with special reference to heavy blasting, air blasting, ground vibrations, fly rocks novel methods of drilling, smooth blasting and pre-splitting.

UNIT-IV:
Surface Mining Methods: Casting, strip, quarrying and Placer Mining, and Modern Methods Excavation and loading: Shovels, Dragline, Front-end loader, Stackers, Graders. Non-Cyclic Surface Mining: Bucket Wheel Excavators and Continuous 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
3. http://www.sciencedirect.com/topics/earth-and-planetary-sciences/rock-mechanics

TUNNELLING & UNDERGROUND SPACE DESIGN
(Open Elective – I)

V Semester **L T P C**
Course Code: 231MI5O03 **3 0 0 3**

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

CO 1: Explain the role of underground space in urban infrastructure and evaluate parameters influencing tunnel location and design.
CO 2: Compare different tunnelling methods for soft and hard ground conditions with supporting techniques.
CO 3: Analyze tunnel excavation through drilling and blasting, including blast design and equipment selection.
CO 4: Evaluate mechanized tunnelling methods including TBMs, road headers, and impact hammers.
CO 5: Design tunnels using field data, numerical modelling, and monitoring systems for stability assessment.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PO	PSO1	PSO2	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 drill ability 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.

Reference Books:

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

Web Links:

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

INTRODUCTION TO MINE ENVIRONMENT
(Open Elective – I)

V Semester		**L**	**T**	**P**	**C**
Course Code:	231MI5O04	**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)

	L	T	P	C
V Semester	L	T	P	C
Course Code: 231AG5O01	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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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-CropProduction and Management-Notes.html#:~:text=%E2%80%A2%20Basic%20Practices%20 of%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: 231AG5O02	**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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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	-	-	-	-	-	-	-
CO 6	1	-	1	1	3	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I
Occurrence and movement of ground water; aquifer and its types & properties; classification of wells, fully penetrating tube wells and open wells, familiarization of various types of bore wells.

Unit – II
Groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; design of open wells; design of tube well and gravel pack, installation of well screen, completion and development of well.

Unit – III

Groundwater hydraulics- determination of aquifer parameters by different method such as Theis, Jacob and Chow's, Theis recovery method; well interference, multiple well systems, estimation of ground water potential, quality of ground water; artificial groundwater recharge techniques.

Unit – IV

Pumping systems: water lifting devices; different types of pumps, classification of pumps, component parts of centrifugal pumps, priming, pump selection, installation and troubleshooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics.

Unit – V

Propeller pumps; Mixed flow pumps and their performance characteristics; Vertical turbine pump-construction, installation, operation, maintenance and troubleshooting; and submersible pump-construction, installation, operation, maintenance and troubleshooting; hydraulic ram- principal of operation; Economics of pumping.

Text Books:

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

Reference Books:

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

Web Links:

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

DRILLING FLUIDS LAB

V Semester **L T P C**
Course Code: 231PT5L01 **0 0 3 1.5**

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

CO 1: Evaluate the suitability of drilling fluid by performing different laboratory tests.
CO 2: Analyze the effect of adding different proportions of bentonite on different essential properties of drilling fluid.
CO 3: Estimate the compressive strength of cement and its suitability for cementing jobs.
CO 4: Function effectively as an individual, and as a member or leader while performing lab experiments.
CO5: Communicate effectively the drilling lab results by documenting experimental results.

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

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

List of Experiments:

1: Measurement of drilling fluid
Equipment: The Baroid mud balance

2: Measurement of mud viscosity.
Equipment: Marsh funnel

3: Measurement of pH of mud.
Equipment: pH meter and hydrino pH dispenser

4: Determination of mud rheology (Viscosity, Gel strength, and Yield point).
Equipment: The Baroid rheometer

5: Determination of the loss of liquid from a mud.
Equipment: Standard API filter press

6: Measurement of a drilling mud cake and evaluate resistivity.
Equipment: Baroid digital resistivity meter

7: Measurement of the effect of adding bentonite on mud properties.
Drilling fluid contamination test (Salt, Gypsum & Cement contamination) and their effect on the drilling fluid properties.

8. Measurement of solid and liquid content and emulsification characteristics of drilling fluid.
Equipment: Sand content set, fann emulsion and electrical stability testers
9. Determination the amount of Calcium Carbonate ($CaCO_3$) and Magnesium Carbonate (Dolomite) in a sample of alkaline earth carbonates such as oil well cores or drilled cuttings.
Equipment: Calcimeter and Procedure is as per ASTM D 4373-84

10. Measurement of Oil, water, solid and clay content.
Equipment: Oil/ water retort kit

List of augmented experiments:
(Students has to perform any two experiments)

11. Measurement of water ratios for Portland cement slurry. (Effect of water ratio on free water separation normal and minimum water content and thickening time)
    a. Equipment: The atmospheric consistometer
12. Measurement of compressive strength of cement test moulds and effect of temperature and pressure on setting of the slurry.
    a. Equipment: Compressive strength testing machine

Reference Books:

1. Petroleum Engineering: Drilling and Well Completion, Carl Gatlin, Prentice-Hall, Inc., 1960.
2. Drilling Engineering: A Complete Well Planning Approach, Neal Adams, Tommie Charrier Pennwell, 1985.
3. Working Guide to Drilling Equipment and Operations, William Lyons, Gulf Publishing, 2009.
4. Applied Drilling Engineering, Adam T. Bourgoyne Jr., Keith K. Millheim, Martine E. Chenevert and F. S. Young Jr., Society of Petroleum Engineers, 1991.
5. Fundamentals of Drilling Engineering, Robert F. Mitchell, Stefan Z. Miska, Society of Petroleum Engineers, 2011.

Web Links:

1. www.slb.com/-/media/Files/resources/oilfield_review/.../Defining-Drilling.pdf?la=en..
2. https://www.spgindia.org/10_biennial_form/P414.pd
3. blog.sciencenet.cn/home.php? mod=attachment&id=3216
4. petrowiki.org/Strength_of_casing_and_tubing
5. petrowiki.org/Directional_drilling

INSTRUMENTATION, PROCESS DYNAMICS AND CONTROL LAB

V Semester **L T P C**
Course Code: 231PT5L02 **0 0 3 1.5**

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

CO 1: Experiment with the dynamic characteristics of first and second order systems.
CO 2: Apply the advanced control methods used for complex processes in the industries.
CO 3: Apply controllers like ON/OFF, P, PI, PD and PID for process systems.
CO 4: Identify the stability of the system with advanced control methods.
CO 5: Experiment with the types of control valves and the response of U-tube manometer.

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

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

List of Experiments:

1. Experiments with single capacity system.
   a. Major equipment- Single tank system, Two-tank systems (Interacting and Non-Interacting).

2. Experiments with two capacity systems with interaction.
   a. Major equipment- Single tank system, Two-tank systems (Interacting and Non-Interacting).
3. Experiments with two capacity systems without interaction.
   a. Major equipment- Single tank system, Two-tank systems (Interacting and Non-Interacting).

4. Control valve characteristics
   a. Major equipment – Control valve set up.

5. Calibration and determination of time lag of various first order instruments.
   a. Major equipment - First order instrument like Mercury-in-Glass thermometer and overall, second order instrument like Mercury-in-Glass thermometer in a thermal well.

6. Calibration and determination of time lag of various second order instruments.
   a. Major equipment - First order instrument like Mercury-in-Glass thermometer and overall, second order instrument like Mercury-in-Glass thermometer in a thermal well

7. Experiments on multi process trainer set up with computer
   a. Major equipment- PC-PID based feed backward Flow, Level, Pressure and Temperature control trainer

8. Experiments on I/P and P/I converters set up
   a. Major equipment – I/P and P/I converters set up

9. Level control trainer
   a. Major equipment - Level control trainer set up with computer.

10. Temperature control trainer
    a. Major equipment -Temperature control trainer with computer.

List of augmented experiments:
(Students has to perform any two experiments)

11. Experiments on proportional, reset, rate mode of control etc.
    a. Major equipment – PID control apparatus

12. Estimation of damping coefficient for U-tube manometer
    a. Major equipment - U-tube manometer.

13. Calibration of various temperature instruments like Thermocouple, RTD and Thermistor
    a. Major equipment: Temperature Measurement System

Reference Books:

1. Process Systems Analysis and Control, D.R. Coughanowr, 2nd Ed. McGraw Hill, 1991.
2. Chemical Process Control, G. Stephanopolous, Prentice Hall, 1984.

Web Links:

1. http://nptel.ac.in/courses/103103037/
2. http://www.bgu.ac.il/chem_eng/pages/Courses/oren%20courses/Chapter_10

MATLAB FOR PETROLEUM ENGINEERS
(Skill Oriented Course-III)

	L	T	P	C
V Semester	**L**	**T**	**P**	**C**
Course Code: 231PT5S01	**0**	**0**	**3**	**2**

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

CO1: Develop a program to create geological model using simple matlab code.
CO2: Make use of different homogeneous models for geological layers.
CO3: Apply the concepts of flow models in porous media.
CO4: Build grids of structured, unstructured and complex grids.
CO5: Develop GUI for the Grids Generated using the MRST

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 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	-	-	3	-	-	-	-	-	-	1
CO2	2	2	-	-	3	-	-	-	-	-	-	1
CO3	2	2	-	-	3	-	-	-	-	-	-	1
CO4	2	2	-	-	3	-	-	-	-	-	-	1
CO5	2	2	-	-	3	-	-	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

List of Experiments:

1. Create a geological model is a grid describing the geometry of the reservoir rock, here chosen as a regular 1 × 1 × 30 Cartesian grid.
2. Generate a square 10 × 10 grid model with a uniform porosity of 0.2 and isotropic permeability equal 200 mD
3. The 58 × 48 × 10 permeability field given in rock1.mat in the module contains an unusual geological structure. Can you find what it is? (Hint: if you want to explore the model interactively, you can try to use plotToolbar from the mrst-gui module).
4. Write a program that the function removeCells, which we will demonstrate in the next example, where we create a regular Cartesian grid that fills the volume of an ellipsoid.
5. Construct an areal Voronoi grid from a set of generating points obtained by perturbing the vertices of a regular Cartesian grid and then use the function makeLayeredGrid to extrude this Voronoi grid to 3D along vertical pillars in the z-direction.
6. Extended the function triangleGrid to triangulated surfaces in 3D. Verify that computeGeometry computes cell areas, cell centroids, face centroids, and face lengths correctly for 3D surfaces.
7. illustrate the use of the discrete operators, let us set up and solve the classical Poisson equation on a simple box geometry,subject to no-flow boundary conditions with q consisting of a point source at (0,0) and a point sink at (1,1).

8. Construct a Radial symmetric grids graded towards the origin are commonly used to increase resolution near wells.
9. Compare the sparsity patterns resulting from potential ordering and use of dmperm for both the upwind and the TPFA matrices.
10. The COORD field contains the pairs of 3D coordinates for the 15 coordinate lines that define the 4×2 mesh of pillars, whereas the ZCORN field gives the z-values that determine vertical positions uniquely along each coordinate line for the eight corner-

Reference Books:

1. Knut-Andreas Lie ,An introduction to reservoir simulation using matbabgnu and Octave, User Guide for the MATLAB Reservoir Simulation Toolbox (MRST),Cambridge press, 2019

Web Links:

1. https://www.mathworks.com/academia/books/an-introduction-to-reservoir-simulation-using-matlab-gnu-octave-lie.html
2. https://www.sintef.no/contentassets/8af8db2e42614f7fb94fb0c68f5bc256/mrst-book-2016.pdf
3. https://www.cambridge.org/core/books/an-introduction-to-reservoir-simulation-using-matlabgnu-octave/modeling-reservoir-rocks/D54C1FD08E64FDD810436E0651E40650

TINKERING LAB FOR PETROLEUM ENGINEERS

V Semester	**L**	**T**	**P**	**C**
Course Code: 231PT5L03	**0**	**0**	**2**	**1**

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

CO1: Design and build a scale model of a drilling rig.
CO2: Design an experiment to measure the viscosity of different fluids
CO3: Analyze different rock and mineral samples
CO4: Identify possible environmental risks from drilling wastes.
CO5: Create a simulated well logging experiment using PVC pipe well and various sensors.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 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	-	-	3	-	-	-	-	-	-	1
CO2	2	2	-	-	3	-	-	-	-	-	-	1
CO3	2	2	-	-	3	-	-	-	-	-	-	1
CO4	2	2	-	-	3	-	-	-	-	-	-	1
CO5	2	2	-	-	3	-	-	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

List of Experiments:

1. Model drilling rig: Design and build a scale model of a drilling rig to demonstrate the drilling process.
2. Sustainable Drilling Fluid Innovation: Develop eco-friendly drilling muds using natural or recycled materials. Material sourcing (e.g., plant-based additives, recycled materials). Cost-benefit and performance trade-offs. Testing rheology and filtrate loss.
3. Understanding real-world petroleum field equipment and processes.
4. Design an experiment to measure the viscosity of different fluids (Water, oil and glycerin).
5. Analyze different rock and mineral samples, collect from different fields. (economical and industrial purpose)
6. Model well logging: Create a simulated well logging experiment using PVC pipe well and various sensors (Temperature and pressure sensors)
7. Investigate the physical properties of rocks (eg: porosity, permeability) using simple experiments.
8. Fluid properties: Measure and compare the properties of different fluids (eg: density, viscosity) using homemade equipment.
9. Redesign The Test" activity — give a flawed or incomplete experiment setup and have students: Identify issues, Redesign the methodology, Justify improvements)

10. Entrepreneurship-Oriented Thinking in Petroleum Engineering: Design Sustainable solutions (bio-based drilling fluids, emission tracking)
11. Environmental Impact Assessment (EIA): Identify possible environmental risks: Drilling waste (cuttings, mud).

Reference Books:

1. Drilling Engineering J.J. Azar and G. Robello Samuel, PennWell Books, 2007.
2. Composition and Properties of Drilling and Completion Fluids, 5th Ed. H.C.H. Darley, George R. Gray, Gulf Professional Publishing, 1988.

Weblinks:

1) https://aim.gov.in/pdf/equipment-manual-pdf.pdf
2) https://atl.aim.gov.in/ATL-Equipment-Manual/
3) https://aim.gov.in/pdf/Level-1.pdf
4) https://aim.gov.in/pdf/Level-2.pdf
5) https://aim.gov.in/pdf/Level-3.pdf

SUMMER INTERNSHIP-I

V Semester **L T P C**
Course Code: 231PT5P01 **0 0 0 2**

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

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

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Guidelines:

1. The Internship is a team activity of 3 to 4 students.
2. The students can undergo Industrial Training / Internship at Govt. Organizations, software MNCs or do Research projects in National Laboratories/Academic Institutions like IITs, NITs etc. during summer breaks after completion of IV Semester.
3. An industrial related Project is an alternative to the Summer Internship, whenever there is an exigency and students cannot pursue their Summer Internship. A group of students or even a single student can take up the Community Service Project during summer breaks. However, a

student can opt for this only once. The students must identify social problems existing in any geographical area/village and try to solve them technically or suggest people the necessary solutions for solving these problems.

4. Prior letter and approval from the Head of the Department must be taken before applying to any organization for the course.
5. Every student should put in a minimum of 180 hours for the industry related Project during the summer vacation.
6. Each class/section should be assigned with a Project Coordinator.
7. The students are motivated to do projects based on societal needs using emerging technologies like IoT, Machine Learning, Deep Learning, Cyber security, cloud computing etc.,
8. After successful completion, students shall submit a summer internship technical report to the department concerned.
9. The student shall appear for the oral presentation before the Project Review Committee (PRC)* and an External Examiner.

PROFESSIONAL ETHICS AND HUMAN VALUES
(Audit Course)

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 work place.
CO5: Apply adequate knowledge on global code of conduct.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 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	-	-	-	-	-	-	2	-	-	-	-	-
CO4	-	-	-	-	-	-	2	-	-	-	-	-
CO5	-	-	-	-	-	-	2	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I
Human Values: Morals, Values and Ethics – Integrity –Trustworthiness - Work Ethics – Service Learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing – Honesty – Courage – Value Time – Co-operation – Commitment – Empathy – Self confidence – Spirituality- Character

Unit – II
Principles for Harmony: Truthfulness – Customs and Traditions -Value Education – Human Dignity – Human Rights – Fundamental Duties - Aspirations and Harmony (I, We & Nature) – Gender Bias - Emotional Intelligence – Salovey – Mayer Model – Emotional Competencies – Conscientiousness.

Unit – III
Engineering Ethics and Social Experimentation: History of Ethics - Need of Engineering Ethics - Senses of Engineering Ethics- Profession and Professionalism —Self Interest - Moral Autonomy – Utilitarianism – Virtue Theory - Uses of Ethical Theories - Deontology- Types of Inquiry –Kohlberg's Theory - Gilligan's Argument –Heinz's Dilemma - Comparison with Standard Experiments — Learning from the Past –Engineers as Managers – Consultants and Leaders – Balanced Outlook on Law - Role of Codes – Codes and Experimental Nature of Engineering

Unit – IV
Engineers' Responsibilities towards Safety and Risk: Concept of Safety - Safety and Risk – Types of Risks – Voluntary v/sInvoluntary Risk – Consequences - Risk Assessment – Accountability – Liability - Reversible Effects - Threshold Levels of Risk - Delayed v/s Immediate Risk - Safety and the Engineer – Designing for Safety – Risk-Benefit Analysis Accidents.

Unit – V
Engineers' Duties and Rights: Concept of Duty - Professional Duties – Collegiality - Techniques for Achieving Collegiality – Senses of Loyalty - Consensus and Controversy - Professional and Individual Rights –Confidential and Proprietary Information - Conflict of Interest-Ethical egoism - Collective Bargaining – Confidentiality - Gifts and Bribes - Problem solving-Occupational Crimes-Industrial Espionage- Price Fixing-Whistle Blowing Globalization and MNCs –Cross Culture Issues.

Text Books:
1. A Text Book On Professional Ethics And Human – R.S.Naagarazan.
2. Professional Ethics And Human Values By – M.P.Raghavan's – Scitech Publications (Indian Pvt., 2013).

Reference Books:
1. Engineering Ethics & Human Values By M.Govindarajan, S.Natarajan And V.S.Senthil Kumar-PHI Learning Pvt. Ltd – 2009.
2. Human Values And Professional Ethics By Jayshree Suresh And B. S. Raghavan, S.Chand Publications
3. Professional Ethics And Human Values By Prof.D.R.Kiran-Tata Mcgraw-Hill – 2014
4. Engineering Ethics By Harris, Pritchard And Rabins, Cengage Learning, New Delhi.

Web Links:
1. https://nptel.ac.in/courses/109104068
2. https://www.reelnreel.com/roles-and-responsibilities-of-a-typical-video-engineer/
3. http://nptel.ac.in/courses/109104068/30
4. http://nptel.ac.in/courses/122106031/Pdfs/2_1.pdf

PETROLEUM RESERVOIR ENGINEERING

VI Semester	**L**	**T**	**P**	**C**
Course Code: 231PT6T01	**3**	**0**	**0**	**3**

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

CO1: Apply basic Concepts of Reservoir Engineering
CO2: Estimate the PVT analysis parameters such as formation volume factor for oil and gas, solution gas ratio
CO3: Apply and estimate the reserves based on General Material Balance Equation
CO4: Evaluate the Permeability and Potential, mobility from Darcy's law
CO5: Apply Basic radial Flow differential equation and stabilized well inflow Estimation for Different system of equations, immiscible fluid displacement and water influx models.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	3	-	-	-	-	-	-	-	-	-	2
CO2	2	3	-	-	-	-	-	-	-	-	-	2
CO3	2	3	-	-	-	-	-	-	-	-	-	2
CO4	2	3	-	-	-	-	-	-	-	-	-	2
CO5	2	3	-	-	-	-	-	-	-	-	-	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
Some basic concepts in reservoir engineering: calculations 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, hydrocarbon phase behavior

Unit – II
PVT analysis of oil: definition of the basic PVT parameters, collection of fluid samples, alternative manner of expressing PVT lab analysis results, complete PVT analysis.

Unit – III
Darcy's Law and Application's: Darcy's Law and field Potential, sign convention, units and unit's conversion, real gas potential, datum pressures, radial steady state flow and well stimulation, two phase flow, effective and relative permeabilities.

Unit – IV
Oil and Gas well testing: objectives and basic concepts of well testing – Draw down and buildup tests for oil and gas reservoirs- interpretation and determination of damage factor, permeability and

reservoir pressure. Flow after flow tests, Isochronal tests and other deliverability tests for gas wells – Interference and pulse tests – type curves.

Unit – V

Immiscible Fluid Displacement: Basic Concepts like rock wettability, capillary pressure, relative permeability, mobility and mobility ratio, fluid displacement efficiency, volumetric displacement efficiency, total recovery efficiency. Fractional flow equations – Buckley – leverette equation – the Welge method.

Text Books:

1. Fundamentals of Reservoir Engineering, L.P.Dake, Elsevier science, 1978(17th Impression 1998).

2. Applied Petroleum Reservoir Engineering, Third Edition, B.C Craft and M.Hawkins, Revised By Ronald E.Terry & J.Brandon Rorgers, Prentice Hall, New York, 2014.

Reference Books:

1. Reservoir Engineering Handbook, Tarek Ahmed, 4th Edition, Gulf Professional Publishing, 2011.

2. Petroleum Engineering: Principles and Practice, J.S. Archer & C.G. Wall, Graham & Trotman Inc, 1986

3. Basic Reservoir Engineering, Rene Cosse, Editions, Technip, 1993.

Web Links:

1. https://author.energy-community.org/enc-author-prd/dam/jcr:4c5bb3db-e989-4b7d-a33e-244f4a51164a/1_PetroleumResEng_Basics.pdf

2. https://petrowiki.org/Fluid_sampling

3. https://petrowiki.org/Material_balance_in_oil_reservoirs

4. https://en.wikipedia.org/wiki/Darcy%27s_law

5. https://petrowiki.org/Oil_well_performance

PETROLEUM REFINING AND PETROCHEMICAL ENGINEERING

VI Semester	**L**	**T**	**P**	**C**
Course Code: 231PT6T02	**3**	**0**	**0**	**3**

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

CO1: Identify the types of petroleum feed stocks and products by their properties
CO2: Make use of process knowledge to solve operational problems and increase the efficiency
CO3: Apply the knowledge of crucial processes to meet the end product demands
CO4: Prioritize the demand of various petrochemicals to optimize the processes
CO5: Distinguish various petrochemical products and their uses

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 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
CO5	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: Overall refinery operations –Structure of a Refinery - World and Indian scenario in refining.
Refinery feed stocks: Crude oil classification - composition and properties – evaluation of crude oils.
Petroleum Products and their specifications: LPG – gasoline - diesel fuels - jet and turbine fuels – lube oils - heating oils – residual fuel oils - wax and asphalt- petroleum coke - all product specifications - product blending.

