Program Syllabus Booklet

Bachelor of Technology in Petroleum Engineering
(B. Tech PE-106)

Session: 2020-21

Guru Gobind Singh College of Engineering and Technology
Guru Kashi University, Talwandi Sabo

GURU KASHI UNIVERSITY
PUNJAB - INDIA

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Annexure -1

Program Course name: Bachelor of Technology in Petroleum Engineering (B Tech PE)
Program Code: 106
Program Outcomes (POs) for the program Bachelor of Technology in Petroleum Engineering (B Tech PE) are as follows:

PO	Statement
PO1	**Engineering knowledge:** To apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** To identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** To design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: To use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** To create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** To apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** To understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** To apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** To function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** To 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.
PO11	**Project management and finance:** To demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** To 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) for the program Bachelor of Technology in Petroleum Engineering (B Tech PE) are as follows:

PSO	Statement
PSO1	Acquire basic knowledge and expertise necessary for professional practices in petroleum engineering for higher studies and research and acquire technical skills to identify, analyze and solve complex problems and issues related to petroleum engineering.
PSO2	Develop a professional attitude as an individual or a team member with consideration for society, professional ethics, environmental factors and motivation for life-long learning.
PSO3	Learn administrative and financial management principles for effective project implementation.

Annexure-2

Study Scheme										
Semester: 1st (Chemistry Group)										
Sr.	Subject Code	Subject Name	Type of Subject T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1	A103101	Basic Electrical Engineering	T	3	1	0	4	40	60	100
2	105106	Physics –I (Electromagnetism)	T	3	1	0	4	40	60	100
3	105107	Mathematics –I (Calculus and Linear Algebra)	T	3	1	0	4	40	60	100
4	105105	Engineering Graphics & Design	T/P	1	0	4	3	60	40	100
5	105108	Physics –I (Electromagnetism)	P	0	0	4	2	30	20	50
6	A103102	Basic Electrical Engineering Lab	P	0	0	2	1	30	20	50
Total No. of Credits				10	3	10	18			

Semester: 2nd (Physics Group)										
Sr.	Subject Code	Subject Name	Type of Subject T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1	A100102	Engineering Chemistry	T	3	1	0	4	40	60	100
2	105201	Mathematics –II (ODE& Complex Variables)	T	3	1	0	4	40	60	100
3	102202	Programming for Problem Solving	T	3	0	0	3	40	60	100
4	100108	English	T	2	0	0	2	40	60	100
5	105202	Workshop Manufacturing Practices	T/P	1	0	4	3	60	40	100
6	A100106	Engineering Chemistry Lab	P	0	0	4	2	30	20	50
7	102203	Programming for Problem Solving Lab	P	0	0	4	2	30	20	50
8	100109	English Lab	P	0	0	2	1	30	20	50
9	100304	Constitution of India	T	3	0	0	NC	NA	NA	NA
Total No. of Credits				15	2	14	21			

Semester: 3rd										
Sr.	Subject Code	Subject Name	Type of Subject T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1	B106301	Material and Energy Balance	T	3	1	0	4	40	60	100
2	B106302	Fluid Flow	T	3	1	0	4	40	60	100
3	B106303	Ground Survey	T	3	0	0	3	40	60	100
4	B106304	Reservoir Engineering-I	T	3	1	0	4	40	60	100
5	B106305	Thermodynamics	T	3	1	0	4	40	60	100
6	B106306	Engineering and Solid Mechanics	T	3	1	0	4	40	60	100
7	B106307	Fluid Flow and Strength of Materials Laboratory	P	0	0	2	1	30	20	50
8	A100302	Environmental Studies	T	3	0	0	NC	NA	NA	NA
9	B106308	Summer/Institutional Training	NA	NA	NA	NA	S/US*	NA	NA	NA
Total No. of Credits				21	5	2	24			

Note: Institutional Training will be imparted in the Institute at the end of 2nd Semester for 6-weeks duration. However this Subject is not applicable to LEET Students.