UNIT-II

Crude distillation: Atmospheric and vacuum distillation units, auxiliary equipment such as desalters, pipe-still heaters and heat exchanger trains etc.
Catalytic reforming and isomerization: Catalytic reforming processes (for petroleum and petrochemical feed stocks) – isomerization processes - feed stocks - feed preparation – process variables - yields.

UNIT-III

Thermal, Catalytic cracking, Hydro Cracking processes: Vis-breaking- delayed coking – fluid catalytic cracking - feed stocks –catalysts - process description and effect of process variables – Hydrocracking: feed stocks process description and effect of process variables.

Hydro treating & Hydro processing: Naphtha, kerosene, diesel, VGO & resid, hydro treating / hydro processing–catalysts – process description and effect of process variables.

UNIT-IV

Environmental issues in petroleum refining: Pollution in petroleum processes and operations-control, and disposal methods.

Petrochemical Industry: – Indian petrochemical industry- feed stocks – process description and process variables - naphtha cracking-gas cracking and gas reforming.

UNIT-V

Chemicals from gas reforming: Methanol- acetic acid- ammonia and urea. Chemicals from ethylene: Ethylene oxide-mono ethylene glycol - ethyl benzene-styrene. Polymers: LDPE, HDPE & LLDPE and polypropylene – PVC - polystyrene.

Text Books:

1. Petroleum Refining: Technology and Economics, J.H. Gary and G. E. Handwerk, 4thEdition, Marcel Dekkar, Inc., 2001.
2. Elements of Petroleum Processing, D S Jones, Wiley 1995.
3. Petrochemical Process Technology, ID Mall, Macmillan India Ltd., 2007.

Reference Books:

1. Petroleum Refining Engineering, WL Nelson, 4thEdition, McGraw Hill Company, 1958.
2. Chemical Technology of Petroleum, W. S. Gruese and D.R. Stevens, McGraw Hill, 1960.
3. Fundamentals of Petroleum Chemical Technology, P Belov, Mir Publishers, 1970.

Web Links:

1. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCH1308.pdf
2. https://www.slideshare.net/slideshow/presentation-on-crude-distillation-unit-cdu/220972295
3. https://www.slideshare.net/slideshow/hydrocracking/62192865
4. https://www.slideshare.net/NAVEN131/02-petrochemical-processes
5. https://chemicals.gov.in/sites/default/files/Reports/Publication%202021%20final-compressed.pdf

PETROLEUM PRODUCTION ENGINEERING

VI Semester	**L**	**T**	**P**	**C**
Course Code: 231PT6T03	**3**	**0**	**0**	**3**

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

CO1: Apply theconcepts of oil and gas properties
CO2: Apply the concept of different types of flow to start the production.
CO3: Apply the concepts of Nodal Analysis for Production Optimization and Well decline analysis for estimation of reserves
CO4: Design and operate artificial lift on reservoir pressure Depletion
CO5: Identify different types of well problems during production and solve them

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	3	-	-	-	-	-	-	-	-	-	2
CO2	2	3	-	-	-	-	-	-	-	-	-	2
CO3	2	3	-	-	-	-	-	-	-	-	-	2
CO4	2	3	-	-	-	-	-	-	-	-	-	2
CO5	2	3	-	-	-	-	-	-	-	-	-	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
Petroleum Production System: Overview of Petroleum Production Systems, production from various types of reservoir-based drive mechanisms, field development methods, safety control system.
Properties of Oil and Natural Gas: Solution gas-oil ratio, density of oil and gas, viscosity of oil and gas, formation volume factor of oil and gas, oil and gas compressibility, specific gravity of gas and gas pseudo critical pressure and temperature.

UNIT-II
Reservoir Deliverability: Flow regimes - transient, steady state, pseudo steady state, PTA, IPR for various types of wells.
Well bore Performance: Single & multiphase liquid flow in oil wells, single phase & mist flow in gas wells.
Choke Performance: Sonic & subsonic flow, single & multiphase flow in oil & gas wells.

UNIT-III
Well Deliverability: Nodal analysis with bottom-hole node, well head node and choke node for oil and gas wells.

Forecast of Well Production: Oil and gas production during transient flow period and pseudo transient period.
Production Decline Analysis: Exponential, harmonic and hyperbolic decline methods-model identification-determination of model parameters.
Safety Protocols and risk analysis: Principles and methods.

UNIT-IV
Artificial Lift Methods: Sucker rod pumping system- selection of unit and types of unit, Load & power requirements, performance analysis; electrical submersible pumps: principle, design & operation; gas lift system: types, evaluation of potential compression requirements, study of flow characteristics, principles of compression, types of compressors, selection of gas lift valves, types of valves, principles of valve operation, setting & testing.

UNIT-V
Well Stimulation: Well problem identification; matrix acidizing- design for sandstone & carbonate reservoirs, hydraulic fracturing – formation fracture pressure, geometry, productivity of fractured wells, hydro-fracture design, selection of fracturing fluid, propant, post frac evaluation.
Sand Control: Sand control and Monitoring Techniques.

Text Books:

1. Petroleum Production Engineering: A Computer Assisted Approach, BoyunGuo, 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, 1994.

Reference Books:

1. Production Technology I-II, Institute of Petroleum Engineering, Herriot Watt University.
2. The Technology of Artificial Lift Method, Vol. 1, Brown E., Pennwell Books, 1977.

Web Links:

1. https://www.academia.edu/31802625/Petroleum_Production_System
2. https://www.globalspec.com/reference/33548/203279/chapter-3-reservoir-deliverability
3. https://www.scribd.com/document/494994065/Guo-2005
4. https://www.slideshare.net/slideshow/artificial-lift-methods-195131260/195131260
5. https://www.slideshare.net/slideshow/well-stimulation-92559483/92559483

SUBSEA ENGINEERING
(Professional Elective – II)

	L	T	P	C
VI Semester	**L**	**T**	**P**	**C**
Course Code: 231PT6E01	**3**	**0**	**0**	**3**

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

CO1: Explain Overview on subsea engineering.
CO2: Explain the Subsea Distribution System.
CO3: Identification and monitoring of Subsea Control Systems
CO4: Studies on Subsea Power Supply and Subsea systems engineering
CO5: Understanding the Hydrates, Wax and Asphaltenes.

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

UNIT-I
Overview of Subsea Engineering: Introduction – Subsea production systems – Flow Assurance & System engineering – Subsea structures & Equipment – Subsea pipelines.
Subsea Field Development: Subsea field development overview – Deepwater or Shallow-Water development – Wet Tree & Drain tree systems – Subsea Tie-back development – Stand-Alone development – Artificial lift methods and Constraints – Subsea processing – Template, Clustered Well Systems & Daisy chain –Subsea field development assessment.

UNIT-II
Subsea Distribution System: Introduction – Design Parameters – SDS component design requirements.
Subsea Control: Introduction – Types of control systems – Topside equipment – SCMMB – SCM – Subsea transducers & Sensors – HIPPS – SPCS – IWOCS.
Subsea Power Supply: Introduction – Electrical power system – Hydraulic power system.

UNIT-III
Installation of Vessels: Introduction – Typical installation vessels – Vessel requirements & selection – Installation - positioning & Analysis.

Subsea System Engineering: Introduction – Typical flow assurance process - System design & Operability.
Hydraulics: Introduction – Composition & Properties of hydrocarbon – Emulsion – Phase behaviour – Hydrocarbon flow – Slugging & Liquid handling – Slug catcher design – Pressure surge – Line sizing.

UNIT-IV
Wax &Asphaltenes: Introduction - wax - wax management – wax remediation – asphaltenes – asphaltenes control design philosophies.
Hydrates: Introduction – physics & phase behaviour – hydrate prevention – hydrate remediation – hydrate control design philosophies – recovery of thermodynamic hydrate inhibitors.

UNIT-V
Heat Transfer & Thermal Insulation: Introduction – heat transfer fundamentals – u value – steady state heat transfer – transient heat transfer – thermal management strategy & insulation.
Subsea Corrosion & Scale: Introduction – pipeline internal corrosion – pipeline external corrosion – scales – overview of erosion & sand management.

Text Books:

1. Subsea Engineering Handbook, Yong Bai & Qiang Bai, Gulf Professional Publishing, New York, 2012.

Reference Books:

1. Offshore Drilling and Completions Training Manual, Drill – Quip, Inc.
2. Manual on Subsea Technology, IOGPT, ONGC.

Web Links:

1. https://chesssubseaengineering.com/wp-content/uploads/2015/05/Introduction-to-Subsea-Engineering-Full-Module.pdf
2. https://www.slideshare.net/slideshow/overview-of-subsea-production-systems-79622258/79622258
3. https://www.academia.edu/108837239/SUBSEA_ENGINEERING_HANDBOOK
4. https://topenergytraining.com/courses/production-to-midstream/lessons/pipelines/topic/hydrate-and-wax/
5 https://chesssubseaengineering.com/wp-content/uploads/2015/06/Subsea-Corrosion-Scale.pdf

FLOW ASSURANCE
(Professional Elective - II)

	L	T	P	C
VI Semester	**L**	**T**	**P**	**C**
Course Code: 231PT6E02	**3**	**0**	**0**	**3**

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

CO1: Explain Overview on subsea engineering.
CO2: Explain the Subsea Distribution System.
CO3: Identification and monitoring of Subsea Control Systems
CO4: Studies on Subsea Power Supply and Subsea systems engineering
CO5: Understanding the Hydrates, Wax and Asphaltenes.

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

Unit-I
Introduction to flow assurance; Pipe friction; Friction in Non-circular pipes; Friction loss in components.

Unit-II
Non-Newtonian Fluid & Friction; Transient flow; Transient flow; Simplified liquid flow solution; Heat Transfer Fundamentals; U-Value; Steady State / Transient Heat Transfer; Thermal management strategy and Insulation; Simulation Results & Program Testing.

Unit-III
Composition & properties of Hydrocarbons; Emulsion, Phase Behavior, Hydrocarbon Flow; Single, two, three & four phase regimes; conservation equations; 2 & 3 fluid models; friction, deposition & entrainment, solving two-phase three fluid equations; gas & Liquid slug including boiling & condensation.

Unit-IV:
Hydraulics
Two Phase Liquid-Liquid Flow; Two Phase Liquid-Gas Flow, Two Phase Liquid-Solid Flow; Three Phase Gas-Liquid-Liquid Flow; Three phase Gas-Liquid-Solid Flow

Unit-V: Hydrates, Wax & Asphaltenes
Physics & Phase Behavior; Hydrate Prevention; Hydrate Remediation; Hydrate Control Design Philosophies; Recovery of Thermodynamic Hydrate Inhibitors.
Wax; Wax Management; Wax remediation; Asphaltenes; Asphaltene control design philosophies

Text Books:
1. "Pipe Flow-1 Single Phase Flow Assurance" – Over Bratland (e-Book).
2. "Pipe Flow-2 Multi Phase Flow Assurance" – Over Bratland (e-Book).
3. "Subsea Engineering Handbook" – Yong Bai & Qiang Bai – Gulf Professional Publishing.

Reference book:
1. "Natural Gas Hydrates in Flow Assurance" – Dendy Sloan et.al – GPP.

Web Links:
1. https://www.drbratland.com/wp-content/uploads/2013/10/PipeFlow1_online_preview.pdf
2. https://thermtest.com/transient-vs-steady-state-for-thermal-conductivity-measurement
3. https://www.slideshare.net/slideshow/hydrocarbon-phase-behaviour/38903450
4. https://hedhme.com/content_map/?link_id=627&article_id=158
5. https://onepetro.org/OTCONF/proceedings/00OTC/00OTC/OTC-11963-MS/40777

NATURAL GAS HYDRATES
(Professional Elective - II)

VI Semester	**L**	**T**	**P**	**C**
Course Code: 231PT6E03	**3**	**0**	**0**	**3**

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

CO1: Explain the necessity of natural gas hydrates, different hydrate types and formers.
CO2: Apply different hand calculation methods and computer methods for rapid estimation of hydrate formation conditions.
CO3: Outline the design information for battling hydrates using chemicals and reasons responsible for dehydration of gas
CO4: Identify the regions fo pressure and temperature for combating hydrate formation and the importance of physical properties of design processes.
CO5: Examine the relationship between fluid phase equilibria and hydrate formation , water content of natural gas.

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

UNIT-I:
Introduction: Overview of natural gas hydrates- Natural gas- Water molecule- Hydrates- Water and natural gas- Free-Water- Heavy water- Units.
Hydrate types and formers: Type I hydrates- Type II hydrates- Size of the guest molecule- n-Butane- Other hydrocarbons and non-hydrocarbon molecules- Chemical properties of potential guests- Liquid hydrate formers- Type H hydrates- Hydrate forming conditions- Pressure-Temperature- Composition- Other hydrate formers- Mixtures- Examples.

UNIT-II:
Physical properties of hydrates: Molar mass - Density- Enthalpy of fusion- Heat capacity- Thermal conductivity- Mechanical properties- Volume of gas in hydrate- Ice versus hydrate- Examples.
Water content of natural gas: Equilibrium with liquid water- Equilibrium with solids- Examples.

UNIT-III:

Hydrate formation hand calculation methods: Gas gravity method- K-Factor method- Baillie-Wichert method- Comments on these methods- Examples.

Hydrate formation computer methods: Phase equilibrium calculations - Van der Waals and Platteeuw- Parrish and Priessnitz-Ng and Robinson Methods-Commercial software packages- Accuracy of these programs- Dehydration- Examples.

UNIT-IV:

Inhibiting hydrate formation with chemicals: Freezing point depression- Hammer-Schmidt equation- Nielsen-Bucklin equation- new method- Brine solutions- Advanced calculation methods- Inhibitor vaporization- Comment on injection rates- Kinetic inhibitors- Examples.

Dehydration of natural gas: Water content specification-Glycol dehydration- Molecular sieves- Refrigeration- Examples.

UNIT-V:

Combating hydrates using heat and pressure: Use of heat- Heat loss from a buried pipeline- Line heater deign- Two-Phase heater transfer- Depressurization- Melting a plug with heat- Examples.

Special problems: Gas hydrate conversion technology to natural gas – flow assurance methods - natural gas storage and transportation as gas hydrates.

Text Books:

1. Natural Gas Hydrates: A Guide for Engineers, John J. Carroll, Gulf Professional Publishers, 2003.
2. Clathrate Hydrates of Natural Gases, E. Dendy Sloan, Jr., C. Koh, 3rdEdition, CRC Press, 2007.

Reference Books:

1. Natural Gas Hydrates in Flow Assurance, E. Dendy Sloan, C. Koh, A. K. Sum, A. L. Ballard, J. Creek, M. Eaton, N. McMullen, T. Palermo, G. Shoup and L. Talley, Elsevier, 2010.

Web Links:

1. http://182.72.188.194:8080/jspui/bitstream/123456789/1509/1/Natural%20Gas%20Hydrates%20a%20Guide%20for%20Engineers%20by%20John%20Carroll.pdf
2. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2008RG000279
3. https://www.globalspec.com/reference/37987/203279/chapter-3-hand-calculation-methods
4. https://www.cheresources.com/invision/blog/4/entry-313-gas-hydrate-inhibitor-injection-calculations/
5. https://www.globalspec.com/reference/37991/203279/chapter-7-combating-hydrates-using-heat-and-pressure

HORIZONTAL WELL TECHNOLOGY
(Professional Elective - III)

VI Semester	**L**	**T**	**P**	**C**
Course Code: 231PT6E04	**3**	**0**	**0**	**3**

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

CO1: Assess various horizontal well technologies.
CO2: Assess the flow performance calculations of horizontal wells.
CO3: Calculate the mathematical solutions to transient well testing for different flow regimes.
CO4: Overcome challenges for different flow rates in horizontal wells.
CO5: Design a horizontal well.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 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	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT-I:
Overview of horizontal well technology: Introduction- Limitations of horizontal wells- Horizontal well applications- Drilling techniques- Horizontal well length based upon drilling techniques and drainage area limitations- Completion techniques.
Reservoir engineering concepts: Skin factor- Skin damage for horizontal wells- Effective wellbore radius r'_w - Productivity index, *f*- Flow regimes- Influence of areal anisotropy.

UNIT-II:
Steady-state solutions: Steady-state productivity of horizontal wells- Effective wellbore radius of a horizontal well- Productivity of slant wells- Comparison of slant well and horizontal well productivities- Formation damage in horizontal wells- Field histories.
Influence of well eccentricity: Introduction- Influence of well eccentricity- Drilling several wells- Horizontal wells at different elevations.

UNIT-III:

Comparison of horizontal and fractured vertical wells: Vertical well stimulation- Types of fractures- Comparison of horizontal wells and finite conductivity fractures- Horizontal wells in fractured reservoirs- Fractured horizontal wells.

Transient well testing: Introduction-Mathematical solutions and their practical implications- Generalized flow regimes- Pressure response- Detailed well testing flow regimes- Pressure derivatives - Wellbore storage effects- Practical Considerations.

UNIT-IV:

Pseudo-steady state flow: Generalized pseudo-steady state equation for vertical wells- Shape factors for vertical wells- Shape factors for fractured vertical wells- Shape factors of horizontal wells- Horizontal well pseudo-steady state productivity calculations- Inflow performance of partially open horizontal wells- Inflow performance relationship (IPR) for horizontal wells in solution gas-drive reservoirs- Predicting horizontal well performance in solution gas-drive reservoirs.

UNIT-V:

Water and gas coning in vertical and horizontal wells: Critical rate definition- Vertical well critical rate correlations- Critical rate by production testing- Decline curve analysis- Water breakthrough in vertical wells- Vertical well post-water breakthrough behavior- Characteristics of water cut versus recovery factor plots- Water and gas coning in horizontal wells- Horizontal well breakthrough time in a bottom water drive - Critical rate for horizontal well in edge-water drive reservoir - practical considerations.

Text Books:

1. Horizontal Well Technology, S. D. Joshi, PennWell Publishing Company, 1991.

Reference Books:

1. Horizontal Wells: Formation Evaluation, Drilling and Production Including Heavy Oil Recovery, Roberto Aguilera, G. M. Cordell, G. W. Nicholl, J. S. Artindete, M. C. Nq., Gulf Publishing Co., 1991.

Web Links:

1. https://www.directionaltech.com/wp-content/uploads/2016/10/tr0565.pdf
2. https://www.academia.edu/9769037/Augmentation_of_Well_Productivity_With_Slant_and_Horizontal_Wells
3. https://academic.oup.com/jge/article/12/6/978/5110795
4. https://core.ac.uk/download/pdf/204433088.pdf
5. https://www.academia.edu/19135950/CHARTER_8_WELL_CONIG

WELL COMPLETIONS, TESTING AND SERVICING
(Professional Elective – III)

	L	T	P	C
VI Semester	**L**	**T**	**P**	**C**
Course Code: 231PT6E05	**3**	**0**	**0**	**3**

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

CO1: Recognize specified equipment for well head installations
CO2: Apply DST/RFT tools to know the initial potential of the wells.
CO3: Illustrate the equipment for setting in the well for testing& production
CO4: Identify the logging tool for testing the zone
CO5: choose good work over operation whenever rigs less operation are required

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 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	3	-
CO2	3	-
CO3	3	-
CO4	3	-
CO5	3	-

UNIT-I:
Well completion: Types of wells- Completion functions- Types of completion.

UNIT-II:
Mechanical aspects of well testing- Logging equipment used in perforation methods and perforation equipment.

UNIT-III:
Packers: Function – Application - Proper selection - Packer setting – Packer loads - water / gas shut off, horizon separation etc.

UNIT-IV:
Completion equipment (SSD, SSSV, mandrels, locks etc.) - Data acquisition in wells - Fiber optics - Permanent gauges - Memory gauges - Intelligent completion equipment.
Tubing string design (dimension, materials and connections etc.) based on pressure, temperature, operating conditions – Media - Safety requirements.

UNIT-V:

Drill Stem Testing: General Procedure and considerations - Test tool components and arrangement - Analysis of Test data.

HPHT and horizontal well completions - Workover equipment and wireline tools - Snubbing unit - Coil tubing completion and work over design and execution. Well Servicing and Workover Operation.

Text Books:

1. Well Completion and Servicing, D. Perrin, Micheal Caron, Georges Gaillot, Editions Technip, 1999.
2. Primer of Well Service Work over and Completion, Petroleum Extension Service (PETEX), University of Texas at Austin, 1997.
3. Well Testing, John Lee, Society of Petroleum Engineers, 1982.

Reference Books:

1. Well Completion Design, Jonathan Bellarby, Elsevier, 2009.
2. Petroleum Engineering: Principles and Practice, J.S Archer & C.G. Wall, Graham & Trotman, Inc., 1986.
3. Advanced Well Completion Engineering, Wan Renpu, Gulf Professional Publishing, 2011.

Weblinks

1. https://www.scmdaleel.com/category/completion-equipment/107
2. https://petrowiki.org/PEH:Tubing_Selection,_Design,_and_Installation.

RESERVOIR MODELING & SIMULATION
(Professional Elective - III)

VI Semester	**L**	**T**	**P**	**C**
Course Code: 231PT6E06	**3**	**0**	**0**	**3**

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

CO1: Develop simple mathematical models to represent the reservoir production using mathematics and fundamentals of fluid flow.
CO2: Enhance the complexity of mathematical model to represent realistic reservoir conditions.
CO3: Represent the actual well production in simulators to simulate the performance.
CO4: Apply model solution approaches using linearization and method of linear equations.
CO5: Use software packages for reservoir characterization

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

UNIT-I:
Introduction: Milestones for the engineering approach-Importance of the engineering and mathematical approaches.
Single-phase fluid equations in multidimensional domain: Properties of single-phase fluid Properties of porous media- Reservoir discretization- Basic engineering concepts-Multidimensional flow in Cartesian coordinates- Multidimensional flow in radial-cylindrical coordinates.

UNIT-II:
Flow equation using CVFD terminology: Introduction- Flow equations using CVFD terminology- Flow equations in radial-cylindrical coordinates using CVFD terminology- Flow equation using CVFD terminology in any block ordering scheme.

UNIT-III:
Simulation with a block-centered grid: Introduction- Reservoir discretization- Flow equation for boundary grid blocks- Treatment of boundary conditions- Calculation of transmissibility-Symmetry and its use in solving practical problems.

UNIT-IV:

Simulation with a point distributed grid: Introduction- Reservoir discretization- Flow equation for boundary grid points-Treatment of boundary conditions-Calculation of transmissibilities - Symmetry and its use in solving practical problems.

Well representation in simulators: Introduction- Single block wells- Multi block wells-Practical considerations dealing with modeling and well conditions.

Petroleum Engineering-Single-phase flow equations for various fluids: Pressure dependence of fluid and rock properties-General single-phase flow equation in multi dimensions.

UNIT-V

Linearization of flow equation: Introduction- Nonlinear terms in flow equations- Nonlinearity of flow equations for various fluids- Linearization of nonlinear terms- Linearized flow equations in time.

Methods of solution of linear equations: Direct solution methods- Iterative solution methods.

Simulation packages: Case studies using packages such as CMG, COMSOL, FLUENT and MATLAB.

Text Books:

1. Petroleum Reservoir Simulation: A Basic Approach, Jamal H. Abou – Kasem, S. M. Fariuq Ali, M. Rafiq Islam, Gulf Publishing Company, 2006.

Reference Books:

1. Principles of Applied Reservoir Simulation, John R. Fanchi, Elsevier, 2005.
2. Practical Reservoir Simulation, M.R. Carlson, PennWell, 2003.
3. Reservoir Simulation: Mathematical Techniques in Oil Recovery, Zhangxin Chen, Cambridge University Press, 2008.
4. Mathematics of Reservoir Simulation, Richard E. Ewing, Society for Industrial and Applied Mathematics (SIAM), 1983.

Weblinks:

1. https://www.slideshare.net/slideshow/chapter-2-basic-single-phaseflow-equation/250867701
2. https://campusstore.miamioh.edu/petroleum-reservoir-simulations-cd-farouq/bk/9780976511366
3. https://onepetro.org/RE/article/6/04/477/53486/Simulation-of-Block-to-Block-Processes-in
4. https://pureadmin.unileoben.ac.at/WS/files/561651/Introduction_to_reservoir_simulation.pdf
5. https://onepetro.org/SJ/article/29/02/885/536057/Guided-Deep-Learning-Manifold-Linearization-of

BASIC CONCRETE TECHNOLOGY
(Open Elective-II)

VI Semester **L T P C**
Course Code: 231CE6O01 **3 0 0 3**

Course Outcomes:

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

CO1: Demonstrate the basic concepts of concrete.
CO2: Illustrate the importance of fresh concrete
CO3: Discuss the basic ingredient's role in the production of concrete.
CO4: Classify the fresh and the hardened concrete properties.
CO5: Design the concrete mix by BIS method.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I
Ingredients of Concrete cements & Admixtures
Portland cement – Chemical composition –Hydration, Setting of cement, Fineness of cement Structure of hydrate cement – Test for physical properties – Different grades of cements –Admixtures – Mineral and chemical admixtures – accelerators, retarders, air entrainers, plasticizers, super plasticizers, fly ash and silica fume.
Aggregates Classification of aggregate – Particle shape & texture – Bond, strength & other mechanical properties of aggregates – Specific gravity, Bulk density, porosity, adsorption & moisture content of aggregate – Bulking of sand –Deleterious substance in aggregate – Soundness of aggregate – Alkali aggregate reaction – Thermal properties – Sieve analysis – Fineness modulus – Grading curves – Grading of fine & coarse Aggregates – Gap graded and well graded aggregate as per relevant IS code – Maximum aggregate size. Quality of mixing water.

Unit – II
Fresh Concrete
Steps in Manufacture of Concrete–proportion, mixing, placing, compaction, finishing, curing – including various types in each stage. Properties of fresh concrete-Workability – Factors affecting workability – Measurement of workability by different tests, Setting times of concrete, Effect of time and temperature on

workability – Segregation & bleeding – Mixing and vibration of concrete, Ready mixed concrete, Concrete.

Unit – III
Hardened Concrete
Water / Cement ratio – Abram's Law – Gel space ratio –Nature of strength of concrete – Maturity concept – Strength in tension & compression – Factors affecting strength – Relation between compression & tensile strength – Curing, Testing of Hardened Concrete: Compression tests – Tension tests – Factors affecting strength – Flexure tests – Splitting tests – Non-destructive testing methods – codal provisions for NDT. Anti washout concrete.

Unit – IV
Elasticity, Creep & Shrinkage
Modulus of elasticity, Dynamic modulus of elasticity, Poisson's ratio, Creep of concrete, Factors influencing creep, Relation between creep & time, Nature of creep, Effects of creep – Shrinkage –types of shrinkage.
Mix Design Factors in the choice of mix proportions – Durability of concrete –Quality Control of concrete – Statistical methods – Acceptance criteria – Concepts Proportioning of concrete mixes by various methods – BIS method of mix design

Unit – V
Special Concretes
Ready mixed concrete, Shotcrete, Light weight aggregate concrete, Cellular concrete, No- fines concrete, High density concrete, Fiber reinforced concrete, Different types of fibers, Factors affecting properties of F.R.C, Polymer concrete, Types of Polymer concrete, Properties of polymer concrete, High performance concrete – Self consolidating concrete, SIFCON, self-healing concrete, Recycled concrete

Text Books:

1. Concrete Technology: Theory and Practice, M.L. Gambhir, McGraw Hill, 5th Edition, 2017.
2. Concrete Technology, M.S.Shetty, Chand Publication, 2006

Reference Books:

1. Concrete Technology, A.M. Neville and J.J. Brooks, Pearson,2019.
2. Concrete Technology, A.R. Santhakumar, Oxford,2018.

Web Links:

1. https://nptel.ac.in/courses/105102012
2. www.brighthubengineering.com › Concrete Technology

BASIC OF SURVEYING
(Open Elective-II)

VI Semester **L T P C**
Course Code: 231CE6O02 **3 0 0 3**

Course Outcomes:

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

CO1: Explain the various fundamental principles Geodetics
CO2: Explain the Measurement of Horizontal Distances.
CO3: Describe the Measurement of Directions and Angles horizontal and vertical plane.
CO4: Explain Plane Table Surveying
CO5: Describe the compute areas and volumes and represent 3D data on plane figures as contours.

Mapping of Course Outcomes with Program Outcomes:

CO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
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 **L T P C**
Course Code: 231CE6O03 **3 0 0 3**

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

CO1: Recognize the mechanisms of degradation of concrete structures and to design durable Concrete structures.

CO2: Conduct field monitoring and non-destructive evaluation of concrete structures

CO3: Design and suggest repair strategies for deteriorated concrete structures, including the use of composites for repair.

CO4: Understand the strengthening methods for concrete structures.

CO5: Assessment of the serviceability and residual life span of concrete structures by visual inspection and in situ tests.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT: I

Materials for repair and rehabilitation- Admixtures- Types of admixtures- Purposes of using admixtures, chemical composition, Natural admixtures and Carbon fiber wraps, Steel Plates, Nondestructive evaluation: Importance-Concrete behavior under corrosion, disintegrated mechanisms- moisture effects and thermal effects –Visual investigation- Acoustical emission methods-Corrosion activity measurement- chloride content–Depth of carbonation-Impact echo methods-Ultra sound pulse velocity methods- pull out tests.

UNIT: II

Strengthening and stabilisation- Techniques- design considerations shear capacity strengthening- Shear Transfer strengthening-stress reduction techniques- Column strengthening-flexural strengthening-Connection stabilization and strengthening, Crack stabilization.

UNIT: III

Bonded installation techniques-Externally bonded FRP-Wetlay 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 Books:

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_Rehabilitatio n_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
Course Code: 231EE6O01

L	T	P	C
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
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 – Draw backs of conventional vehicles – Need for electric vehicles– Advantages and applications of Electric Vehicles – History of Electric Vehicles – EV Market in India and outside India –Types of Electric Vehicles.

UNIT – II
Components of Electric Vehicles
Main components of Electric Vehicles – Electric Traction Motor and Controller –Power Converters – Rectifiers used in EVs – Bidirectional DC–DC Converters – Voltage Source Inverters – PWM inverters used in EVs.

UNIT – III

Motors for Electric Vehicles

Characteristics of traction drive – requirements of electric machines for EVs – Comparison of Different motors for Electric and Hybrid Vehicles – Induction Motors – Synchronous Motors – Permanent Magnetic Synchronous Motors – Brushless DC Motors – Switched Reluctance Motors (Construction details and working only).

UNIT – IV

Hybrid Electric Vehicles

Evolution of Hybrid Electric Vehicles – Advantages and Applications of Hybrid Electric Vehicles – Architecture of HEVs – Series and Parallel HEVs – Complex HEVs – Range extended HEVs – Examples – Merits and Demerits.

UNIT – V

Energy Sources for Electric Vehicles

Batteries– Types of Batteries – Lithium-ion – Nickel-metal hydride – Lead-acid – Comparison of Batteries – Battery Charging – Fast Charging –Battery Management System – Ultra capacitors – Flywheels – Compressed air energy storage (CAES)– Fuel Cell – it's working.

Text Books:

1 Iqbal Hussein - Electric and Hybrid Vehicles: Design Fundamentals - CRC Press - 2021.
2 Tom Denton, Hayley Pells - Electric and hybrid vehicles, Third Edition, 2024

Reference Books:

1 Kumar - L. Ashok - and S. Albert Alexander. Power Converters for Electric Vehicles. CRC Press - 2020.
2 Chau - Kwok Tong. Electric vehicle machines and drives: design - analysis and application. John Wiley & Sons - 2015.
3 Berg - Helena. Batteries for electric vehicles: materials and electrochemistry. Cambridge university press - 2015.

Web Links:

1 MOOC at https://www.edx.org/learn/electric-cars
2 https://archive.nptel.ac.in/courses/108/106/108106170

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)

	L	T	P	C
VI Semester	**L**	**T**	**P**	**C**
Course Code: 231ME6O01	**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:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	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

Weblinks:

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: 231ME6O02	**3**	**0**	**0**	**3**

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

CO1: Explain the theories of management and techniques of plant layout

CO2: Develop an efficient work system using method study and time study

CO3: Analyze the characteristics of quality control using control charts.

CO4: Explain the scope and nature of financial management

CO5: Discuss human resource management and value engineering

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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:

CO/PSO	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 – X and R –charts X and S charts and their applications, numerical examples.

Total Quality Management: Zero defect concept, quality circles, implementation, applications, ISO quality systems. Six Sigma–definition, basic concepts

Unit - IV

Financial Management: Scope and nature of financial management, Sources of finance, Ratio analysis, Management of working capital, estimation of working capital requirements, stock management, Cost accounting and control, budget and budgetary control, Capital budgeting – Nature of Investment Decisions – Investment Evaluation criteria- NPV, IRR, PI, Payback Period, and ARR, numerical problems.

Unit – V

Human Resource Management: Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job- evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, and types.

Value Analysis: Value engineering, implementation procedure, enterprise resource planning and supply chain management.

Text Books:

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

Reference Books:

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

Weblinks:

1. https://onlinecourses.nptel.ac.in/noc20_mg43/preview
2. https://onlinecourses.nptel.ac.in/noc24_me15/preview
3. https://onlinecourses.nptel.ac.in/noc20_me43/preview

ADDITIVE MANUFACTURING
(Open Elective-II)

VI Semester	**L**	**T**	**P**	**C**
Course Code: 231ME6O03	**3**	**0**	**0**	**3**

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

CO1: Demonstrate appropriate level of understanding on principles of additive manufacturing processes.
CO2: Identify the materials for solid based AM process.
CO3: Apply powder-based RP systems.
CO4: Analyze and apply various rapid tooling techniques.
CO5: Represent a 3D model in STL format and other RP data formats to store and retrieve the geometric data of the object.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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:

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

UNIT – 1
INTRODUCTION TO ADDITIVE MANUFACTURING: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages and Limitations of AM and Types of materials for AM.

LIQUID-BASED ADDITIVE MANUFACTURING PROCESS: Stereo lithography Apparatus (SLA): models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid Ground Curing (SGC): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT – 2
SOLID-BASED ADDITIVE MANUFACTURING PROCESS: Laminated object manufacturing (LOM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

Fused deposition modelling (FDM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

UNIT – 3

POWDER BASED ADDITIVE MANUFACTURING PROCESS: Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, Case studies. Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, applications, advantages and disadvantages, Case studies.

UNIT – 4

RAPID TOOLING: Introduction to rapid tooling (RT), conventional tooling Vs RT, Need for RT. rapid tooling classification: indirect rapid tooling methods: spray metal deposition, RTV epoxy tools, Ceramic tools, investment casting, spin casting, die casting, sand casting process. Direct rapid tooling: Direct AIM, LOM Tools, and Direct Metal Tooling using 3DP.

UNIT – 5

RAPID PROTOTYPING DATA FORMATS: STL Format, STL File Problems, consequence of building valid and invalid tessellated models, STL file Repairs: Generic Solution, other Translators, and Newly Proposed Formats.

AM APPLICATIONS: Application in engineering, analysis and planning, aerospace industry, automotive industry, jewelry industry, coin industry, GIS application, RP medical and bioengineering applications: customized implants and prosthesis, forensic sciences.

Text Books:

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

Reference Books:

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

Weblinks:

1. https://www.nist.gov/additive-manufacturing
2. https://archive.nptel.ac.in/courses/112/103/112103306/
3. https://www.open.edu/openlearn/science-maths-technology/additive-manufacturing/content-section-0?active-tab=description-tab

VEHICLE TECHNOLOGY
(Open Elective-II)

	L	T	P	C
VI Semester	**L**	**T**	**P**	**C**
Course Code: 231ME6O04	**3**	**0**	**0**	**3**

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

CO1: Discuss the latest trends in engine technology
CO2: Discuss the need of advanced combustion technologies and its impact on reducing carbon 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:

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/PSO	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	**L**	**T**	**P**	**C**
Course Code: 231ME6O05	**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:

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/PSO	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=jFDWlKayrTc

PRINCIPLES OF COMMUNICATIONS
(Open Elective-II)

	L	T	P	C
VI Semester	**L**	**T**	**P**	**C**
Course Code: 231EC6O01	**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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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, compounding 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.
3. 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.
5. https://soaneemrana.org/onewebmedia/ELECTRONICS%20COMMUNICATION%20SYSTEM%20BY% 20GEORGE%20KENNEDY.pdf

BIOMEDICAL ENGINEERING
(Open Elective-II)

VI Semester	**L**	**T**	**P**	**C**
Course Code: 231EC6O02	**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.
3. Medical Instrumentation Application and design, John G.Webster, Wiley India Edition, 2009.
4. Handbook of Biomedical Instrumentation, Khandpur R.S, Tata McGraw-Hill, New Delhi, 2nd edition, 2003

Reference Books:

1. Handbook of Bio-Medical Instrumentation, Khandapur, R.S., McGrawHill, 2nd edition, 2003
2. Biomedical Instrumentation, Arumugam, M., Anuradha Publications, 2006.
3. Health Care Systems, Technology and Techniques, Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Springer, 1st Edition, 2011.
4. Standard Handbook of Biomedical Engineering and Design, Myer Kutz, McGraw Hill Publisher, 2003.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_ee17/preview, 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/

ECAD TOOLS
(Open Elective-II)

VI Semester | **L** 3 | **T** 0 | **P** 0 | **C** 3
Course Code: 231EC6O03

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

CO1 Summarize the basic concepts on ECAD tools and PSPICE.
CO2 Build various types passive element circuits and its performance using PSPICE.
CO3 Construct BJT configuration amplifiers using PSPICE.
CO4 Build various FET amplifiers circuits using PSPICE.
CO5 Make use of MATLAB functions for solving the mathematical equations.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I
Introduction to ECAD tools: Introduction, various ECAD tools, applications of ECAD tools
Introduction to PSPICE: History, professional version, types of sources, analysis menu, circuit topology and analysis.

Unit – II
Implementation of passive circuits (RC, RL, LC, RLC) using Pspice: Voltage-current relation of an inductors, capacitors, series and parallel connections of initially uncharged capacitors and inductors, phasor relation for a resistor, capacitor, inductors. Charging and discharging responses of capacitors and inductors, natural responses of RLC circuits.

Unit – III
Implementation of active circuits using PSPICE: Diodes, transistor switches, BJT amplifiers-CE amplifier, CC amplifier, differential amplifier, and tuned amplifier, JFET amplifiers, MOSFET amplifiers-common source amplifier, common drain amplifier.

Unit – IV
Introduction to MATLAB: Array of numbers, MATLAB for plotting, functions in MATLAB, Vectors and matrices, linear equations geometry and statics, polynomials equations, Iterative solution of equations

Unit – V

MATLAB Simulink: Introduction to Simulink, model of momentum law, capacitor discharge, a mass spring dash spot system, series RLC circuit.

Applications of frequency domain: Introduction, signals, DFT, power spectrum, trigonometric expansion of signals, high frequency signals.

Text Books:

1. Circuit analysis with PSPICE, Nassir H. Sabah, 2017.
2. MATLAB and Simulink, Adrian B. Biran, CRC press Taylor& Francis group.

Reference Books:

1. Electronics Circuits and Systems, Owen Bishop, 4th edition, 2011.
2. MATLAB for Electrical and computer engineering, Roland Priemer, 2013.

Web Links:

1. https://www.mccormick.northwestern.edu/documents/students/undergraduate/introduction-to-matlab.pdf
2. https://vdocument.in/orcad-pspice-course-material.html

WEB TECHNOLOGIES
(Open Elective-II)

	L	T	P	C
VI Semester	**L**	**T**	**P**	**C**
Course Code: 231CS6O01	**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, Robet W Sebesta, Pearson.
2. Pro Mean Stack Development, 1st Edition, ELadElrom, 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: 231DS6O01

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:

1. Wes McKinney, "Python for Data Analysis",O'REILLY, ISBN:978-1-449-31979-3, 1st edition, October 2012.
2. Rachel Schutt & O'neil, "Doing Data Science", O'REILLY, ISBN:978-1-449-35865-5, 1st edition, October 2013

Reference Books:

1. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 2015
2. 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)

		L	T	P	C
VI Semester					
Course Code:	231IT6O01	**3**	**0**	**0**	**3**

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

CO1: Describe various concepts of operating systems and system calls.
CO2: Describe the concept of program, process and thread and analyze various CPU Scheduling Algorithms and compare their performance
CO3: Solve Inter Process Communication problems by various methods
CO4: Compare various Memory Management Schemes especially paging and Segmentation in Operating System and apply various Page Replacement Techniques.
CO5: Outline File Systems implementation in Operating System.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	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,10thEdition, 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: 231AM6O01	**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	-	-	-	-	-	-	-	-	-	-	-
CO2	1	3	-	-	-	-	-	-	-	-	-	-
CO3	1	2	-	-	-	-	-	-	-	-	-	-
CO4	1	3	-	-	-	-	-	-	-	-	-	-
CO5	2	2	-	-	-	-	-	-	1	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, ZvonkoVranesic, SafwatZaky, 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 **L T P C**
Course Code: 231PT6O01 **3 0 0 3**
Course Outcomes:

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

CO 1: Discuss about overview of drilling.
CO 2: Identify different types of drilling fluids and their hydraulics.
CO 3: Explain about types casing and cementation processes.
CO 4: Explain about application of directional drilling.
CO5: Estimate the kick and explain special kick problems.

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	2	-	2
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.

Web Links:

1. https://onepetro.org/books/book/74/chapter/14371674/Introduction-to-Well-Planning
2. https://onepetro.org/books/book/74/chapter/14367439/Fluid-Mechanics-for-Drilling
3. https://www.scribd.com/document/335022086/Casing-and-Cement-Theory
4. https://www.drillopedia.com/direction-drilling-applications
5. https://www.academia.edu/17285077/Well_Control_Manual

INTRODUCTION TO WELL COMPLETIONS
(Open Elective-II)

VI Semester **L T P C**
Course Code: 231PT6O02 **3 0 0 3**

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

CO 1: Discuss about functions of completions.
CO 2: Identify different types of perforation techniques.
CO 3: Explain about various completion equipment.
CO 4: Discuss about General Procedure and considerations of DST and Tubing string design.
CO5: Explain about well servicing and stimulation system.

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

CO / PSO	PSO 1	PSO 2
CO1	-	-
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.

Web Links:

1. https://www.slideshare.net/slideshow/well-completionspptx/256626844
2. https://www.scribd.com/presentation/454225251/Well-logging-perforation
3. https://www.scribd.com/document/742870395/H03440-Completion-Solutions-Catalog
4. https://www.scribd.com/document/517200042/Tubing-string
5. https://www.slideshare.net/slideshow/well-completion-well-intervention-stimulation-and-workover/92609098

INTRODUCTION TO PETROLEUM PRODUCTION ENGINEERING
(Open Elective – II)

VI Semester | **L T P C**
Course Code: 231PT6O03 | **3 0 0 3**

	L	T	P	C
VI Semester				
Course Code: 231PT6O03	3	0	0	3

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

CO 1: Explain about petroleum production system.
CO 2: Discuss about reservoir deliverability
CO 3: Explain about Choke performance
CO 4: Design of transportation system
CO5: Explain about artificial lift methods.

Mapping of Course Outcomes with Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	2	-	2
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.

Web Links:

1. https://www.scribd.com/document/381408982/Petroleum-Production
2. https://www.globalspec.com/reference/33548/203279/chapter-3-reservoir-deliverability
3. https://www.scribd.com/document/367547540/5-Choke-Performance-Pages-59-67
4. https://onlinelibrary.wiley.com/doi/10.1155/2021/6638135
5. https://www.slideshare.net/slideshow/introduction-artificial-lift/107960240

MINERAL ECONOMICS
(Open Elective – II)

VI Semester **L T P C**
Course Code: 231MI6O01 **3 0 0 3**

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

CO 1: Explain the economic significance of the mineral industry and analyze factors influencing mineral prices and national mineral policies.
CO 2: Classify mineral reserves and resources, apply geostatistical tools for estimation, and interpret demand trends through market surveys.
CO 3: Illustrate conservation methods, sampling techniques, and evaluate mineral losses, dilution, and recovery in economic terms.
CO 4: Conduct mine valuation using static and dynamic investment appraisal methods and analyze cost components in mine budgeting and finance.
CO 5: Assess mineral taxation systems, understand international trade in minerals, and evaluate the structure and challenges of mineral information systems.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT-I
General: Economic importance of the mineral industry; Risky nature of the mining industry; Demand and Supply analysis, National mineral policy;
Mineral price and pricing: International monetary system, Factors affecting mineral price, kinds of price quotation, Mineral price index, Mineral prices.

UNIT-II
Mineral Resource/Reserve: Concept, classification and estimation of reserves. Applications of Geostatistics.
Mineral inventory: concept, characteristic features, composition and economic significance; Estimation of life index.
Demand analysis and Market survey: Meaning and law of demand; methodology of demand analysis, Market survey.