* (S/US) Satisfactory/Unsatisfactory

Semester: 4th										
Sr.	Subject Code	Subject Name	Type of Subject T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1	B106401	Geology of Petroleum	T	3	0	0	3	40	60	100
2	B106402	Drilling Technology	T	3	0	0	3	40	60	100
3	B106403	Heat Transfer	T	3	1	0	4	40	60	100
4	B106404	Mass Transfer	T	3	1	0	4	40	60	100
5	B106405	Industrial Engineering and Management	T	3	0	0	3	40	60	100
6	B106406	Reservoir Engineering-II	T	3	1	0	4	40	60	100
7	100305	Essence of Indian Traditional Knowledge	T	3	0	0	NC	NA	NA	NA
8	B106407	Heat Transfer Laboratory	P	0	0	2	1	30	20	50
9	B106408	Mass Transfer Laboratory	P	0	0	2	1	30	20	50
10	100306	Mentoring and Professional Development of Students	P	0	0	2	S/US*	NA	NA	NA
Total No. of Credits				21	3	6	23			

* (S/US) Satisfactory/Unsatisfactory

Semester: 5th										
Sr.	Subject Code	Subject Name	Type of Subject T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1	B106503	Drilling Fluids & Cements	T	3	1	0	4	40	60	100
2	B106504	Process Instrumentation& Control	T	3	1	0	4	40	60	100
3	B106505	Petroleum Refining Engineering	T	4	0	0	4	40	60	100
4		Professional Elective Course I	T	4	0	0	4	40	60	100
5	106511	Chemical Reaction Engineering	T	3	1	0	4	40	60	100
6	B106508	Process Instrumentation& Control Laboratory	P	0	0	2	1	30	20	50
7	106512	Petroleum Engineering Laboratory	P	0	0	2	1	30	20	50
8	106513	Chemical Reaction Engineering Laboratory	P	0	0	2	1	30	20	50
Total No. of Credits				17	3	6	23			

Semester: 6th										
Sr.	Subject Code	Subject Name	Type of Subject T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1	B106605	Offshore Drilling and Production Practices	T	3	1	0	4	40	60	100
2	B106606	Numerical Methods	T	3	1	0	4	40	60	100
3	106610	Mechanical Operations	T	3	1	0	4	40	60	100
4	106611	Probability and Statistics	T	3	1	0	4	40	60	100
5		Professional Elective Course II	T	4	0	0	4	40	60	100
6		Open Elective Course I	T	4	0	0	4	40	60	100
7	106611	Mechanical Operations Laboratory	P	0	0	2	1	30	20	50
8	B106609	Numerical Methods Laboratory	P	0	0	2	1	30	20	50
Total No. of Credits				20	4	4	26			

Semester: 7th										
Sr.	Subject Code	Subject Name	Type of Subject T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1	B106701	Process Economics and Management	T	4	0	0	4	40	60	100
2	B106703	Oil & Gas Transportation System	T	3	1	0	4	40	60	100
3	B106704	Natural Gas Engineering	T	4	0	0	4	40	60	100
4		Professional Elective Course III	T	4	0	0	4	40	60	100
5		Open Elective Course II	T	4	0	0	4	40	60	100
6	106712	Process Equipment Design	P	0	0	4	2	30	20	50
7	106713	Industrial/Institutional Training-I*	NA	NA	NA	NA	4	60	40	100
Total No. of Credits				19	1	4	26			

* Industrial/Institutional Training-I:- The marks of industrial Training-I undergone at the end of 6th semester will be included here.

Semester: 8th										
Sr.	Subject Code	Subject Name	Type of Subject T/P	(Hours Per Week)			No. of Credits	Internal Marks	External Marks	Total Marks
				L	T	P				
1	A105802	Industrial Safety and Environment	T	3	0	0	3	40	60	100
2	106803	Oil & Well Testing Techniques	T	3	1	0	4	40	60	100
3		Professional Elective Course IV	T	4	0	0	4	40	60	100
4		Professional Elective Course V	T	4	0	0	4	40	60	100
5		Open Elective Course III	T	4	0	0	4	40	60	100
6	106804	* Project	P	0	0	6	3	60	40	100
7	106805	Industrial/Institutional Training-I**	NA	NA	NA	NA	5	120	80	200
Total No. of Credits				18	1	6	27			

* Project: - The problem related with design, construction, modeling, fabrication, experimentation etc. is to be carried out. The project work will be carried out in groups.

** Training-II:- The student will cover this training on the basis of his/her elective subject choice or outside of institute.