UNIT-III

Conservation of mineral resources – Means of conservation and limitations in the scope of Conservation
Mine Sampling: Definition, purpose and scope, Preparation of samples, methods and computations; Application of statistical methods in sampling.
b - Classification and incorporation of losses, co-efficient of completeness of mineral extraction, Dilution and recovery
Examination of mineral properties: Definition, purpose, type and scope of examination.

UNIT-IV

Mine valuation: Basic concept, Earlier approaches to mine valuation, recent approaches to evaluation
Investment Appraisal: Elements of investment appraisal, Static methods of investment appraisal, Dynamic methods of appraisal, discounted cash flow analysis
Mining costs: Capital and operating costs; Factors affecting operating cost; Methods of estimating future costs; Standard cost and forecast; Budget and budgetary control.
Mine finance: Capital – its importance, various forms and formation; mine accountancy and book keeping.

UNIT-V

Mineral Taxation System: Theory of taxation on minerals, Mineral tax designing, Types of mineral taxes, Taxes affecting mineral sector
Internal and External Trade: Taxes and duties; Imports and exports; International investment and trade in mineral materials & products.
Mineral information system: Data-information-informatics-data base, Mineral information system in India and problems, Mineral information system in outside India.

Text Books:

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.

Reference Books:

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, discontinum 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.

Reference Books:

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.rocscience.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)

		L	T	P	C
VI Semester		3	0	0	3
Course Code:	231MI6O03				

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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'.

Reference Books:

1. Fundamentals of Remote Sensing' by George Joseph, Universities Press, (2013) 3rd Edition.
2. 'Fundamentals of Geographic Information Systems' by Michael N. Demers, Wiley India Pvt. Ltd, (2012) 4th Edition.

Web Links:

1. http://geology.wlu.edu/harbor/geol260/lecture_notes/notes.html
2. https://lecturenotes.in/subject/572/remote-sensing-and-gis-rsg
3. https://nptel.ac.in/downloads/105108077/

GEOSTATISTICS
(Open Elective – II)

VI Semester | **L T P C**
Course Code: 231MI6O04 | **3 0 0 3**

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

CO 1: Explain the stages of mineral exploration, sampling methods, and classical ore reserve estimation techniques.
CO 2: Apply classical statistical distributions and understand the foundational principles and scope of geostatistics in mineral resource evaluation.
CO 3: Construct and interpret semi-variograms and co-variograms, address modeling challenges, and apply basic Kriging methods for resource estimation.
CO 4: Analyze advanced geostatistical concepts including anisotropy, non-stationarity, and estimation variances for accurate grade control and mine planning.
CO 5: Utilize geostatistical tools for exploration optimization, mineral inventory computation, grade-tonnage modeling, and simulate real-world case studies.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PO	PSO1	PSO2	PSO3
CO1	-	-	-
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 statictics. Academic press. 1981.
2. Andereson F. Geo statictics 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 **L T P C**
Course Code: 231AG6O01 **3 0 0 3**

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

CO1: Calculate the basic engineering properties of a biological material.
CO2: Analyze the flow behavior of biological materials and force deformation.
CO3: Analyze the Maxwell and Kelvin model equations in the rheology for important biological materials.
CO4: Explain the applications of frictional and aerodynamic properties in the design of processingequipment.
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 propertiesin 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, AmericanSociety of Agricultural Engineers (ASAE), St. Joseph, Ml.
2. Engineering Properties of Biological Materials, O.P. Singhal and D.V.K. Samuel, SarojPrakashan,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)

	L	T	P	C
VI Semester	**L**	**T**	**P**	**C**
Course Code: 231AG6O02	**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

PETROLEUM ANALYSIS LAB

VI Semester **L T P C**
Course Code: 231PT6L01 **0 0 3 1.5**

Course Outcomes:

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

CO 1: Recognize specified equipment for testing various samples
CO 2: Apply various apparatus/equipment in determining analyze the various products of petroleum components
CO 3: Illustrate the equipment's for different petroleum products
CO 4: Identify the physical properties of different petroleum products
CO5: Choose transport properties of different petroleum products

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

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

List of Experiments:

1: Determination of Distillation characteristics of Crude Oil, Gasoline, Diesel and Kerosene.

2: Determination of Reid Vapor Pressure of Crude oil & Gasoline.

3: Determination of Viscosity of Diesel and Transformer oils.

4: Determination of Smoke Point of Kerosene.

5: Determination of Carbon Residue of petroleum oils.

6: Determination of Flash & Fire points of gasoline, kerosene and other products.

7: Estimation of Water content in petroleum products.

8. Estimation of Calorific value of solid, liquid and gaseous fuels by Junker's Calorimeter.

9: Determination of Aniline point of Gasoline and Diesel oil.

10: Determination of softening point of bitumen

List of augmented experiments: (Students has to perform all experiments)

11: Determination of Cloud & Pour Points of petroleum products.

12. Detection of Corrosiveness of petroleum products by copper strip equipment.

References:

1. http://www.corex.co.uk/our-services/pvtlaboratory-services/

PETROLEUM RESERVOIR SIMULATION AND ENGINEERING LAB

VI Semester **L T P C**
Course Code: 231PT6L02 **0 0 3 1.5**

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

CO 1: Recognize specified equipment for testing various samples
CO 2: Apply various apparatus/equipment in determining analyze the various products of petroleum components
CO 3: Illustrate the equipment's for different petroleum products
CO 4: Identify the physical properties of different petroleum products
CO5: Choose transport properties of different petroleum products

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

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

Reservoir Simulation Experiments:

1. File organization and structure
2. Selection of suitable by grid sensitivity studies.
3. Screening Criteria
   i. Fluid properties
   ii. Rock properties
4. Well Pattern and Boundary Conditions
5. Aquifer modelling (single and multiphase fluid flow: Oil-Water/Oil-Water-Gas)
6. History matching consisting of adjusting the parameters of the model such as permeability and porosity until the computed results for the historical period are close to historical data
7. Prediction of properties including permeability, relative permeability, saturation etc.

Reservoir Engineering List of Experiments:

1. Determination of effective porosity by gas expansion method.
   Equipment: Helium Porosimeter.
2. Determination of fluid density using Pycnometer and hydrometer methods.
   Equipment: Pycnometer and hydrometer.
3. Liquid viscosity measurement using capillary tube viscometer (Ostwald type).
   Equipment: Capillary tube viscometer.
4. Measurement of contact angle (between oil, water and solid surface) using imaging method.
   Equipment: The image system set-up.

5. Measurement of absolute permeability.
   Equipment: Constant head Permeameter with the Hassler cell.
6. Absolute permeability measurement using core flooding.
   Equipment: The Darcy apparatus.

.

Reference Books:

1. Principles of Applied Reservoir Simulation, JohnR.Fanchi,Elsevier,2005

Web Links:

1. http://authors.library.caltech.edu
2. http://www.cmg.org
3. http://www.ipt.ntnu.no
4. http://www.cadfamily.com
5. http://adl.stanford.edu

DRILLING SIMULATION LAB
(Skill Oriented Course-IV)

VI Semester **L T P C**
Course Code: 231PT6S01 **0 0 3 2**

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

CO 1: Assess the differences between normal drilling operations and abnormal conditions in drilling.
CO 2: Prevent abnormal conditions like Well kicks, Blowouts, Mud losses etc.
CO 3: Apply the concepts of handling the BOP, Panels, Choke manifold, remote panels etc., in case of any emergency situation.
CO 4: Apply the Well shut in procedures.
CO5: Assess the properties of drilling fluids for effective drilling.
Carry out sensitivity analysis for drill bit penetration.

Mapping of Course Outcomes with Program Outcomes

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

The following experiments are to be carried out using a drilling simulator:

1. **Familiarization and line-up of operational components – I**: Sand pipe manifold, draw work console, drilling console.
2. **Familiarization and line-up of operational components – II:** Blow out preventer (BOP) panel, remote panel.
3. **Familiarization and line-up of operational components – III:** Choke manifold.
4. **Operation of major components – I:** Mud pumps, operating slow circulation rate, operating the rotary table,
5. **Operation of major components – II:** Pulling weight on bit running in and pulling out of hole, remote choke panel operating.
6. **Kick identifications:** Setting flow alarms (deviation mud volume), setting flow alarms for return mud volume, identifying kick warning signs.
7. **Well shut in procedures:** Utilizing shut in procedures to kill well, well control computations.

8. Studies on the effect of weight on drill bit and rotary speed on the rate of penetration and wear of the bit.
9. Studies on the effect of mud density on the penetration and wear of the bit.
10. Studies on the effect of flow rate on the penetration and wear of the bit.

Reference Books:

1. Oilwell Drilling Engineering: Principles and Practice, H. Rabia, Graham & Trotman, 1985.
2. Fundamentals of Drilling Engineering, Robert F. Mitchell and Stefan Z. Miska, Society of Petroleum Engineers, 2011.
3. Well Control for the Rig-Site Drilling Team, IADC Well Control Committee, International Association of Drilling Contractors (IADC), 1992.

Web Links:

1. **https://iadc.org/wp-content/uploads/2020/04/DrillGuide_Example.pdf?utm**
2. **https://www.wellcontrol.com/?utm**

TECHNICAL PAPER WRITING & IPR
(Audit Course)

VI Semester **L T P C**
Course Code: 231MC6T01 **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:

1. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.

2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.

Reference Books:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books).

2. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.

3. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

4. Mayall, "Industrial Design", McGraw Hill, 1992.

Weblinks:

1. https://aits-tpt.edu.in/wp-content/uploads/2023/08/English-for-Research-Paper-Writing-20AOE9901-min.pdf

2. **https://www.scribbr.com/academic-writing/repetition-redundancy/**

3. **https://www.archives.gov/federal-register/write/legal-docs/ambiguity.html**

SOFT SKILLS
(Audit Course)

VI Semester **L T P C**
Course Code: 231MC6T03 **2 0 0 0**

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

CO1: Solve the problems on Time & Work, Time & Distance by simple methods.
CO2: Derive the conclusions, assumptions and arguments from the available information.
CO3: Write technical reports and emails for professional communication.
CO4: Solve problems on Permutations & Combination, Probability.
CO5: Participate confidently in a formal discussion and present themselves effectively.
CO6: Comprehend the techniques of skimming and scanning for effective communication.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

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

ENHANCED OIL RECOVERY TECHNIQUES

VII Semester	**L**	**T**	**P**	**C**
Course Code: 231PT7T01	**3**	**0**	**0**	**3**

Course Outcomes:

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

CO 1: Assess the secondary / tertiary recovery methods required for specific crude oil reservoirs.
CO 2: Design the injection and CO_2 flooding systems
CO 3: Apply the basic concepts of polymer flooding for its design.
CO 4: Apply the basic concepts of alkaline and surfactant flooding for their design.
CO5: Design the steam flooding, in-situ combustion and microbial systems for enhanced oil recovery.

Mapping of Course Outcomes with Program Outcomes

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

UNIT-I

Introduction: Different secondary and tertiary oil recovery techniques. Methods to improve the recovery factor at pore scale and macro scale, displacement and sweep efficiency.

UNIT-II

Low salinity water flooding:

Gas injection: Introduction, predictive performance, gas injection in carbonate reservoirs, inert gas injection, candidates for gas injection.

Miscible flooding: Introduction, sweep efficiency - high pressure gas injection, enriched gas drive, LPG slug drive; predictive technique, field applications.

Carbon dioxide flooding: Process description, field projects, CO_2 sources- problem areas, designing a CO_2 flood, guidelines for selection of miscible CO_2 projects, Immiscible CO_2 flooding conclusions, CO_2, WAG process.

UNIT-III

Polymer flooding: Introduction, polymer products and theory of use, planning polymer flood projects.
Polyacrylamides: Introduction, polyacrylamides chemistry, application of PAM/AA in enhanced oil recovery, factors affecting flow in porous media, Field considerations- site factors, Field operation.

UNIT-IV

Alkaline flooding: Introduction, types of caustic used, entrapment of residue oil, displacement mechanisms in alkaline flooding, crude oil properties, alkali consumption, pH of injected caustic, effect of sodium ions and sodium chloride, effect of divalent ions.
Surfactant flooding: Introduction, classification of EOR surfactants, mechanism of oil displacement by surfactant flooding, ultra-low interfacial tension in relation to oil displacement by surfactant flooding, factors influencing oil recovery, surfactant gas flooding for oil recovery, present status of the use of surfactants in oil recovery.

UNIT-V

Steam flooding for enhanced oil recovery: Introduction, theory- screening criteria for steam flood prospects, reservoir rock and fluid properties, heat losses and formation heating, an overview of steam flood modeling, parametric studies in steam flooding, economics of the steam flooding process - Cyclic steam injection - CCS and Steam assisted gravity drainage.
In-situ combustion technology: Introduction, reservoir characteristics, ignition-ignition methods, process in-situ combustion, use of in-situ combustion, conclusions, current status of in-situ combustion.
Microbial EOR: Introduction, Screening criteria for potential microbes, production characteristics and economics.

Text Books:
1. Applied Enhanced Oil Recovery, AurelCarcoana, Prentice Hall, 1992.
2. Enhanced Oil Recovery, Larry W. Lake, Prentice Hall, 1998.

Reference Books:
1. Enhanced Oil Recovery Processes and Operations, E.C. Donaldson, G. V. Chillingarian, T.F. Yew, Elsevier, 1998.
2. Basic Concepts in Enhanced Oil Recovery Processes, Marc Baviere, SCI, 1991.
3. Enhanced Oil Recovery: Proceedings of the Third European Symposium on Enhanced Oil Recovery, F. John Fayers, Elsevier, 1981.

Web Links:
1. https://onepetro.org/books/book/37/chapter/10934050/Introduction-to-Eor-Processes
2. https://core.ac.uk/download/pdf/286607734.pdf
3. https://www.academia.edu/5203818/POLYMER_FLOODING
4. https://onepetro.org/books/book/37/chapter/10938479/Chemical-Flooding
5. https://www.mdpi.com/2227-9717/13/3/618

MANAGEMENT AND ORGANIZATIONAL BEHAVIOUR

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231HS7T02	**2**	**0**	**0**	**2**

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

CO1: Explain a range of organizational behavior models key elements and roles.
CO2: Analyze the behavior of individuals and groups in organizations in terms of organizational behavior, interpersonal behavior and personality traits concepts.
CO3: Utilize various stress and emotional organizational behavior concepts, models and theories to real life management situations through case analysis.
CO4: Make use of organizational communication and organization culture to understanding of organizational communication and culture to cope up with the organization better way
CO5: Classify the different groups and teams in the organization and its features for dealing these groups in a good way for better result and motivate them

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I
Organizational Behavior: Concept of Organizational Behavior (OB)- Importance of Organizational Behaviour2¬ Key Elements of Organizational Behavior, Role of Managers in OB- Interpersonal Roles- Informational Roles- Decisional Roles, Foundations or Approaches to Organizational Behavior, Challenges and Opportunities for OB.

Unit – II
Interpersonal Behavior: Nature and meaning of Interpersonal Behavior, Concept of Self, Transaction Analysis (TA), Benefits and uses of Transactional Analysis, Johari Window Model.
Personality: Definition and Meaning of Personality - Importance of Personality, Determinants of Personality, Theories of Personality, Personality Traits Influencing OB.

Unit – III
Emotions: Nature and Meaning of Emotions - Characteristics of Emotions, Theories of Emotions, Emotions in the Context of OB.
Organizational Stress: Definition and Meaning, Sources of Stress, Types of Stress, Impact of Stress on Organizations, Stress Management Techniques.

Unit – IV

Organizational Communication: Meaning and Importance of Communication, Functions,process,types,InterpersonalCommunication,Organizational Communication, Tips for Effective Communication.

Organization Culture: Meaning and Nature of Organization Culture - Origin of Organization Culture, Functions of Organization Culture, Types of Culture, Creating and Maintaining Organization Culture, Managing Cultural Diversity.

Unit – V

Groups and Teams: Meaning and Importance of Groups, Reasons for Group Formation, Types of Groups, Stages of Group Development, Meaning and Importance of Teams, Types of Teams, Creating an Effective Team.

Text Books:

1. K. Ashwathappa, Organizational Behavior, Himalaya Publishing House, 2005.
2. Dr.P.Subba Rao and Prof. N.SambasivaRao:"Management and Organizational Behaviour - (Text and Cases)", Himalaya Publishing House, Mumbai

Reference Books:

1. UdaiPareek, Understanding OrganisationalBehaviour, 2nd Edition, Oxford Higher Education, 2004
2. Mc Shane & Von Glinov, OrganisationalBehaviour, 4th Edition, Tata Mc Graw Hill, 2007
3. Anjali Ghanekar, Organizational Behavior, Everest Publications, 2001
4. PareekUdai: "Understanding Organizational Behavior", Oxford University Press, New Delhi, 2007.

Web Links:

1. https://www.youtube.com/watch?v=JIa7vP3gyL4
2. https://www.youtube.com/watch?v=-sLHfYnxh8s&list=PLbMVogVj5nJQYXoO3foSZ6CrU7aCCwTsb
3. https://www.youtube.com/watch?v=YIyjkkUk80w

HSE IN PETROLEUM INDUSTRY
(Professional Elective-IV)

VII Semester **L T P C**
Course Code: 231PT7E01 **3 0 0 3**

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

- CO 1: Assess the environment issues.
- CO 2: Design safe drilling fluids and control the toxic effects of drilling fluids on environment.
- CO 3: Assess toxicity of the petroleum hydrocarbons and their mixtures
- CO 4: Implement the oil mines regulations in petroleum operations.
- CO5: Apply the HAZOP in various petroleum operations to identify the risk.

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

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

UNIT-I
Introduction to environmental control in the petroleum industry: Overview of an environmental impact studies as per the norms - a new attitude-air emissions
Drilling and production operations: Drilling- production.

UNIT-II
The impact of drilling and production operations: Measuring toxicity- hydrocarbons- salt- heavy metals-production chemicals- drilling fluids- produced water- nuclear radiation- air pollution- acoustic impacts-effects of offshore platforms- risk assessment.
Environmental transport of petroleum wastes: Surface paths- subsurface paths- atmospheric paths, planning for environmental protection.
Waste treatment methods: Treatment of water- treatment of solids- treatment of air emissions-waste water disposal: surface disposal.

UNIT-III
Oil mines regulations: Introduction-returns, notices and plans- inspector, management and duties- drilling and workover- production- transport by pipelines- protection against gases and fires- machinery, plants and equipment- general safety provisions- miscellaneous-remediation of contaminated sites- site assessment-remediation process.

UNIT-IV

Toxicity, physiological, asphyxiation, respiratory, skin effect of petroleum hydrocarbons and their mixtures - sour gases with their threshold limits-toxicity of additives for acidizing and hydro-fracturing.

UNIT-V

Hazard identification- Hazard evaluation- HAZOP and what if reviews- developing a safe process and safety management- personal protection systems and measures – safe installation and operation of electrical equipment.

Classification of fires- the fire triangle- distinction between fires and explosions- flammability characteristics of liquids and vapors- well blowout fires and their control- fire fight equipment- suppression of hydrocarbon fires.

Text Books:

1. Environmental Control in Petroleum Engineering, John C. Reis, Gulf Publishing Company, 1996.
2. Application of HAZOP and What if Reviews to the Petroleum, Petrochemical and Chemical Process Industries, Dennis P. Nolan, Noyes Publications, 1994.
3. Oil Industry Safety Directorate (OISD) Guidelines, Ministry of Petroleum & Natural Gas, Government of India and Oil Mines Regulations-1984, Directorate General of Mines Safety, Ministry of Labor and Employment, Government of India.

Reference Books:

1. Guidelines for Process Safety Fundamentals in General Plant Operations Centre for Chemical Process Safety, American Institute of Chemical Engineers, 1995.
2. Guidelines for Fire Protection in Chemical, Petrochemical and Hydrocarbon Processing Facilities, Centre for Chemical Process Safety, American Institute of Chemical Engineers, 2003.
3. Guidelines for Hazard Evaluation Procedures Centre for Chemical Safety, Wiley- AIChE, 3rd Edition, 2008.
4. Guideline for Process Safety Fundamentals in General Plant Operations, Centre for Chemical Process Safety, AIChE, 1995.
5. Chemical Process Industry Safety, K S N Raju, Mc Graw Hill, 2014.

Web Links:

1. https://download.e-bookshelf.de/download/0000/0040/57/L-G-0000004057-0002333401.pdf
2. https://www.ifc.org/content/dam/ifc/doc/2000/2007-english-offshore-oil-and-gas-dev-retired.pdf
3. https://www.scribd.com/document/831232500/PSO-SYLLABUS
4. https://www.scribd.com/document/239880035/r41273-Hse-Ff-in-Petroleum-Industry-1
5. https://www.bostontech.net/wp-content/uploads/2020/10/Pocket-Guide-Automations-4.HAZOPs-Hazard-Operations.pdf

OIL FIELD CHEMICALS
(Professional Elective- IV)

VII Semester **L T P C**
Course Code: 231PT7E02 **3 0 0 3**

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

CO 1: Explain about Characterization of Drilling Muds.
CO 2: Discuss about Bacteria Control and Corrosion Inhibitors
CO 3: Differentiate between various cement additives.
CO 4: Illustrate the Mechanism of Drag Reducers and Antifreeze Agents
CO5: Difference between Dispersants, Defoamers and Demulsifiers

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

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

UNIT – I:
Drilling Muds: Classification of Muds, Mud Compositions, Additives, Cuttings Removal by Sweep Materials, Junk Removal, Drilling Fluid Disposal, Characterization of Drilling Muds. Fluid Loss Additives: Mechanism of Action of Fluid Loss Agents, Polysaccharides, Synthetic Polymers. Clay Stabilization: Properties of Clays, Mechanisms Causing Instability, Inhibitors of Swelling, Chemicals in Detail. Bit Lubricants: Refractory Metals, Natural Compounds.

UNIT – II:
Bacteria Control: Mechanisms of Growth, Treatments with Biocides, Bactericides, Various Biocides, Bacterial Corrosion, Assessment of Bacterial Corrosion, Mechanisms of Microbial Corrosion.
Corrosion Inhibitors: History, Classification of Corrosion Inhibitors, Fields of Application, Application Techniques, Analytic Procedures, Side Effects, Amides and Imidazolines, Nitrogenous Bases with Carboxylic Acids, Nitrogen Quaternaries, Polyoxylated Amines, Amides, and Imidazolines, Nitrogen Heterocyclics, Carbonyl Compounds, Phosphate Esters, Silicate-based Inhibitors, Miscellaneous Inhibitors.

UNIT – III:
Scale Inhibitors: Scale Inhibition, Mathematical Models, Chemicals in Detail, Characterization,
Gelling Agents: Basic Mechanisms of Gelling Agents.

Filter-cake Removal: Organic Acids, Bridging Agents, Enzymatic Breaker, Peroxides, Oligosaccharide, Oscillatory Flow.
Cement Additives: Basic Composition of Portland Cement, Special Cement Types, Classification of Cement Additives, Additives in Detail.

UNIT – IV:
Transport: Pretreatment of the Products, Corrosion Control, Paraffin Inhibitors, Pour Point Depressants, Drag Reducers, Hydrate Control, Additives for Slurry Transport, Additives for Odorization, Cleaning.
Drag Reducers: Operating Costs, Mechanism of Drag Reducers, Drag Reducers in Detail
Gas Hydrate Control: The Relevance of Gas Hydrates, Inclusion Compounds, Clathrates, Conditions for Formation, Formation and Properties of Gas Hydrates, Inhibition of Gas Hydrate Formation, Hydrate Inhibitors for Drilling Fluids.
Antifreeze Agents: Theory of Action-colligative Laws, Overview of Antifreeze Chemicals, Heat-transfer Liquids, Hydraulic Cement Additives, Pipeline Transportation of Aqueous Emulsions of Oil, Low-temperature Drilling Fluids.
Odorization: Additives for Odorization, Measurement and Odor Monitoring, Uses and Properties.

UNIT – V:
Water Shutoff: Basic Principles, Chemicals for Water Shutoff.
Oil Spill-treating Agents: History, Contents.
Dispersants: Cement, Aqueous Drilling Muds, Miscellaneous.
Defoamers: Uses in Petroleum Technology, Classification of Defoamers, Theory of Defoaming.
Demulsifiers: Emulsions in Produced Crude Oil, Waterflooding, Oil Spill Treatment, Desired Properties, Mechanisms of Demulsification, Performance Testing, Classification of Demulsifiers, Chemicals in Detail.

Text Books:

1. Oil Field Chemicals, Johannes Karl Fink, Gulf Professional Publishing is an imprint of Elsevier Science, 2003.

Reference Books:

1. Oil and Gas Production Handbook: An Introduction to Oil and Gas Production, Havard Devold, ABB Oil and Gas, 2006.

Web Links:

1. https://www.learntodrill.com/post/drilling-fluids-types
2. https://www.frontiersin.org/journals/materials/articles/10.3389/fmats.2018.00010/full
3. https://international.scholarvox.com/catalog/book/88829586?_locale=en
4. https://catalog.buse.ac.zw/cgi-bin/koha/opac-detail.pl?biblionumber=84285
5. https://inis.iaea.org/collection/NCLCollectionStore/_Public/37/098/37098386.pdf

ADVANCED NATURAL GAS ENGINEERING
(Professional Elective- IV)

VII Semester **L T P C**
Course Code: 231PT7E03 **3 0 0 3**

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

- CO 1: Estimation of Natural gas properties and application of suitable techniques for natural gas exploration and production.
- CO 2: Estimation of liquid loads on gas wells using various techniques
- CO 3: Design Natural gas transportation systems, pipelines and compression systems
- CO 4: Selection & design of Liquified Natural Gas processes & loading /transportation systems.
- CO5: Design of Natural gas underground storage and operational aspects.

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

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

UNIT-I:
Natural Gas Basics: Natural gas origin and its types -Accumulations- Natural gas resources-Natural gas composition and phase behavior- Review of natural gas properties. Estimation of the Natural Gas in the Reservoir.

UNIT-II:
Unique issues in natural gas exploration, Drilling and Well completion: Exploration Drilling-Well completion.
Natural Gas Production: Darcy and non-Darcy flow in porous media -Gas well inflow under Darcy flow and non-Darcy flow -Horizontal gas well inflow- Hydraulic fracturing- Well deliverability.
Liquid loading on gas wells: Turner's methods – Guo's methods – Comparison of methods.

UNIT-III:
Natural gas processing: Natural gas and liquid separation- Dehydration-Sweetening.
Natural gas transportation- Pipelines and compressed natural gas: Pipelines- Marine CNG Transportation.

UNIT-IV:
Hydrate control: Hydrate forming conditions – Preventing hydrate formation.
Pipeline cleaning: Pigging system – Selection of pigs – Major applications – Pigging procedure.
Liquefied Natural gas: LNG liquefaction processes- Thermodynamic analyses- C3 MR process Single mixed refrigerant loop process- Mixed fluid cascade process- Liqulifin TM process DMR process- LNG carriers- LNG terminals.

UNIT-V:
Gas-To-Liquids (GTL): Why GTL? - GTL processes GTL based on direct conversion of natural gas- GTL based on indirect conversion of natural gas- GTL economics.
Underground Natural gas storage: Types of underground storage- Storage measures -Losses in gas storage- Injectivity in gas storage well.

Text Books:
1. Advanced Natural Gas Engineering, Xiuli Wang and Michael Economides, Gulf Publishing Company, 2009.
2. Natural Gas Engineering Handbook, Bojun Guo and Ali Ghalambor, Gulf publishing company, 2005.

Reference Books:
1. Handbook of Natural Gas Engineering, D.L.Katz, McGraw-Hill, 1959.
2. Natural Gas Production Engineering, Chi U. Ikoku, Krieger Publishing Company, 1992.
3. Troubleshooting Natural Gas Processing: Well head to Transmission, Norman P. Lieberman, Pennwell Publishing Company, 1997.
4. Practical Natural Gas Engineering, R.V.Smith, 2nd Edition, PennWell, 1990.

Web Links:
1. https://www.slideshare.net/EngElsayedAmer/3-natural-gas-composition
2. https://www.degruyterbrill.com/document/doi/10.1515/9783110691023-006/pdf?licenseType=restricted&srsltid=AfmBOoqr765kE_wiSR6BNfOtaKauqvTud3Zfupb5ISWY7zL1-qgKPZUU
3. https://www.slideshare.net/slideshow/le-03-natural-gas-ng-transportation-and-distribution/137720008
4. https://library.e.abb.com/public/34d5b70e18f7d6c8c1257be500438ac3/Oil%20and%20gas%20production%20handbook%20ed3x0_web.pdf
5. https://petrowiki.spe.org/Gas_to_liquids_(GTL)

PETROLEUM ECONOMICS, POLICIES AND REGULATIONS
(Professional Elective- V)

VII Semester	**L**	**T**	**P**	**C**
Course Code: 231PT7E04	**3**	**0**	**0**	**3**

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

CO 1: Assess the importance of petroleum sector in the world economy, both the macro and micro-economic environment and as applicable to India.
CO 2: Apply the principles, methods and techniques of petroleum engineering economics in the evolution of petroleum projects.
CO 3: Demonstrate the Project lifecycles and estimation of oil reserves.
CO 4: Explain the demand and marketing of petroleum products.
CO5: Apply the policies and regulations in project implementation and operation of petroleum projects.

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

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

UNIT-I
Macro-Economic Approach of Petroleum Industry: Political environment related to petroleum industry and issues related to government and corporate interests, need for understanding petroleum economics required to make investment decisions; introduction, role and value of oil & gas, evolution of national oil companies, organization of petroleum exporting countries.

UNIT-II
Principles, Methods and Techniques of Petroleum Engineering Economics: Introduction, outline and key terminologies and generic issues of micro-economic analysis applicable to all sectors of the oil and gas supply chain, capital budgeting and capital efficiency, sources of revenue and cost and profitability analysis, operating expenditures (OPEX) and their fixed, variable and marginal components, economic indicators and yardsticks used to rank asset values (NPV, IRR, etc.)
Managing and Mitigating Uncertainty and Risk: Risk, uncertainty and decision analysis, analysis of alternative selections and replacements**,** managing and mitigating uncertainty and risk -breakeven and

sensitivity analysis, optimization techniques, geopolitical risks and opportunities and hedging strategies to mitigate market and price risks, asset valuation process: fair market value, probability and risk.

UNIT-III

Application and Project Evaluation: Project lifecycles, optimum economic life and multi-year cash flows, oil fields exploration and drilling operations, estimation of oil reserves and evaluation of an oil property, project financial analysis, project development - utilization oil fields - production operations - oil transportation - crude oil processing.

UNIT-IV

Valuing Petroleum Assets, Portfolios and Companies: Asset valuation process: fair market value, probability and risk, risk adjustments when valuing petroleum reserve categories, the portfolio approach to asset and corporate management, portfolio characterization, balance and diversification.

Demand and Marketing of Petroleum Products: Crude oil fundamentals, price of crude, crude oil prices in transactions, internal markets and prices, marketing and sale of motor, aviation, lubricant, asphalt and propane transportation: fundamentals of transportation, pipelines, oil tankers, downstream transportations, distribution of petroleum products.

UNIT-V

Oil & Gas Policies and Regulations: Petroleum, oil & gas rules and regulations in India, the oil fields regulations and development act, new exploration licensing policy (NELP), functions of directorate general of hydrocarbons, petroleum and natural gas regulatory board.

Case studies: Economic study of an oil filed development project, petrochemical plant project, natural gas liquefaction cost (including industrial and managerial economics).

Text Books:

1. Petroleum Economics and Engineering, Third Edition, Hussein K. Abdel-Aal, Mohammed A. Alsahlawi, CRC Press, 2013.
2. Petroleum Economics, Heriot-Watt University, 2003.

Reference books:

1. The Global Oil & Gas Industry: Management, Strategy and Finance, Andrew Inkpen & Michael H. Moffett, 2011.
2. Petroleum Economics, Jean Masseron, Technip; 4th revised Edition, 2000.

Web Links:

1. https://www.elibrary.imf.org/display/book/9781616353797/ch003.xml
2. https://www.scribd.com/presentation/720305879/Introduction-to-Petroleum-Economics
3. https://www.spe.org/industry/docs/PRMS_Guidelines_Nov2011.pdf
4. https://www.vignan.ac.in/subjectsnew/16PL308.pdf
5. https://blog.ipleaders.in/regulation-natural-gas-sector-india/

ASSET MANAGEMENT
(Professional Elective- V)

VII Semester **L T P C**
Course Code: 231PT7E05 **3 0 0 3**

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

CO 1: Apply the principles of asset management for oil and gas industry.
CO 2: Evaluate the processes and modelling paradigms needed to develop the skills to increase reservoir output, profitability and decrease speculation.
CO 3: Develop modern reservoir management teams keeping in mind the technical diversity.
CO 4: Implement the concepts of reservoir management.
CO5: Create an interdisciplinary approach for solving day to day problems in petroleum assets.

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

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

UNIT-I
Asset Management: The corporate dimension – data gathering – interpreting the main data.

UNIT-II
Developing a Decision Making Frame Work: Populating asset management plans – creating a strategic outline and business case for investment – the corporate asset management plan; developing an integrated asset management and capital planning system.

UNIT-III
Concepts of Reservoir Management: Reservoir management process – data acquisition, analysis and management - reservoir performance analysis and forecast – reservoir management economics – reservoir management case studies.

UNIT-IV
Industrial Asset Management Strategies for the Oil and Gas Sector: Over view of onshore and offshore assets – integration and optimization methodology – a case study in OPEX of the assets – evaluation of asset performance.

UNIT-V

An Asset Management Model: Typical oil field workflow – workflows for asset management – an automated approach to data quality management – change management – risk based asset management model – program evaluation and evaluation techniques (PERT) And Critical path method (CPM) .

Text Books:

1. A guide to Asset Management and Capital Planning in Local authorities, CIPFA, 2008.
2. The Big Picture: Integrated Asset Management Cedric Bouleau et al, Oil field Review, 2007/2008.
3. Integrated Petroleum Reservoir Management, A team approach, Abdus, Satter and Ganesh C. Thakur, PennWell, Tulsa, 1994.

Reference Books:

1. Handling Risk and Uncertainty in Petroleum Exploration and Asset Management, American Association of Petroleum Geologists, 2015.
2. Integrated Reservoir Asset Management: Principles and Best Practices: Fanchi John R Fanchi¸ Gulf Professional Publishing, 2010.

Web Links:

1. https://www.imperva.com/learn/data-security/data-asset-management/
2. https://bpb-us-w2.wpmucdn.com/sites.udel.edu/dist/1/1139/files/2014/06/Report-189-Asset-Management-273ljse.pdf
3. https://pennwellbooks.com/content/Integrated_Petroleum_Reservoir_Management_TOC_Sample.pdf?srsltid=AfmBOor0qHr_4cvwlOOrqotK4IOJ0oiiUh1e-wKliwBzfNYMUuN4BGeb
4. https://terotam.com/blog/asset-management-strategies-to-follow-in-oil-gas-industry
5. https://www.investopedia.com/terms/a/assetmanagement.asp

SURFACE PRODUCTION OPERATIONS
(Professional Elective- V)

VII Semester **L T P C**
Course Code: 231PT7E06 **3 0 0 3**

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

CO 1: Discuss about various types of facilities Controlling the process
CO 2: Differentiate the two phase and three phase separation systems.
CO 3: Explain about oil treater and dehydrators.
CO 4: Difference between heat exchangers, pumps and compressors
CO5: Design of produced water treating systems

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

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

UNIT-I:
Production facilities: Various types of facilities Controlling the process - Basic system configuration design & selection of facilities: Wellhead and manifold- Separation - Initial separation pressure - Stage Separation, Selection of Stages, Process flow sheets, P&IDs, monitoring well performance testing & optimization of flow.

UNIT-II:
Two phase liquid and gas separation: Functional sections of a gas-liquid separator - Inlet diverter section- Liquid collection section- Gravity settling section - Mist extractor section - Equipment description of different separators - Scrubbers - Slug catchers - Selection considerations - Vessel internals- Mist extractors - Potential operating problems.
Three phase oil, gas and water separation: Equipment description - Horizontal separators - Derivation of equation- Free -water knockout - Flow splitter - Horizontal three-phase separator with or without liquid “Boot” - Vertical separator - Selection considerations - Vessel internals- Coalescing plates- turbulent flow coalesces and potential operating problems.

UNIT-III:
Crude oil treating: Equipment description of various treaters and heaters - Indirect and fired heaters - Heater sizing - Vertical heater-treaters - Coalescing media - Horizontal heater treaters - Electrostatic heater - treaters - Oil dehydrators - Emulsion treating theory Agitation - Emulsifying agents - Demulsifiers - Field

optimization - Emulsion treating methods - General considerations - Chemical addition - Amount of chemical - Bottle test considerations - Chemical selection.
Oil desalting systems: Oil desalting systems - Equipment description of desalters - Mixing equipment - Process description - Single stage desalting - Two stage desalting; Monitoring of oil quality.

UNIT-IV:
Custody transfer: Storage facilities, measurements - custody transfer, marketing - transportation modes & dispatch - Gas dehydration compression - measurements custody transfer marketing - transportation dispatch. Fire protection systems for tank farm pumping /compressor stations. Shell and tube heat exchangers, pumps and compressors

UNIT-V:
Produced water treating systems: Characteristics of produced water - Sand and other suspended solids - Dissolved gases - Oil in water emulsions - Dissolved oil concentrations - Dispersed oil – Toxicants - Gravity separation – Coalescence – Dispersion – Flotation – Filtration - Equipment description - Retention time and performance considerations - Design of produced water treating systems. Disposal standards - Disposal methods - Offshore & Onshore operations.

Text Books:
1. Surface Production Operations, Ken Arnold & Maurice Stewart, Vol. 1 & 2, 3rd Edition, Gulf Professional Publishing, 2008.

Reference Books:
1. Petroleum and Gas Field Processing, H. K. Abdel-Aal and Mohamed Aggour and M.A. Fahim, Marcel Dekkar Inc., 2003.

Web Links:
1. https://www.slideshare.net/HctorNguemaOndo/oil-and-gas-separators
2. https://www.scribd.com/document/271390351/Chapter-4-a-General-Theory-Two-Phase-Separators
3. https://www.scribd.com/doc/234134721/Heater-treaters
4. https://www.emerson.com/documents/automation/article-oil-gas-custody-transfer-en-us-42184.pdf
5. https://www.scribd.com/document/691835243/4-2

INDUSTRIAL WASTEWATER MANAGEMENT
(Open Elective-III)

VII Semester **L T P C**
Course Code: 231CE7O01 **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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	1	-	-	2	3	-	-	-	-	-
CO2	2	-	1	-	-	3	2	-	-	-	-	-
CO3	3	-	1	-	-	1	1	-	-	-	-	-
CO4	1	-	2	-	-	1	2	-	-	-	-	-
CO5	3	-	1	-	-	2	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I
Industrial water Quantity and Quality requirements:
Boiler and cooling waters–Process water for Textiles, Food processing, Brewery Industries, power plants, fertilizers, sugar mills.

Unit – II
Miscellaneous Treatment:
Use of Municipal wastewater in Industries – Advanced water treatment – Adsorption, Reverse Osmosis, Ion Exchange, Ultra filtration, Freezing, elutriation, Removal of Iron and Manganese, Removal of Colour and Odour

Unit – III
Basic theories of Industrial Wastewater Management:
Industrial waste survey – Measurement of industrial wastewater Flow-generation rates –
Industrial wastewater sampling and preservation of samples for analysis – Wastewater Characterization-Toxicity of industrial effluents-Treatment of wastewater-unit operations and processes-Volume and Strength reduction – Neutralization – Equalization and proportioning- recycling, reuse, and resources recovery.

Unit – IV

Industrial wastewater disposal management:

Discharges into Streams, Lakes and oceans and associated problems, Land treatment – Common Effluent Treatment Plants: advantages and suitability, Limitations, and challenges- Recirculation of Industrial Wastes- Effluent Disposal Method

Unit – V

Process and Treatment of specific Industries:

Manufacturing Process and origin, characteristics, effects, and treatment methods of liquid waste from Steel plants, Fertilizers, Textiles, Paper and Pulp industries, Oil Refineries, Coal and Gas based Power Plants.

Text Books:

1. Wastewater Treatment by M.N. Rao and A.K. Dutta, Oxford & IBH, New Delhi,2016
2. Industrial Wastewater Treatment by KVSG Murali Krishna.

Reference Books:

1. Industrial Water Pollution Control by W. Wesley Eckenfelder, Mc- GrawHill, Third Edition, 2015
2. Wastewater Treatment- Concepts and Design Approach by G.L. Karia & R.A. Christian, Prentice Hall of India

Web Links:

1. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ce32/
2. https://www.un-ihe.org/online-course-industrial-effluent-treatment

BASICS OF RS&GIS
(Open Elective-III)

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231CE7O02	**3**	**0**	**0**	**3**

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

CO1: Explain the evolution of Remote Sensing and GIS, the energy interactions in the atmosphere and earth surface features.
CO2: Elaborate on photogrammetry and various satellites.
CO3: Interpret the images for preparation of thematic maps.
CO4: Develop GIS based raster and vector data models.
CO5: Explain navigation applications based on GCS and GPS systems.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I
History and Basic Concept of Remote Sensing:
Introduction to remote sensing: Evolution of Remote Sensing- use of hot air balloons, pigeons and platforms of remote sensing, low-medium-high altitude imaging.
Basic concepts of remote sensing: Electromagnetic spectrum and its interaction with atmosphere, energy interaction with the earth surfaces characteristics of remote sensing systems.

Unit – II
Photogrammetry; Aerial and Terrestrial; photo interpretation. Sensors; Radar imaging; colour scanners; thematic mapper. Introduction to space agencies - IRS, Landsat, SPOT, Cartosat, Ikonos, Envisat etc. sensors, sensor resolutions (spatial, spectral, radiometric and temporal).

Unit – III

Geographic Information System:

Introduction to GIS; Components of a GIS, Geospatial Data: Spatial Data and Attribute data, Joining Spatial and Attribute data.

Image interpretation:

Introduction, elements of visual image interpretations, digital image processing- image pre-processing, image enhancement, image classification, supervised classification, unsupervised classification using GIS Environs.

Unit – IV

Data Models: Vector data model: Representation of simple features – Topology and its importance; coverage and its data structure, Shape file; Relational Database, Raster Data Model: Elements of the Raster data model, Types of Raster Data, Raster Data Structure, Data conversion

Unit – V

Coordinate Systems:

Geographic Coordinate System: Approximation of the Earth, Datum; Map Projections: Types of Map Projections-Map projection parameters, commonly used Map Projections. Global positioning system and various navigation applications.

Text Books:

1. Textbook of Remote Sensing and Geographical Information Systems, by Anji M. Reddy · 2018, BS Publications.
2. Remote Sensing and GIS, Basudev Bhatta, Oxford Publishers 2015

Reference Books:

1. Basics of Remote sensing & GIS by S. Kumar, Laxmi Publications.
2. Introduction to Geographic Information System, Kang-Tsung Chang, McGraw- Hill 2015.

Web Links:

1. http://geology.wlu.edu/harbor/geol260/lecture_notes/notes.html
2. https://lecturenotes.in/subject/572/remote-sensing-and-gis-rsg

SAFETY ENGINEERING
(Open Elective-III)

	L	T	P	C
VII Semester **Course Code:** 231CE7O03	3	0	0	3

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

CO1: Develop management plans to prevent accidents in construction Industry.
CO2: Prepare plans to safe guard workers in construction of high-risk Buildings.
CO3: Ensure safety while operating construction machinery.
CO4: Outline safety plans for demolition of buildings.
CO5: Prepare fire safety plans for a given building.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I
Accidents Causes and Management Systems:
Problems impeding safety in construction industry- causes of fatal accidents, types and causes of accidents related to various construction activities, human factors associated with these accident – construction regulations, contractual clauses – Pre contract activates, preconstruction meeting - design aids for safe construction – permits to work
– quality assurance in construction - compensation – Recording of accidents and safety measures – Education and training.

Unit – II
Hazards of Construction and Prevention:
Excavations, basement and wide excavation, trenches, shafts – scaffolding , types, causes of accidents, scaffold inspection checklist – false work – erection of structural frame work, dismantling – tunneling – blasting, pre blast and post blast inspection – confined spaces – working on contaminated sites – work over water – road works – power plant constructions – construction.

Unit – III

Working At Heights:

Fall protection in construction OSHA 3146 – OSHA requirement for working at heights, Safe access and egress – safe use of ladders- Scaffoldings , requirement for safe work platforms, stairways, gangways and ramps – fall prevention and fall protection , safety belts, safety nets, fall arrestors, controlled access zones,
safety monitoring systems – working on fragile roofs, work permit systems, height pass – accident case studies.