Professional Elective Course	
B106601	Petrochemical Technology
106806	Enhanced Oil Recovery
106807	Well Logging
106808	Non-conventional Petroleum Resources
B106702	Process Modelling and Simulation
106809	Membrane Separation Processes
B106603	Transport Phenomena
106810	Reservoir Modeling & Simulation
106811	Pipeline Engineering
106812	Directional Drilling
106813	Polymer Technology
B106705	Modern Separation Processes
B106706	Optimization Techniques
B106708	Energy Engineering
B106709	Petroleum Engineering System Design
B106710	Process Plant Design
106814	Plant Utilities
106815	Coal Bed Methane and Gas Hydrates
106816	Oil & Gas Marketing &resource Management
106817	Chemical Technology

Open Elective Course	
A102702	Web Designing and Development
105939	Computer Aided Design
A105804	Operation Research
A102405	Organizational Behavior
102513	Mobile Application Development
A105920	Management Information System
A102602	Human Resource Management
102617	Dataware Housing & Data Mining
102611	Computer Network
A105605	Refrigeration & Air Conditioning
105902	Non-Conventional Energy Resources
105942	Solar Energy
A105918	Total Quality Management
A101403	Hydrology & Water Resources Engineering
A101405	Disaster Preparedness & Planning
103708	Utilization of Electrical Energy and Traction
103616	Power Plant Engineering

Annexure-3

Course Name: Basic Electrical Engineering

Course Code: A103101

Semester: 1st

L T P

Credits: 04 **3 1 0**

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Discuss the DC and AC electrical circuit elements with RLC in detail.
CO2	Analyze simple circuits with dc excitation, Superposition, Thevenin and Norton Theorems.
CO3	Analyze Single Phase AC Circuits and representation of alternating quantities and determination of power in these circuits.
CO4	Classify the different types of Electrical machines.
CO5	Understand the different type of electrical installation devices.

Course Content

Module 1: DC Circuits (8 hours)

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

Module 2: AC Circuits (8 hours)

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three-phase balanced circuits, voltage and current relations in star and delta connections.

Module 3: Transformers (6 hours)

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

Module 4: Electrical Machines (8 hours)

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

Module 5: Power Converters (6 hours)

DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.

Module 6: Electrical Installations (6 hours)

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

Suggested Text / Reference Books

(i) Kothari, D. P. and Nagrath, I. J. (2010). *Basic Electrical Engineering*. Tata McGraw Hill.
(ii) Kulshreshtha, D. C. (2009). *Basic Electrical Engineering*. McGraw Hill.
(iii) Bobrow, L. S. (2011). *Fundamentals of Electrical Engineering*. Oxford University Press.
(iv) Hughes, E. (2010). *Electrical and Electronics Technology*. Pearson,

Correlation of COs to the Program Outcomes (POs) and Program Specific Outcomes (PSOs) for Basic Electrical Engineering

PO/PSO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	2	2	1	1	2	1	2	1	2	2	2	2
CO2	1	2	2	2	-	1	2	1	1	2	2	1	3	3	2
CO3	2	3	-	3	2	1	1	2	2	1	2	2	2	2	-
CO4	3	2	2	2	2	2	-	1	1	2	-	2	3	2	2
CO5	2	2	2	3	2	1	2	2	1	2	1	2	2	2	2
AVERAGE	**1.8**	**2.2**	**2**	**2.4**	**2**	**1.2**	**1.2**	**1.6**	**1.2**	**1.8**	**1.2**	**1.8**	**2.4**	**2.2**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Physics (Electromagnetism)
Course Code: 105106
Semester: 1st

Credits -4

L	T	P
3	1	0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Apply knowledge of electricity and magnetism to explain natural physical processes and related technological advances.
CO2	Use the knowledge regarding calculus along with physical principles to effectively solve problems encountered in everyday life, further study in science and in the professional world.
CO3	Design experiments and acquire data in order to explore physical principles, effectively communicate results, and critically evaluate related scientific studies.
CO4	Assess the contributions of physics to our evolving understanding of global change and sustainability while placing the development of physics in its historical and cultural context.
CO5	Acknowledge the concepts of induction and self-induction, to solve problems using Faraday's and Lenz's laws and analyze and solve RL circuits

Course Content

Module 1: Electrostatics in vacuum (8 lectures)
Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential and uniqueness of their solution and connection with steady state diffusion and thermal conduction; Practical examples like Farady's cage and coffee-ring effect; Boundary conditions of electric field and electrostatic potential; method of images; energy of a charge distribution and its expression in terms of electric field.