Unit – IV

Construction Machinery:

Selection, operation, inspection and testing of hoisting cranes, mobile cranes, tower cranes, crane inspection checklist - builder's hoist, winches, chain pulley blocks – use of conveyors
– concrete mixers, concrete vibrators – safety in earth moving equipment, excavators, dozers, loaders, dumpers, motor grader, concrete pumps, welding machines, use of portable electrical tools, drills, grinding tools, manual handling scaffolding, hoisting cranes – use of conveyors and mobile cranes – manual handling.

Unit – V

Safety in Demolition Work:

Safety in demolition work, manual, mechanical, using explosive - keys to safe demolition, pre survey inspection, method statement, site supervision, safe clearance zone, health hazards from demolition - Indian standard - trusses, girders and beams – first aid – fire hazards and preventing methods – interesting experiences at the construction site against the fire accidents.

Fire Safety:

Fire –fire load-control and institutional fire protection systems, Fire Hydrant and extinguishers, Electrical Hazards, protection and interlock- Discharge rod and earthling 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)

	L	T	P	C
VII Semester				
Course Code: 231EE7O01	**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	PO12
CO1	2	3	2	-	-	1	-	-	-	-	-	1
CO2	2	3	2	-	-	1	-	-	-	-	-	1
CO3	2	2	3	-	-	1	-	-	-	-	-	1
CO4	2	2	3	-	-	1	-	-	-	-	-	1
CO5	2	2	3	-	-	1	-	-	-	-	-	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I

EV Batteries

Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel. Lead Acid Batteries: Lead acid battery basics, special characteristics of lead acid batteries, battery life and maintenance, Li-ion batteries. Nickel-based Batteries: Nickel cadmium, Nickel metal hydride batteries. Sodium-Based Batteries:
Introduction, sodium sulphur batteries, sodium metal chloride (Zebra) batteries. Lithium Batteries:
Introduction, the lithium polymer battery, lithium ion battery

UNIT – II

Battery Charging Strategies

Charging algorithms for a single battery: Basic terms for charging performance evaluation and characterization, CC charging for NiCd/NiMH batteries, CV charging for lead acid batteries, CC/CV charging for lead acid and Li-ion batteries, MSCC charging for lead acid, NiMH and Li-ion batteries, TSCC/CV charging for Li-ion batteries, CVCC/CV charging for Li-ion batteries, Pulse charging for lead acid, NiCd/NiMH and Li-ion batteries, Charging termination techniques, Comparisons of charging algorithms and new development; Balancing methods for battery pack charging: Battery sorting Overcharge for balancing, Passive balancing,Active balancing.

UNIT – III

Charging Infrastructure

Domestic Charging Infrastructure, Public charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

UNIT – IV

Battery-Management-System Requirements

Battery-pack topology, BMS design requirements, Voltage sense, Temperature sense, Current sense, Contactor control, Isolation sense, Thermal control, Protection, Charger control, Communication via CAN bus, Log book, SOC estimation, Energy estimation, Power estimation, Diagnostics.

UNIT – V

Battery Modelling

General approach to modelling batteries, simulation model of rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of NiCd battery model, Simulation examples.

Text Books:

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)

	L	T	P	C
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:

CO/PO	PO 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	2	2	1	-	-	-	-	-	-	-	-	-
CO4	2	3	1	-	-	-	-	-	-	-	-	-
CO5	2	3	1	-	-	-	-	-	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	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) - Home Area Network (HAN) - Neighborhood Area Network (NAN) - Wide Area Network (WAN).

Text Books:

1. Integration of Green and Renewable Energy in Electric Power Systems - by Ali Keyhani - Mohammad N. Marwali - Min Dai Wiley - 2009.

2. The Smart Grid: Enabling Energy Efficiency and Demand Response - by Clark W.Gellings - Fairmont Press - 2009.

Reference Books:

1. The Advanced Smart Grid: Edge Power Driving Sustainability:1 by Andres Carvallo - John Cooper - Artech House Publishers July 2011

2. Smart Grid: Technology and Applications - by Janaka B. Ekanayake - Nick Jenkins -Kithsiri Liyanage - Jianzhong Wu - Akihiko Yokoyama - Wiley publishers - 2012.

Web Links:

1. https://nptel.ac.in/courses/108104052/
2. https://nptel.ac.in/downloads/108101040/
3. https://nptel.ac.in/courses/108101040/

FINITE ELEMENT METHODS
(Open Elective-III)

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231ME7O01	**3**	**0**	**0**	**3**

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

CO1: Understand the concepts behind variational methods and weighted residual methods in FEM.

CO2: Solve bar and truss problems Solve bar and truss problems**.**

CO3: Solve beam problems**.**

CO4: Apply suitable boundary conditions for 2D stress analysis and develop the formulation for axi-symmetric problems and higher order iso-parametric elements.

CO5: Evaluate the concepts of steady state heat transfer analysis and dynamic analysis.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/SPO	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: 231ME7O02	**3**	**0**	**0**	**3**

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

CO1: Describe mechatronics systems and various types of sensors and transducers.
CO2: Demonstrate knowledge of solid-state devices, analog circuits, and MEMS applications
CO3: Explain the components and operation of hydraulic, pneumatic, electro-pneumatic, electro-hydraulic, mechanical, and electrical actuating system
CO4: Discuss digital electronics, microcontrollers, PLCs, and their applications in control systems.
CO5: Apply system interfacing, data acquisition, system response, and mechatronics design trends.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 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:

CO/PSO	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)

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231ME7O03	**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:

CO/PO	PO 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:

CO/PSO	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, Cre Problem Solving, Invention, Brainstorming, Morphological Analysis, Behavioural Aspects of Decision Making, Dec Theory, Decision Matrix, Decision Trees.
MODELING AND SIMULATION:
Triz, Role of Models in Engineering Design, Mathematical Modeling, Similitude and Scale Models, Computer Simulation, Geometric Modeling on Computer, Finite-Element Analysis.

Unit -II

PRODUCT MANAGEMENT:
The operation of product management: Customer focus of product management, product planning process, L 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, the polit 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, Fault Isolat design and Self-Diagnostics. Product Design for Safety, Product Safety and User Safety Concepts, Examples o 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
---|---|---|---|---
VII Semester | L | T | P | C

Course Code: 231ME7O04 — **3 0 0 3**

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

CO1: Explain the materials science and engineering concepts of varied materials to understand the correlations between structure and properties.
CO2: Apply the concept of strengthening mechanisms to assess the properties of special metallic materials and alloys.
CO3: Apply the concept of strengthening mechanisms to assess the properties of polymers and composite materials.
CO4: Analyze the role of functional & smart materials in the contemporory 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:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	-
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.
2. **G. E. Dieter, "Mechanical Behavior of Materials," 3rd Edition, McGraw-Hill, 1986.**

Reference Books:

1. **L. M. Nieckele, "Advanced Materials: Properties, Processing, and Applications," CRC Press, 2019.**
2. **R. W. Cahn and P. Haasen (Eds.), "Physical Metallurgy," 4th Edition, Elsevier, 1996.**
3. **S. C. Sharma, "Advanced Materials and Their Applications," Dhanpat Rai Publishing Company, 2018.**
4. **V. Raghavan, "Materials Science and Engineering," PHI Learning, 2014.**

Weblinks:

1. https://ocw.mit.edu/courses/3-051j-materials-for-biomedical-applications-spring-2006/
2. https://www.youtube.com/playlist?list=PLbRMhDVUMngdzwQyMgoUgdaGBqi_p4nVM
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: 231ME7O05 | | 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:

CO/PO	PO 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:

CO/PSO	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 Artifical 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 **L T P C**
Course Code: 231EC7O01 **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	-	-	-	-	-	-	-	-	-	-

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	**L**	**T**	**P**	**C**
Course Code: 231EC7O02	**3**	**0**	**0**	**3**

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

CO1 Construct Op Amps using the differential amplifier and other improvement circuits.
CO2 Explain parameters related to measurement of Op-Amp characteristics.
CO3 Construct the circuits for different linear and non-linear applications using Op-Amp.
CO4 Construct the circuits for different Data conversion and Filtering applications using Op-Amp.
CO5 Compare different digital logic families.

Mapping of Course Outcomes with Program Outcomes:

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

Unit – I
Introduction to Integrated Circuits: Integrated Circuits Types, Classification, Package Types, Temperature ranges and Power supplies. Differential Amplifier-DC And AC analysis of differential amplifier configurations, circuits for improving CMRR, Necessity of swamping resistors, Cascaded Differential Amplifier Stages and Level translator.

Unit – II
Characteristics of Op-Amps: Block Diagram of a Op-Amp, Pin diagram, symbolic representation and features of 741 IC, Ideal and practical characteristics of an Op-Amp, Equivalent circuit of an Op-Amp, Define the terms input offset voltage and current, input bias current, CMRR, Slew Rate, PSRR, etc, Virtual ground concept, DC characteristics, AC characteristics and Measurement of Op-Amp parameters.

Unit – III
Linear and Non-Linear Applications of Op- Amps: Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier, AC amplifier, V to I, I to V converters, Buffers. Non-Linear Applications-Comparators, Multivibrators, Triangular and Square wave generators, Log and Anti- log Amplifier, Precision rectifiers.

Unit – IV
D-A and A-D Converters: Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, and IC 1408 DAC, Different types of ADCs parallel Comparator type ADC, counter type ADC, Successive Approximation ADC and dual slope ADC.DAC and ADC Specifications.
Active Filters: Introduction, Butter worth filters – 1st order, 2nd order LPF, HPF filters. Band pass, Band reject and All pass filters.

Unit – V

Digital Logic Families and Interfacing: Introduction to logic families, CMOS logic, CMOS steady state and dynamic electrical behavior, CMOS logic families. Bipolar logic, transistor-transistor logic, TTL families, CMOS/TTL interfacing, low voltage CMOS logic and interfacing, Emitter coupled logic.

Text Books:

1. Op Amps and Linear Integrated Circuits, Ramakant A. Gayakwad,4th Edition, PHI, Pearson Education, 2015.
2. Linear Integrated Circuits– D. Roy Choudhry, Shail Jain, New Age International(p)Ltd, 5th Edition, 2018.
3. Digital Design Principles & Practices – John F. Wakerly, PHI/ Pearson Education Asia, 4th Edition, 2008.

Reference Books:

1. Design with Operational Amplifiers & Analog Integrated Circuits-Sergio Franco, McGrawHill,1988.
2. OPAMPS and Linear Integrated Circuits concepts and Applications, James MFiore, Cengage Learning India Ltd, 2010.
3. Operational Amplifiers & Linear Integrated Circuits–R.F.Coughlin & Fredrick Driscoll, PHI, 6th Edition, 2001.
4. Fundamentals of Digital Logic with VHDL Design- Stephen Brown, Zvonko Vranesic, McGrawHill, 3rd Edition, 2017.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc24_ee73/preview
2. https://ocw.mit.edu/courses/6-01sc-introduction-to-electrical-engineering-and-computer-science-i-spring-2011/pages/unit-3-circuits/op-amps/

***

PRINCIPLES OF EMBEDDED SYSTEMS
(Open Elective-III)

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231EC7O03	**3**	**0**	**0**	**3**

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

CO1 Summarize the building blocks of an embedded system.
CO2 Interpret the hardware modules required to design an embedded system.
CO3 Infer the firmware design approaches for an embedded system.
CO4 Illustrate the hardware integration with firmware.
CO5 Outline the process of embedded system development and choose the tools for embedded system implementation and testing.

Mapping of Course Outcomes with Program Outcomes:

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

Unit – I

Introduction: Embedded system-Definition, History of Embedded systems, classification of embedded systems, major application areas of embedded systems, purpose of embedded systems, the typical embedded system-core of the embedded system, Memory, Sensors and Actuators, Communication Interface, Characteristics of an embedded system, Quality attributes of embedded systems, Application-specific and Domain-Specific examples of an embedded system.

Unit – II

Embedded Hardware Design: Analog and digital electronic components, I/O types and examples, Serial communication devices, Parallel device ports, Wireless devices, Timer and counting devices, Watchdog timer, Real time clock, multi processors architectures.

Unit – III

Embedded Firmware Design: Embedded Firmware design approaches, Embedded Firmware development languages, Interrupt sources, ISR concept, Interrupt servicing mechanism, Multiple interrupts, DMA, Device driver programming, Concepts of C versus Embedded C.

Unit – IV

Real Time Operating System: Operating system basics, Types of operating systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling, Task communication, Task synchronization.
Hardware Software Co-Design:
Fundamental Issues in Hardware Software Co-Design, Computational models in embedded design, Hardware software Trade-offs, Integration of Hardware and Firmware.

Unit – V

Embedded System Development: The integrated development environment, Types of files generated on cross-compilation, Deassembler/ Decompiler, Simulators, Emulators and Debugging, Target hardware debugging, Boundary Scan, Embedded Software development process and tools.
Embedded System Implementation and Testing: The main software utility tool, CAD and the hardware, Translation tools-Pre-processors, Interpreters, Compilers and Linkers, Debugging tools, Quality assurance and testing of the design, Testing on host machine.

Text Books:

1. Introduction to Embedded Systems, Shibu. K. V, Tata McGraw Hill Education Private Limited, 2nd Edition, 2016.
2. Embedded Systems – SoC, IoT, AI and Real-Time Systems, Raj Kamal, McGraw Hill Education India 4th Edition, 2020

Reference Books:

1. Embedded System Design, Frank Vahid and Tony Givargis, John Wiley Publications, 2013.
2. Hardware Software Co-Design Principles and Practice, J. Staunstrup, Springer Publications, 2013
3. Embedded Systems Architecture, Tammy Noergaard, Elsevier Publications, 3rd Edition, 2013.

Web Links:

1. https://www.coursera.org/learn/introduction-embedded-systems
2. https://www.linkedin.com/learning/introduction-to-embedded-systems-with-rust
3. https://www.udemy.com/course/embedded-systems-and-microcontrollers/

CYBER SECURITY
(Open Elective-III)

		L	T	P	C
VII Semester		**L**	**T**	**P**	**C**
Course Code: 231CS7O01		**3**	**0**	**0**	**3**

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

CO1: Explain the cyber security and security management methods to maintain security protection
CO2: Illustrate the nature of secure software development and operating systems.
CO3: Summarize the Network management and cloud computing security issues.
CO4: Analyse 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 **L T P C**
Course Code: 231DS7O01 **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 Madisetti,"Big Data Science& Analytics: A Hands On Approach",VPT, 2016.
4. Learning Spark: Lightning Fast Big Data Analysis Paper back,Holden Karau

Web Links:

1. Hadoop:http://hadoop.apache.org/
2. Hive:https://cwiki.apache.org/confluence/display/Hive/Home
3. http://nptel.ac.in/courses/106106142/
4. https://hortonworks.com/tutorial/how-to-process-data-with-apache-hive/
5. https://databricks.com/spark/getting-started-with-apache-spark

INTERNET OF THINGS
(Open Elective-III)

VII Semester **L T P C**
Course Code: 231IT7O01 **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 Madisetti, Arshdeep Bahga, Internet of Things A Hands-On- Approach,2014

Reference Books:

1. An Introduction to Internet of Things, Connecting devices, Edge Gateway and Cloud with Applications, Rahul Dubey, Cengage, 2019.Adrian McEwen, Designing the Internet of Things, Wiley Publishers, 2013.

2. IoT Fundamentals, Networking Technologies, Protocols and Use Cases for the Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetette, rob Barton, Jerome Henry, CISCO, Pearson, 2018.

3. Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, Wiley.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_cs17/preview

2. https://arduinomakerspace.com/iot-projects-using-arduino/

3 https://www.coursera.org/specializations/iot

COMPUTER NETWORKS
(Open Elective-III)

VII Semester	**L**	**T**	**P**	**C**
Course Code: 231AM7O01	**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 **L T P C**
Course Code: 231PT7O01 **3 0 0 3**

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

CO 1: Illustrate Fluid physical properties and flow in pipes
CO 2: Derive the single phase fluid flow equations
CO 3: Determine the flow regime and pressure drop calculations.
CO 4: Estimation of pressure loss across control valves
CO5: Explain the design aspects of subsea and buried pipelines.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	2	-	2
CO2	2	-	-	-	-	-	-	-	-	2	-	2
CO3	2	-	-	-	-	-	-	-	-	2	-	2
CO4	2	-	-	-	-	-	-	-	-	2	-	2
CO5	2	-	-	-	-	-	-	-	-	2	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

CO / PSO	PSO 1	PSO 2
CO1	-	-
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 drops 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 drops 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 TJsing 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

Web Links:
1. https://www.scribd.com/presentation/424126821/08-Fluid-Flow
2. https://www.slideshare.net/slideshow/single-phase-gas-flow-correlations/141745504
3. https://pure.unileoben.ac.at/portal/files/1851003/AC07138243n01vt.pdf
4. https://www.katmarsoftware.com/articles/pipe-fitting-pressure-drop.htm
5. https://blog.fluidflowinfo.com/a-study-of-choked-flow-in-gas-piping-systems-2/

INTRODUCTION TO SEISMIC METHODS
(Open Elective-III)

VII Semester **L T P C**
Course Code: 231PT7O02 **3 0 0 3**

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

CO 1: Illustrate the Geophysical exploration methods
CO 2: Differentiate between Seismic Refraction and Seismic Reflection
CO 3: Explain the application of seismic refraction method.
CO 4: Estimation of Seismic Reflection methods and its applications
CO5: Explain the recent advances in seismic methods.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	2	-	2
CO2	2	-	-	-	-	-	-	-	-	2	-	2
CO3	2	-	-	-	-	-	-	-	-	2	-	2
CO4	2	-	-	-	-	-	-	-	-	2	-	2
CO5	2	-	-	-	-	-	-	-	-	2	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

CO / PSO	PSO 1	PSO 2
CO1	-	-
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, 4thEdition, 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, 4thEdition, 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).

Web Links:

1. https://www.slideshare.net/slideshow/presentation-on-geophysical-methods/63210936
2. https://pburnley.faculty.unlv.edu/GEOL452_652/seismology/notes/SeismicNotes01SIntro.html
3. https://www.slideshare.net/slideshow/seismic-refraction-method-lec22/62542437
4. https://escweb.wr.usgs.gov/share/mooney/1989_Seismic%20methods.pdf
5. https://pubs.geoscienceworld.org/seg/geophysics/article/71/4/SI139/107262/The-virtual-source-method-Theory-and-case-studyThe

INTRODUCTION TO ARTIFICIAL LIFT METHODS
(Open Elective-III)

VII Semester **L T P C**
Course Code: 231PT7O03 **3 0 0 3**

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

CO 1: Illustrate the Purpose of artificial lift selection
CO 2: Explain about Sucker rod lift system and its advantages and disadvantages
CO 3: Differentiate between continuous and intermittent gas lift advantages and limitations.
CO 4: Explain about design process of Electrical submersible pumps
CO5: Apply the skills for the selection and type of artificial lift method.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	2	-	2
CO2	2	-	-	-	-	-	-	-	-	2	-	2
CO3	2	-	-	-	-	-	-	-	-	2	-	2
CO4	2	-	-	-	-	-	-	-	-	2	-	2
CO5	2	-	-	-	-	-	-	-	-	2	-	2

Mapping of Course Outcomes with Program Specific Outcomes:

CO / PSO	PSO 1	PSO 2
CO1	-	-
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.

Web Links:

1. https://www.learntodrill.com/post/artificial-lift-system-functions
2. https://www.laxmiudyog.com/index.php?page=liftequip
3. https://medwinpublishers.com/PPEJ/PPEJ16000121.pdf
4. https://www.slideshare.net/slideshow/electrical-submersible-pump-esp/79169708
5. https://onepetro.org/books/book/76/chapter/14379495/Artificial-Lift-Selection

MINE WASTE MANAGEMENT
Open Elective -III

	L	T	P	C
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 Cunning, 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

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231MI7O02	**3**	**0**	**0**	**3**

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

CO1: Explain sustainable development principles and regulatory requirements applicable to the mining sector.
CO2: Evaluate mining policies and their influence on sustainable mining practices nationally and globally.
CO3: Apply clean technologies and resource recovery methods to enhance mining sustainability.
CO4: Implement water and air pollution control measures and monitor environmental quality in mining operations.
CO5: Develop and manage mine closure plans, land reclamation projects, and promote biodiversity conservation in mining areas.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I
Concept of Sustainable development for mining industry-Sustainable development –a perspective of mineral professional community. International sustainability reporting and tools for measurement of sustainability. Milos statement on Sustainable mineral industry. Legislative measures for sustainable development- MMDR Act- star rating of Indian mines (Non-coal), Environmental responsibility – Corporate social responsibility. District mineral fund, its collection, utilization etc.

UNIT – II
Current status of mining practices and their impact on sustainability. Mining and environmental frame work, National mineral policies in mineral based countries. Indian national mineral policy, its historical development with the changing goals and sustainable practices. Issues of leases, auctions for mineral development in India.

UNIT – III
Clean coal technologies, Coal bed methane, abandoned coal mine methane, Underground gasification of coal. Leaching of old dumps and recovery of metals. Recycling of metals. Application of new techniques for sustainable development

UNIT – IV
Mine water- Water conservation Acts and rules in India. New Initiatives in mines. Underground mine water, Water pollution and control measures, Phyto-remediation, Sewage and effluent treatment plants, their use and benefits. Air quality in open pit mines, dust control measures, noise levels- pollution, monitoring and control.

UNIT – V
Bio-diversity- Land reclamation and plantation. Mine closure plan- Collection and disbursement of Mine closure fund for both open pit and underground mines in India.
Best mining practices for Sustainable mining. - Case studies. Innovative practices for achievement of sustainability. Benefits of sustainability.

Text Books:

1. MMRD Act 2015 and amendments, Ministry of Mines
2. Mineral concession Rules

Reference Books:

1. Guidelines of MOEF and Climate change - Annual reports of MOEF&CC, Ministry of Mines, Ministry of Coal in India,
2. Sustainable mining practices –A global perspective by Vasudevan Rajaram, Subijoy Dutta, Krishna Paremeswaran, ISBN-90-5809-689-0

Web Links:

1. **https://www.slideshare.net/slideshow/sustainable-mining-practices-240275756/240275756**
2. https://www.teriin.org/sites/default/files/files/Sustainable_Mining_Practices_India.pdf
3. **https://www.unep.org/resources/report/green-mining-sustainable-mining-practices**

*****

MINE RECLAMATION
Open Elective -III

VII Semester	**L**	**T**	**P**	**C**
Course Code: 231MI7O03	**3**	**0**	**0**	**3**

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

CO1: Describe environmental problems caused by mining and assess the impact of mining machinery on the environment.
CO2: Evaluate land degradation and plan for effective waste disposal and tailings impoundment.
CO3: Apply land reclamation techniques, including soil conservation and vegetation restoration for disturbed mining sites.
CO4: Implement engineering and biological reclamation methods for mine closure and land restoration.
CO5: Develop environmental management plans and ensure compliance with environmental laws, standards, and corporate social responsibility practices in mining.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I
Recent changes in development paradigms; concepts of carrying capacity and sustainable development; environmental problems caused by mining and influencing factors. Environmental aspects of various Mining Machines.

UNIT – II
Land Degradation; land use categories; pre-mining investigations; landscape planning and visual impact; waste disposal, overburden dumps and tailings impoundment.

UNIT – III
Land reclamation procedures; Influence of type of deposit, topography and equipment; top soil characteristics; top soil removal and storage; application of mulches, stabilizing agents and
fertilizers;
Land Reclamation: Re-vegetation and restoration methodologies; Plant species selection; Reclamation methods by using different combination of equipment, Case studies of coal and metalliferous mine dumps/spoils.

UNIT – IV
Engineering and biological reclamation; afforestation of mine areas, tailing ponds, mine closure and amenity banks; best practices of mined out land reclamation.

UNIT – V
Corporate Social Responsibility towards mine closure and reclamation: Concepts and principles. Environmental policies and laws: Environmental management systems, environmental impact assessment and environmental management planning; base line studies, environmental audit, ISO 14001, OHSAS.

Text Books:

1. Dr. B.B. Dhar, Environmental Management of Mining Operations. Pub

2. Bulk Handling in Open Pit Mines & Quarries: Reinhard H. Wohlbier
3. Coal Mines Regulations, 1957 and Metalliferous Mines Regulations, 1961
4. Introductory Mining Engineering: Howard L. Hartman

Reference Books:

1. Modern Coal Mining Technology: Samir Kumar Das
2. Opencast Mining – Technology and Integrated Mechanization: V.V. Rzhevsky
3. Opencast Mining – Unit Operations: V.V. Rzhevsky
4. SME Hand Books
5. Surface Mining: G.B. Misra
6. Surface Mining Technology: Samir Kumar Das
7. Proceeding of the National & International Seminars/Symposium organized in concernwith 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

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231MI7O04	**3**	**0**	**0**	**3**

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

- CO1: Explain environmental management principles and global/local environmental issues affecting mining.
- CO2: Identify types of pollution, assess their impacts, and recommend control and preventive measures.
- CO3: Analyze land pollution challenges, tailing management techniques, and implement mine closure plans.
- CO4: Apply environmental management tools including EIA, audits, and economic analysis for mining operations.
- CO5: Demonstrate knowledge of key environmental legislation and regulatory compliance for mining projects.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I

Introduction: Goals, strategies and tools for environmental management – systems approach to environmental management – environmental guideline – National Policies on environment with respects to mining activities – Global and Local environmental issues – resource degradation – desertification – Industrialization, Objectives of Sustainable Development. Structure of the atmosphere – ozone layer depletion – Acid rain – Greenhouse gases and global warming Ambient Air quality and emission standards, Air quality Sampling and monitoring, Dispersion of air pollutants.

UNIT – II

Environmental Pollution – I: Environmental Pollutants due to surface – Air, Water, Noise, Sources and Classification of pollutants including dust and their effect on human health, Sources, hazards, sampling and analysis, standards, instrumentation and measurement of pollutants including dust, Air born dust modeling, Control and preventive measures for air pollution including for dust, , Water pollution standards, Noise standards – Measurement – Noise Impact Index assessment, Control and preventive measures for water, noise pollution. Pollution due to blast and equipment vibrations their monitoring, prevention and control.

UNIT – III

Environmental Pollution – II: Land pollution, land for alternation dealing with mind out land, re-vegetation, tailing management, tailing dams, method and construction, land use plan, Mine closure planning. Textural classification and properties of soil. Impact of pollution on human health, miner's diseases and their social impact.

UNIT – IV

Environmental Management: Environmental quality objectives, Emission and ambient standards – Minimum National standards – International environmental standards – ISO 14000 – EIA Notification – Sitting of Industries – Environmental management plans, Environmental impact assessment, Environmental management system audits, Environmental economics – Principles of cost benefit analysis – Valuing the Environment – Environmental Accounting, Environmental administration- training awareness and competence, Mine subsidence, its prediction and control.

UNIT – V

Environmental Legislations: Environmental laws, the Environmental (Protective) Act, 2004, The Water Act (1974), The Air act (1981), The Forest Act 1927, The forest conservation act 1980, Power and responsibilities of regularity agencies and occupation consent to establish and operate wild life protection act and rules, Environmental clearance procedure for a mining
Project.

Text Books:

1. Manahan S.E. Environmental Science and Technology.
2. Mackenthun, K.M. Basic Concepts in Environmental Management, Lewis Publications,London, 1998.

Reference Books:

1. Noel de Nevers, Air Pollution Control Engg., McGraw Hill, New York, 1995
2. Anjaneyulu,Y. Air Pollution & Control Technologies, Allied Publishers (P) Ltd, India, 2002.
3. Nick Hanley, Jaison F. Shogren and Ben White. Environmental Economics – In Theory and Practice, Macmillan India Ltd, New Delhi, 1999.
4. Roger Perman, Yue Ma and James McGilvray. Natural Resources and Environmental Economics, Second edition, Addison Wesley Longman Ltd, Singapore, 1997

Web Links:

1. https://nptel.ac.in/courses/124/105/124105076/downloads/Lecture_Notes_Environmental_Management_Mining.pdf
2. https://www.academia.edu/38723281/Environmental_Management_Pollution_Control_in_Mining_Industries
3. https://moef.gov.in/wp-content/uploads/2023/04/guidelines_for_environmental impact assessment_emp.pdf

*****

WATER HARVESTING AND SOIL CONSERVATION STRUCTURES
(Open Elective-III)

VII Semester — **L** 3, **T** 0, **P** 0, **C** 3
Course Code: 231AG7O01

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

CO1: Recommend the short term and long-term runoff harvesting at appropriate places in watershed.
CO2: Design criteria and cost estimation of farm ponds.
CO3: Explain the functions of soil erosion control structures.
CO4: Apply the concept hydraulic jump, runoff measuring structures and various permanent gully control structures.
CO5: Estimate the load analysis on various components of soil conservation structures.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I
Water harvesting -principles, importance and uses. Water harvesting techniques – classification based on source, storage and use. Runoff harvesting – short-term and long-term techniques. Short-term harvesting techniques - contour bunds, semicircular hoop, trapezoidal bunds, graded bunds, rock catchment and ground catchment. Long term harvesting techniques- purpose and design criteria

Unit – II
Structures - farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes. Farm pond - components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction. Percolation pond - site selection, design and construction details. Design considerations of nala bunds.

Unit – III
Soil erosion control structures - introduction, classification and functional requirements. Design of Gabion structures. Permanent structures for soil conservation and gully control – check dams, drop, chute and drop inlet spillways - design requirements, planning for design, design procedures - hydrologic, hydraulic and structural design and stability analysis.

Unit – IV

Hydraulic jump and its application. Drop spillway - applicability, types - straight drop, box-type inletspillways - 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 WaterConservation 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 **L T P C**
Course Code: 231CE7O04 **3 0 0 3**

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

CO1: Explain physical properties of soil and its determination
CO2: Determine the various index properties and the classification of soil
CO3: Assess the stress developed due to various loads and soil conditions
CO4: Explain the various compaction methods and the determination of permeability
CO5: Explain the concept of consolidation, compressibility and settlement calculation

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I
Physical Properties of Soil:
Three phase system - phase diagram - physical properties Functional Relationships between physical properties-determination of water content, specific gravity, In-situ density-Relative density

Unit – II
Plasticity Characteristics of soil: Consistency, Atterberg's limits and their determination liquid limit, plastic limit, shrinkage limit - Index Properties-Activity-Free swell index. Soil Classification: Soil classification- need and criteria for soil classification-IS Particle size classification-Classification tests-grain size analysis - hydrometer analysis- grain size distribution curve - Unified Soil Classification-Indian Standard Soil classification- Coarse grained soils- Fine grained soils-Plasticity chart.

Unit – III
Effective stress: Stresses due to self-weight-total, neutral and effective stresses – Pressure diagrams under different soil conditions. Stresses due to applied loads: Boussinesq theory- Concentrated load-Strip footing- circular footing- Rectangular footing-Newmark's influence chart - Pressure bulb-Significant depth Westergaard's theory - 2:1 distribution method

Unit – IV

Compaction: Principle of compaction, OMC and MDD, Lab tests-IS light weight and heavy weight compaction tests, Factors affecting compaction - zero air void line-Effect of compaction on engineering properties of soils - Field compaction control – Proctor's Needle.

Permeability and Seepage: types of soil water, Permeability-Darcy's law-Factors effecting permeability- laboratory tests-Average permeability of stratified soils. Seepage pressure critical hydraulic gradient -quick sand condition.

Unit – V

Consolidation: Definition and significance-mechanism-Terzaghi's soil-spring analogy -lab consolidation test – e-log p curve-Coefficient of compressibility-coefficient of volume change-compression index-determination of consolidation settlement – Terzaghi's theory of 1D consolidation- Time-settlement calculations. Determination of coefficient of consolidation-time fitting methods – Pre-consolidation pressure- normally consolidated and over consolidated clays- secondary consolidation.

Text Books:

1. Arora, K.R. (2019), "Soil Mechanics and Foundation Engineering", Standard Publishers, Delhi
2. Gopal Ranjan and Rao, A.S.R., "Basic and Applied Soil Mechanics", New Age Ltd. International Publisher New Delhi (India) 2016

Reference Books:

1. Craig, R.F. (2019), "Soil Mechanics", McGraw hill, New Delhi
2. Narasinga Rao, B.N.D. (2015), Soil Mechanics and Foundation Engineering, Wiley Publishers

Web Links:

1. http://nptel.ac.in/courses/105103097/

CONSTRUCTION MATERIALS AND EQUIPMENTS
(Open Elective-IV)

VII Semester **L T P C**
Course Code: 231CE7O05 **3 0 0 3**

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

CO1: Explain the tests on stones, cement and aggregates.
CO2: Explain the concepts of strength and durability testing on mortar and concrete.
CO3: Compare the properties of most common and advanced building materials.
CO4: Selection of Automation techniques in construction industry.
CO5: Analyze benefits of robotics versus conventional construction equipment.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO 1	PSO 2
CO1	-	-
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

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/

– Mix proportioning – BIS method – High Strength Concrete and HPC – Self compacting Concrete –Other types of Concrete–Durability of Concrete.

NATURAL DISASTER MANAGEMENT & MITIGATION
(Open Elective-IV)

VII Semester	**L**	**T P**	**C**
Course Code: 231CE7O06	**3**	**0 0**	**3**

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

CO1: Explain the aspects of disaster management and adopt remedial measures
CO2: Explain disaster risk assessment and coping measures.
CO3: Explain the vulnerability conditions
CO4: Assess the impact of hazards on structures
CO5: Adopt the rehabilitation procedures

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I
Introduction Concept of Disaster Management. Types of Disasters. Disaster mitigating agencies and their organizational structure at different levels.

Unit – II
Overview of Disaster Situations in India Vulnerability of profile of India and Vulnerability mapping including disaster – prone areas, communities, places. Disaster preparedness – ways and means; skills and strategies; rescue, relief reconstruction. Case Studies: Lessons and Experiences from Various Important Disasters in India and Biological disasters – SARS- spread and transmisstions -pandemic, endemic and epidemic.

Unit – III
Flood and Drought Disaster Raising flood damage, assessing flood risk, flood hazard assessment, flood impact assessment, flood risk reduction options. Drought and development, relief management and prevention, drought mitigation and management- integrating technology and people.

Unit – IV

Landslide and Earthquake Disaster Land slide hazards zonation mapping and geo environmental problems associated with the occurrence of landslides. The use of electrical resistivity method in the study of landslide.
Causes and effects of earthquakes. Secondary effects. Criteria for earthquake resistant design.

Unit – V
Cyclone and Fire Disaster Cyclone occurrence and hazards. Cyclone resistant house for coastal areas. Disaster resistant construction role of insurance sector. Types of fire. Fire safety and firefighting method, fire detectors, fire extinguishers. Rehabilitation: Rehabilitation programmes, Management of Relief Camp.

Text Books:
1. Disaster Management, RB Singh (Ed), Rawat Publications, 2000.
2. Disaster Management Future Challenges and Opportunities, Jagbir Singh, I.K International publishing house

Reference Books:
1. Natural Hazards in the Urban habitat by Iyengar, CBRI, Tata McGraw Hill
2. Natural Disaster management, Jon Ingleton (Ed), Tulor Rose, 1999

Web Links:
1. https://www.youtube.com/watch?v=2v7N5a3tLgE
2. https://www.youtube.com/watch?v=5KtVocJfVGw

CONCEPTS OF POWER QUALITY
(Open Elective-IV)

VII Semester	**L**	**T**	**P**	**C**
Course Code: 231EE7O03	**3**	**0**	**0**	**3**

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

CO1	Differentiate between different types of power quality problems and sources of voltage sag, voltage swell.
CO2	Explain about the sources of transient over voltages in a power system.
CO3	Explain about the Long – Duration Voltage Variations and Flickering.
CO4	Analyse the Harmonic distortion and solutions and their indices.
CO5	Explain the concepts of distributed generation technologies.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I
Introduction - Terms & Definitions
Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations – Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power frequency variations – Voltage Sags – Voltage Swell.

UNIT – II
Transient Over Voltages:
Sources of Transient Over voltages - Principles of Over voltage protection- Devices for Over voltage protection – Utility Capacitor Switching Transients - Utility System Lightning Protection – Managing Ferro resonance – Switching Transient Problems with Loads.

UNIT – III

Long – Duration Voltage Variations:

Principles of regulating the voltage – Device for voltage regulation – Utility voltage regulator application – Capacitor for voltage regulation – End–user capacitor application – Regulating utility voltage with distributed resources – Flicker.

UNIT – IV

Harmonic distortion and solutions:

Voltage distortion vs. Current distortion –Harmonic indices: THD - TDD and True Power Factor– Sources of harmonics – Effect of harmonic distortion – Impact on capacitors, transformers, motors and meters – Concept of Point of common coupling – Passive and active filtering – Numerical problems.

UNIT – V

Distributed Generation and Monitoring:

Resurgence of distributed generation – DG technologies – Interface to the utility system – Power quality issues and operating conflicts – DG on low voltage distribution networks.

Monitoring:

Power quality monitoring and considerations – Historical perspective of PQ measuring instruments – PQ measurement equipment – Assessment of PQ measuring data.

Text Books:

1 Electrical Power Systems Quality - Dugan R C - McGranaghan M F – Santoso S - and Beaty H W - Second Edition - McGraw–Hill - 2012 - 3rd edition.
2 Electric power quality problems – M.H.J.Bollen IEEE series-Wiley india publications – 2011.
3 Power Quality Primer - Kennedy B W - First Edition - McGraw–Hill - 2000.

Reference Books:

1 Understanding Power Quality Problems: Voltage Sags and Interruptions - Bollen M HJ - First Edition - IEEE Press; 2000.
2 G. T, Heydt, "Electric Power Quality", Stars in a Circle Publications, 1991 Power System Harmonics - Arrillaga J and Watson N R - Second Edition - John Wiley & Sons - 2003.
3 Electric Power Quality control Techniques - W. E. Kazibwe and M. H. Sendaula – Van 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

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231EE7O04	**3**	**0**	**0**	**3**

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

CO1: Explain core principles of quantum mechanics and their technological implications.
CO2: Analyze quantum phenomena like superposition and entanglement.
CO3: Apply mathematical tools to model and solve quantum systems.
CO4: Demonstrate understanding of quantum algorithms and quantum circuits.
CO5: Evaluate potential applications and challenges in quantum communication and sensing.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I
Fundamentals of Quantum Mechanics: Historical background: Blackbody radiation, photoelectric effect, and Compton scattering; Dual nature of light and matter; De Broglie hypothesis; Schrödinger equation; Free particle, infinite potential well, step potential; Operators and observables: position, momentum, Hamiltonian; Commutation relations and uncertainty principle; Quantum postulates and measurement theory; Eigenvalues, eigenfunctions..

UNIT – II
Quantum Information Theory: Classical vs. quantum information; Qubit representation using Bloch sphere; Quantum superposition and quantum entanglement; Dirac notation (bra-ket), tensor products, and composite systems; Bell states and EPR paradox; Quantum gates: Pauli-X, Y, Z; Hadamard; Phase; T; CNOT; Quantum circuit models and notation; Measurement in computational basis; Quantum teleportation and no-cloning theorem; Quantum state tomography (introductory).

UNIT – III
Quantum Computing: Classical computing review and limitations; Quantum parallelism and interference; Deutsch and Deutsch-Jozsa algorithms; Grover’s search algorithm, Oracle and amplitude amplification; Shor’s factoring algorithm (overview and significance); Quantum Fourier Transform (QFT); Quantum error correction: Bit-flip, phaseflip, and Shor’s 9-qubit code; Introduction to quantum programming: Qiskit, Cirq, IBM Quantum Experience (overview).

UNIT – IV
Quantum Communication: Introduction to quantum cryptography; Quantum key distribution (QKD): BB84 protocol; Entanglement-based QKD: Ekert protocol (E91); Eavesdropping and security of QKD; Quantum teleportation (circuit and protocol); Quantum dense coding; Quantum networks and entanglement swapping; Role of quantum repeaters; Single-photon sources and detectors; Implementation challenges (loss, decoherence, noise).

UNIT – V

Quantum Technologies and Applications: Quantum sensors: magnetometry, gravimetry; Quantum metrology: standard time, atomic clocks; Quantum imaging and lithography; Quantum materials: topological insulators, graphene, quantum dots; NV centers in diamonds for sensing; Hardware platforms: Superconducting qubits, Trapped ions, Photonic quantum processors; Quantum supremacy and NISQ era; Global initiatives: IBM, Google, DWave, IonQ, India's NQM; Ethical concerns and future prospects.

Text Books:

1. "Quantum Computation and Quantum Information" by Michael A. Nielsen and Isaac L. Chuang
2. "Quantum Mechanics: Concepts and Applications" by Nouredine Zettili

Reference Books:

1. Vedran Dunjko, Jacob M. Taylor and Hans J. Briegel, "*Quantum-Enhanced Machine Learning*", Physical Review Letters 117 (13).
2. Maria Schuld and Nathan Killoran, *Quantum machine learning in feature Hilbert spaces*, Phys. Rev. Lett. 122

Web Links:

1. https://nptel.ac.in/courses/104104082
2. https://nptel.ac.in/courses/115104096
3. https://nptel.ac.in/courses/122106034

*****

OPTIMIZATION TECHNIQUES
(Open Elective-IV)

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231ME7O06	**3**	**0**	**0**	**3**

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

CO1: Understand the classical optimization techniques
CO2: Learn numerical methods for optimization
CO3: Get insights into genetic algorithm and its variants
CO4: Know the applications of optimization in mechanical engineering
CO5: Understand the concept of reliability

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 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:

CO/PSO	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 PROCESSESS
(Open Elective-IV)

VII Semester **L T P C**
Course Code: 231ME7O07 **3 0 0 3**

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

CO1: Explain the working principle of various nonconventional machining processes and their applications.
CO2: Explain the working principles of additive manufacturing methods.
CO3: Understand various surface treatment techniques and processing of ceramics.
CO4: Gain the knowledge on advanced coating processes.
CO5: Describe various fabrication methods for microelectronic devices.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 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 of Course Outcomes with Program Specific Outcomes:

CO/PSO	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)

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231ME7O08	**3**	**0**	**0**	**3**

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

CO1: Explain the quality management philosophies and frameworks.
CO2: Explain quality costs and leadership.
CO3: Explain the concepts of customer focus, continuous quality improvement and supplier partnership
CO4: Apply various TQM tools to improve management processes
CO5: Calculate process capability index in TQM process

Mapping of Course Outcomes with Program Outcomes:

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	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:

CO/PSO	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, TataMcgraw HillPublishing Company Ltd., 2005

Reference Books:

1. Management Quality-Concepts and Tasks, Narayana V and Sreenivasan N.S.,New age publishers;1st edition(1January2005).
2. Statistical Quality Control, SeventhEdition, RichardS.Leavenworth & Eugene LodewickGrant,7th Edition,TataMcgrawHill,2015
3. Total QualityManagement, Subburaj Ramasamy, TataMcGrawHill Publishing CompanyLtd., NewDelhi, 2005.

Web links:

1. https://nptel.ac.in/courses/110/105/110105039/
2. https://nptel.ac.in/courses/110/104/110104085/
3. https://nptel.ac.in/courses/110/104/110104080/#

-

OPERATIONS MANAGEMENT
(Open Elective-IV)

VII Semester	**L**	**T**	**P**	**C**
Course Code: 231ME7O09	**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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
CO1	2	1	1	-	-	2	-	-	-	-	1	1
CO2	1	1	1	-	-	1	-	-	-	-	1	1
CO3	3	2	1	-	-	1	-	-	-	-	1	1
CO4	2	1	1	-	-	2	-	-	-	-	1	1
CO5	2	1	1	-	-	2	-	-	-	-	1	1

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – 1
INTRODUCTION - definition– characteristics and phases – types of operation research models – applications. Linear programming: Problem formulation – graphical solution – simplex method – artificial variables techniques -two–phase method, big-M method – duality principle.

UNIT – 2
TRANSPORTATION PROBLEM: Formulation – optimal solution, unbalanced transportation problem – degeneracy, assignment problem – formulation – optimal solution - variants of assignment problem- travelling salesman problem.
SEQUENCING – Introduction – flow –shop sequencing – *n* jobs through two machines – *n* jobs through three machines – job shop sequencing – two jobs through 'm' machines.

UNIT – 3
REPLACEMENT THEORY: Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.
GAME THEORY: Introduction – mini. max (max. mini) – criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points – 2 x 2 games – dominance principle – m x 2 & 2 x n games -graphical method.

UNIT – 4

WAITING LINES: Introduction – single channel – poison arrivals – exponential service times – with infinite population and finite population models– multichannel – poison arrivals – exponential service times with infinite population single channel.

PROJECT MANAGEMENT: Basics for construction of network diagram,Program Evaluation and Review Technique (PERT), Critical Path Method (CPM) – PERT Vs. CPM, determination of floats-Project crashing and its procedure.

UNIT – 5

RELIABILITY: Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, hazard analysis

Text Books:

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

References:

1. Introduction to O.R/Hiller & Libermann/TMH
2. Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.
3. Operations Research: Methods & Problems / Maurice Saseini, ArhurYaspan& Lawrence Friedman/Wiley
4. Operations Research / R.Pannerselvam/ PHI Publications.
5. Operations Research / Wagner/ PHI Publications.

Web Links:

1. https://nptel.ac.in/courses/110/106/110106062/
2. https://ocw.mit.edu/courses/sloan-school-of-management/15-760a-operations-management-summer-2002/

ENERGY AUDITING
(Open Elective-IV)

VII Semester
Course Code: 231ME7O10

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:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12
CO1	3	2	1	1	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:

CO/PSO	PSO1	PSO 2
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)

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231EC7O04	**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)

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231EC7O05	**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,DavidA.Bell, 2nd edition, PHI, 2003
2. Electronic test Instruments, analog and digital measurements, Robert A.Wittie, 2nd edition, Pearson education, 2004.
3. Electronic measurements and Instrumentations, K.Lal Kishore, Pearson education, 2005

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

***

SENSORS AND ACTUATORS
(Open Elective-IV)

VII Semester
Course Code: 231EC7O06

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: 231CS7O02 **3 0 0 3**

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

CO1: Explain the fundamental usage of the concept Machine Learning system with an emphasis on statistical learning
CO2: Demonstrate various regression techniques and linear models for binary classification
CO3: Analyze the role of Ensemble Learning Methods and Support Vector Machines in Machine Learning
CO4: Illustrate the Clustering Techniques and Dimensionality Reduction Models in Machine Learning
CO5: Discuss the Neural Network Models and Fundamentals concepts of Deep Learning

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

Unit - I
Introduction- Artificial Intelligence, Machine Learning, Deep learning, Types of Machine Learning Systems, Main Challenges of Machine Learning.Statistical Learning: Introduction, Supervised and Unsupervised Learning, Training
and Test Loss, Tradeoffs in Statistical Learning, Estimating Risk Statistics, Sampling distribution of an estimator, Empirical Risk Minimization.

Unit – II
Supervised Learning(Regression/Classification):Basic Methods: Distance based Methods, Nearest Neighbours, Decision Trees, Naive Bayes, Linear Models: Linear Regression, Logistic Regression, Generalized Linear Models, Support Vector Machines, Binary Classification: Multiclass/Structured outputs, MNIST, Ranking.

Unit – III
Ensemble Learning and Random Forests: Introduction, Voting Classifiers, Bagging and Pasting, Random Forests, Boosting, Stacking.Support Vector Machine: Linear SVM Classification, Nonlinear SVM 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", Oreilly

Web Links:

1. https://www.deeplearning.ai/machine-learningyearning/
2. https://www.cse.huji.ac.il/~shais/UnderstandingMachineLearning/index.html
3. https://onlinecourses.nptel.ac.in/noc21_cs24/preview
4. https://www.udemy.com/course/machinelearning/

DATA VISUALIZATION
(Open Elective-IV)

VII Semester **L T P C**

Course Code: 231DS7O02 **3 0 0 3**

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

CO1: Identify and recognize visual perception and representation of data.
CO2: Illustrate about projections of different views of objects.
CO3: Apply various Interaction and visualization techniques.
CO4: Analyze various groups for visualization.
CO5: Apply visualizations for volumetric data to present them graphically.

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	-
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 visualizeation 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)

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231IT7O02	**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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

UNIT – I
Introduction to Cloud Computing Fundamentals
Cloud computing at a glance, defining a cloud, cloud computing reference model, types of services (IaaS, PaaS, SaaS), cloud deployment models (public, private, hybrid), utility computing, cloud computing characteristics and benefits, cloud service providers (Amazon Web Services, Microsoft Azure, Google App Engine).

UNIT – II
Cloud Enabling Technologies
Ubiquitous Internet, parallel and distributed computing, elements of parallel computing, hardware architectures for parallel computing (SISD, SIMD, MISD, MIMD), elements of distributed computing, Inter-process communication, technologies for distributed computing, remote procedure calls (RPC), service-oriented architecture (SOA), Web services, virtualization.

UNIT – III
Virtualization and Containers
Characteristics of virtualized environments, taxonomy of virtualization techniques, virtualization and cloud Computing, pros and cons of virtualization, technology examples (XEN, VMware), building blocks of containers,

container platforms (LXC, Docker), container orchestration, Docker Swarm and Kubernetes, public cloud VM (e.g. Amazon EC2) and container (e.g. Amazon Elastic Container Service) offerings.

UNIT-IV

Cloud computing challenges

Economics of the cloud, cloud interoperability and standards, scalability and fault tolerance, energy efficiency in clouds, federated clouds, cloud computing security, fundamentals of computer security, cloud security architecture, cloud shared responsibility model, security in cloud deployment models.

UNIT –V

Advanced concepts in cloud computing

Serverless computing, Function-as-a-Service, serverless computing architecture, public cloud (e.g. AWS Lambda) and open-source (e.g. OpenFaaS) serverless platforms, Internet of Things (IoT), applications, cloud-centric IoT and layers, edge and fog computing, DevOps, infrastructure-as-code, quantum cloud computing.

Text Books:

1. Mastering Cloud Computing, 2nd edition, Rajkumar Buyya, Christian Vecchiola, Thamarai Selvi, Shivananda Poojara, Satish N. Srirama, Mc Graw Hill, 2024.
2. Distributed and Cloud Computing, Kai Hwang, Geoffery C. Fox, Jack J. Dongarra, Elsevier, 2012.

Reference Books:

1. Cloud Computing, Theory and Practice, Dan C Marinescu, 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: 231AM7O02	**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, IanSommerville,10thEdition, Pearson
2 Software Engineering, Principles and Practices, Deepak Jain, Oxford University Press.

Web Links:

1 https://nptel.ac.in/courses/106105087
2 https://nptel.ac.in/courses/106101061
3 https://www.coursera.org/specializations/software-design-architecture

DEEPWATER TECHNOLOGY
(Open Elective-IV)

VII Semester **L T P C**
Course Code: 231PT7O04 **3 0 0 3**

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

CO 1: Analysis of waves and fluid-induced forces on offshore structures, Current and wind forces.
CO 2: Understand the Deepwater exploration and Deepwater drilling techniques.
CO 3: Apply the concepts of fixed platforms, compliant towers, subsea systems, extended reach wells and floating production systems.
CO 4: Extend innovative subsea completion, installation and associated problem.
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 geo-hazards, gas hydrate etc., Deep water drilling with emphasis on the additional inputs to normal offshore Drilling operation.

UNIT –III:
Deep-water Production System: Fixed Platforms, Compliant Towers, Subsea systems, Extended Reach Wells, Floating production systems like FPSO, FPSS, TLPS, Spar platform and FSO.

UNIT-IV:

Deep-water applications of Subsea Technology: Subsea completion, X-mas tree, Control systems, Manifolds, Templates, ROV, Deepwater installation vessels with DP system and associated problems – Offshore mobile units, station- keeping methods like mooring and dynamic positioning system.

UNIT-V:

Deep-water pipelines, Umbilical's & emerging Deep-water Technologies:

Issues in Deep-water pipeline design, Rigid and Flexible flow lines, pipe-in-pipe, Deep-water Risers and their configurations, Pipeline installation methods, Umbilical's-functions, configurations and installation, Flow assurance strategies, Innovative floating production concepts, subsea processing, subsea separation and any new innovations.

Text Books:

1. Subsea Engineering Handbook, Yong bai and Qiangbai, Gulf Professional Publishing, 2010.
2. Offshore Petroleum Drilling and Production, By Sukumar Laik, 1st Edition, Published June 30, 2020 by CRC Press.
3. Deepwater Petroleum Exploration & Production by William L. Leffler, Richard Pattarozzi, Gordon Sterling Penn Well Books, 2003.

Reference Books:

1. Floating Drilling: Equipment and Its Use, by Riley Sheffield Volume 2 of Floating Drilling and Volume 2 of Practical drilling technology-1980
2. Handbook On Nondestructive Testing of Concrete By V.M. Malhotra And N.J. Carino, Second Edition Crc Press-2004
3. Offshore Handbook Vol.1 to 5: Gulf Pub. Co.
4. Offshore Pipeline Design, Analysis, and Methods by A. H. Mousselli, Publisher, Penn Well Books, 1981.
5. Drilling and Producing Offshore, by R. Stewart Hall, Publisher, Pennwell Corp- 1984.

Web Links:

1. https://www.civil.iitb.ac.in/~mcdeo/waves_book1/wave.pdf
2. https://sut.org/wp-content/uploads/2017/09/OSIG-Guidance-Notes-2017-online-version.pdf
3. https://www.slideshare.net/slideshow/oil-gas-offshore-platform-overview-with-details/270656574
4. https://isomase.org/OCAri/Book/Introduction%20to%20Subsea%20Tree/Introduction%20to%20Subsea%20Tree.pdf
5. https://www.scrivenerpublishing.com/cart/title.php?id=576

INTRODUCTION TO ACIDIZING AND HYDRO-FRACTURING
(Open Elective-IV)

		L	T	P	C
VII Semester					
Course Code:	231PT7O05	**3**	**0**	**0**	**3**

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

CO 1: Apply the modelling of hydraulic fractures for different reservoirs.
CO 2: Assess fracturing fluid properties and their usage.
CO 3: Analyze the fracturing fluid proppant characteristics.
CO 4: Apply the methods of matrix acidization and fracture acidization.
CO5: Apply the concepts of hydraulic fracturing and its design

Mapping of Course Outcomes with Program Outcomes

CO/PO	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:
Modelling of hydraulic fractures: Conservation laws and constitutive equations, fracture propagation models, fluid flow modelling, acid fracturing.

UNIT-II:
Fracturing fluid chemistry: Water base fluids, oil base fluids, multiphase fluids, additives execution.

UNIT-III:
Fracturing fluid proppant and characterization: Rheology, shear and temperature effects on fluid properties, foam fracturing fluids, slurry rheology, proppant transport, fluid loss, formation and fracture damage, and proppants.

UNIT-IV:
Matrix acidization and fracture acidization: Well Stimulation acids, matrix acidizing carbonate formations, fracture acidizing carbonate formations, Acid–rock interaction, sandstone acidizing design, carbonate acidizing design.

UNIT-V:

Hydraulic Fracturing: Introduction, formation fracturing pressure, fracture geometry, productivity of fractured wells, stimulated reservoir volume (SRV) - hydraulic fracturing design.

Text Books:

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.

Web Links:

1. https://link.springer.com/article/10.1007/s40948-025-00986-8
2. https://onepetro.org/books/book/34/chapter/10917733/Fracturing-Fluids-and-Additives
3. https://www.sciencedirect.com/topics/materials-science/fracturing-fluid
4. https://pubs.acs.org/doi/10.1021/acsomega.3c07132
5. https://www.mdpi.com/1996-1073/14/22/7727

INTRODUCTION TO RESERVOIR ENGINEERING
(Open Elective-IV)

VII Semester | | **L T P C**
Course Code: 231PT7O06 | | **3 0 0 3**

		L	T	P	C
VII Semester		**L**	**T**	**P**	**C**
Course Code:	231PT7O06	**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 (17thImpression 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

	L	T	P	C
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

	L	T	P	C
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 (Dynami), 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 – Venture 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 – Geo-phones. 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, NOx – 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. Morrris, A.S. Principles of Measurement and Instrumentation, Print ice-Hall of India Pvt., Ltd. New Delhi, 1999.
3. Doeblin, 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

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231MI7O07	**3**	**0**	**0**	**3**

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

CO1: Demonstrate knowledge of historical safety practices and major global mining disasters.
CO2: Apply risk assessment techniques and HIRA methodology in identifying and controlling mining hazards.
CO3: Utilize advanced risk analysis methods such as FMEA, HAZOP, FTA, and Markov Models.
CO4: Analyze mine accidents using safety engineering theories, ANN, and SEM tools.
CO5: Evaluate and implement ergonomic principles to improve safety and productivity in mining environments.

Mapping of Course Outcomes with Program Outcomes:

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

UNIT – I
Introduction: Historical Developments of Mine Safety in India and Abroad; Need for Approving, Safety Engineering Approach in Mining, Industry; Engineering Safety Goals; Mine Safety Facts and Figures; Worldwide Major Mine Disasters.

UNIT – II
Risk Management: Risk Management Related Terms and Definitions; Basic Concept of Risk, Reliability and Hazard Potential; Risk Components and Types; Risk Management Objectives; Risk Management Process; Functions of a Risk Manager; Common Errors in Risk Management; Risk Estimates for Selective, Events; Hazards Identification and Risk Assessment (HIRA) Methodology; Implementation of HIRA and its Controls & Review; Advantages of Risk Management

UNIT – III
Statistical Methods of Risk analysis: Basic Risk Analysis Methods based on Frequency Rates and Severity of Accidents Appraisal of advanced techniques - Preliminary Hazards Analysis (PHA); Hazards and Operability Analysis (HAZOP); Failure Mode and Effect Analysis (FMEA); Failure Mode Effect and Critical Analysis (FMECA); Job Safety Analysis (JSA); Fault Tree Analysis (FTA); Markov Model (MM) – An Important Risk analysis Tool.

UNIT – IV
Analyzers: Dissolved Analyzer: Conductivity meter – pH meter – Dissolved oxygen analyzer System Safety Engineering Concept in Mine Safety: An Introduction to Systems Safety Engineering; Different School of Thoughts in Accident Causations - Domino Model; Behavioral Accident Model based on the human perception; Epidemiological Accident Models, Normal Accident Theory; The Swiss Cheese Model; Systems-Theoretic Accident Modeling and Process (STAMP); In-depth Study of Accidents Due to Various Causes; Application of Structural Equation Modelling (SEM) and Artificial Neural Network (ANN) in Determining the Accident Causation in Mines. Safety audits and control: Objectives of safety audit in mines; Different steps in safety audit; Risk control procedures.

UNIT – V

Mine Ergonomics: Domain, Philosophy and Objective of Mine Ergonomics; Ergonomics/ human, Factors fundamentals; Work physiology, and stress; Human body- structure and, function, anthropometrics; Posture and movement; Posture and Job Relation – Work Posture Analysis using OWAS, Method; Oxygen Consumption and Workload Analysis of Mine Workers..

Text Books:

1. Engineering Safety: Fundamentals, Techniques and Applications by B. S. Dhillon; World Scientific Publisher.
2. Mine Health and Safety Management – Edited by Michael Karmis.
3. Kejriwal, B. K., Safety in mines, Lovely Prakashan.

Reference Books:

1. Dhillon, B. S. (2008). Mining equipment reliability, maintainability, and safety (Springer Series in Reliability Engineering). Springer.
2. Dhillon, B. S. (2010). Mine safety: A modern approach (Springer Series in Reliability Engineering). Springer..

Web Links:

1. https://www.dgms.gov.in/writereaddata/UploadFile/History_of_Mine_Safety_in_India.pdf
2. https://miningandblasting.files.wordpress.com/2009/09/risk_management_in_mining.pdf
3. https://www.slideshare.net/slideshow/system-safety-engineering-and-risk-analysis/23457298

*****

MINERAL EXPLORATION
Open Elective-IV

	L	T	P	C
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 | **L** | **T** | **P** | **C**
Course Code: 231AG7O02 | **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	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

Unit - I
Planning and layout of farmstead. Scope, importance and need for environmental control, physiological reaction of livestock environmental factors, environmental control systems and their design, control of temperature, humidity and other air constituents by ventilation and other methods.

Unit – II
Livestock production facilities, BIS Standards for dairy, piggery, poultry and other farm structures. Design, construction and cost estimation of farm structures; animal shelters, compost pit, fodder silo, fencing and implement sheds, barn for cows, buffalo, poultry, etc

Unit – III
Storage of grains and Causes of spoilage. Water activity for low and high moisture food grains and its limits for storage, Moisture and temperature changes in grain bins; Traditional storage structures and their improvements, Improved storage structures (CAP, hermetic storage, Pusa bin, RCC ring bins). Design consideration for grain storage godowns, Bag storage structures, Shallow and Deep bin, Calculation of pressure in bins and Storage of seeds

Unit – IV

Protected cultivation: Introduction, History, origin, development, national and International Scenario, components of green house, perspective, Types of green houses, polyhouses /shed nets, Cladding materials, Plant environment interactions – principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment. Design and construction of greenhouses – site selection, orientation, design, construction, design for ventilation requirement using exhaust fan system, selection of equipment, Greenhouse cooling system – necessity, methods – ventilation with roof and side ventilators, evaporative cooling, different shading material fogging, combined fogging andfan-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, KalyaniPublishers, Ludhiana.
2. Ojha, T.P and Michael, A.M. Principles of Agricultural Engineering, Vol. I, Jain Brothers, Karol Bag,New Delhi.

Reference Books:

1. Venugopal Rao, P. Text Book of Environmental Engineering, Prentice Hall of India, New Delhi.
2. Sahay, K.M. and Singh, K.K. Unit Operations of Agricultural Processing, Vikaspublishing pvt. Ltd,Noida.
3. Singh Brahma and Balraj Singh. 2014. Advances in protected cultivation, New India PublishingCompany.
4. Sharma P. 2007. Precision Farming. Daya Publishing House New Delhi.

Web Links:

1. https://nptel.ac.in/courses/104103020/3
2. http://ecoursesonline.iasri.res.in/mod/page/view.php?id=618
3. https://agrimoon.com/agricultural-structures-and-environmental-control-pdfbook

PETROLEUM EQUIPMENT DESIGN & SIMULATION-LAB
(Skill Oriented Course-V)

VII Semester		**L**	**T**	**P**	**C**
Course Code:	231PT7S01	**0**	**0**	**3**	**2**

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

CO 1: Design and simulation of the two-phase, three phase separators and compressors
CO 2: Design and simulation of absorber-stripper unit for removal of CO_2 and H_2S from natural gas
CO 3: Size /rate the pipeline & pumping systems for liquid pumping & simulate water hammer conditions
CO 4: Design and simulation of flash vaporization units
CO5: Generating sized equipment data sheets as per the industry standards with required information for detailed design / manufacture

Mapping of Course Outcomes with Program Outcomes

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

Mapping of Course Outcomes with Program Specific Outcomes

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

List of Experiments:

1. To study Oil- Water separator
2. To study Gas- Oil-Water separator
3. To study Lean / rich amine heat exchanger
4. To study Air-cooled heat exchanger.
5. To study CO_2 and H_2S absorber unit using, MEA/DEA amine solution.
6. To study Stripping unit
7. To study Single stage flash vaporization unit
8. To study three stage flash vaporization unit.

9. To study Liquid pumping system & simulation of water-hammer phenomena
10. To study Gas Compressor unit

List of Augmented Experiments:

11. To study Expander
12. To study Conversion Reaction
13. To study Equilibrium Reaction

Reference Books:

1. Process Modeling, Simulation and Control for Chemical Engineering, Luyben, McGraw Hill Education; 2 edition, 2013.
2. Optimization of Chemical Processes, Thomas F. Edgar, David M. Himmelblau, Thomas E. Casson, 2nd Edition, 2001.
3. Elements of Chemical Reaction Engineering, Fogler H.S, Prentice Hall India Learning Private Limited; 4 edition, 2008.

Web Links:

1. https://petrowiki.org/Oil_and_gas_separators
2. http://www.thermopedia.com/content/551/
3. https://en.wikipedia.org/wiki/Amine_gas_treating
4. www.chemprosys.com/products/evoporators/multi-stage-flash/
5. https://worldwidescience.org/topicpages/w/water+hammer+phenomena.html

SUMMER INTERNSHIP-II

VII Semester **L T P C**
Course Code: 231PT7P01 **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.

RESEARCH METHODOLOGY
(Audit Course)

	L	T	P	C
VII Semester	**L**	**T**	**P**	**C**
Course Code: 231MC7T03	**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 tendancy, coefficient of variation, correlation and regression

Mapping of Course Outcomes with Program Outcomes:

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

Mapping of Course Outcomes with Program Specific Outcomes:

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

UNIT – I
Meaning of Research - Function of Research - Characteristics of Research – Steps involved in Research – Research in Pure and Applied Sciences - Inter Disciplinary Research. Factors which hinder Research – Significance of Research - Research and scientific methods – Research Process– Criteria of good Research – Problems encountered by Researchers – Literature Review.

UNIT – II
Identification of Research Problem : Selecting the Research problem – Necessity of defining the problem – Goals and Criteria for identifying problems for research. Perception of Research problem – Techniques involved in defining the problem.

UNIT – III

Research Design: Formulation of Research design – Need for Research design – Features of a good design – Important concepts related to Research design

UNIT – IV

Interpretation and Report Writing: Meaning and Technique of interpretation – Precautions in interpretation – Significance of report writing – Different steps in writing a report – Layout of a Research report.

UNIT – V

Statistical Techniques and Tools: Introduction of statistics – Functions – Limitations – Measures of central tendency - Arithmetic mean – Median – Mode – Standard deviation – Co-efficient of variation (Discrete serious and continuous serious) – Correlation - Regression

Text Books:

1 Research Methodology Methods & Techniques, C.R. Kothari – New Age international Publishers, Reprint 2008
2 A Hand Book of Methodology of Research, Rajammall, P. Devadoss and K. Kulandaivel, RMM Vidyalaya press, 1976

Reference Books:

1 Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd., 1997.
2 Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi, 2011
3 Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi,1999.

Web Links:

1 https://nptel.ac.in/courses/127106227
2 https://www.youtube.com/watch?v=IZLn9_PA_4s

PROJECT
(Full Semester Internship)

	L	T	P	C
VIII Semester	**L**	**T**	**P**	**C**
Course Code: 231PT8P01	**0**	**0**	**24**	**12**

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

CO1 Find a problem statement by carrying out technical survey.
CO2 Demonstrate technical data by collecting and analyse the skills.
CO3 Develop potential solutions to the significant issues that have been highlighted by the data analysis.
CO4 Identify, analyse, and solve problems creatively through sustained critical investigation.
CO5 Provide concrete methods for implementing social, and professional ethical standards
CO6 Apply cutting-edge methods for data analysis to get fastidious results from the project.
CO7 Evaluate the solution that was achieved with in the context of engineering framework that supports the environmental considerations.
CO8 Practice the skills, diligence, and commitment to excellence needed to engage in lifelong learning.
CO9 Preparation of technical report and presentation.
CO10 Demonstrate communication skills effectively to work as a team.

Guidelines for Project:

1. The objective of this project work is to enable the student to take up investigative study in the field of Agricultural
2. Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by
3. the department for four to six students in a group, under the guidance of a supervisor. This is expected to provide
4. 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/Modelling/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/Modelling/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.