Module 2: Electrostatics in a linear dielectric medium (4 lectures)
Electrostatic field and potential of a dipole. Bound charges due to electric polarization; Electric displacement; boundary conditions on displacement; Solving simple electrostatics problems in presence of dielectrics – Point charge at the centre of a dielectric sphere, charge in front of a dielectric slab, dielectric slab and dielectric sphere in uniform electric field.

Module 3: Magnetostatics (6 lectures)

Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; the equation for the vector potential and its solution for given current densities.

Module 4: Magnetostatics in a linear magnetic medium (3 lectures)

Magnetization and associated bound currents; auxiliary magnetic field ; Boundary conditions on and . Solving for magnetic field due to simple magnets like a bar magnet; magnetic susceptibility and ferromagnetic, paramagnetic and diamagnetic materials; Qualitative discussion of magnetic field in presence of magnetic materials.

Module 5: Faraday's law (4 lectures)

Faraday's law in terms of EMF produced by changing magnetic flux; equivalence of Faraday's law and motional EMF; Lenz's law; Electromagnetic breaking and its applications; Differential form of Faraday's law expressing curl of electric field in terms of time-derivative of magnetic field and calculating electric field due to changing magnetic fields in quasi-static approximation; energy stored in a magnetic field.

Module 6: Displacement current, Magnetic field due to time-dependent electric field and Maxwell's equations (5 lectures)

Continuity equation for current densities; Modifying equation for the curl of magnetic field to satisfy continuity equation; displace current and magnetic field arising from time-dependent electric field; calculating magnetic field due to changing electric fields in quasi-static approximation. Maxwell's equation in vacuum and non-conducting medium; Energy in an electromagnetic field; Flow of energy and Poynting vector with examples. Qualitative discussion of momentum in electromagnetic fields.

Module 7: Electromagnetic waves (8 lectures)

The wave equation; Plane electromagnetic waves in vacuum, their transverse nature and polarization; relation between electric and magnetic fields of an electromagnetic wave; energy carried by electromagnetic waves and examples. Momentum carried by electromagnetic waves and resultant pressure. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

Suggested Text Books

(i) David J Griffths. (1999). *Introduction to Electrodynamics*. PrenticeHall.
(ii) Walker, Jearl, David Halliday, and Robert Resnick. (2011). *Fundamentals of Physics*. Hoboken, N.J: Wiley.
(iii) Saslow, W. (2008). *Electricity, magnetism and light*. e-book.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	3	2	1	2	-	2	2	2	2	2	2	2
CO2	3	3	3	2	2	1	-	1	2	3	2	3	3	3	3
CO3	2	3	3	2	2	2	1	-	1	2	1	2	2	3	2
CO4	2	3	2	3	1	-	2	2	2	3	2	3	2	1	3
CO5	3	2	2	2	2	2	1	2	-	3	-	3	2	2	2
Average	**2.4**	**2.6**	**2.4**	**2.4**	**1.**	**1.5**	**1.5**	**1.6**	**2.**	**2.6**	**2.**	**2.**	**2.2**	**2.2**	**2.**

					8				**2**		**2**	**6**			**4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name : Mathematics –I (Calculus and Linear Algebra)

Course code: 105107

Semester: 1st

Credits -4

L	T	P
3	1	0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Perform matrix operations and solvethe matrix equations using elementary matrix operations
CO2	Use system of linear equations and matrix equations to determine linear dependency or independency and Evaluate the eigen values and corresponding eigenvectors for a linear transformation
CO3	Set up and evaluate multiple integrals for regions in the plane to find area of the region bounded by curves and volume, surface area, Mass, C.G and M.I of solid geometric figures.
CO4	Demonstrate the fundamental theorem of calculus and use it for evaluating definite integrals and derivatives of integrals with variable limits of integration
CO5	Distinguish between the concepts of sequence and series, and determine limits of sequences and convergence and approximate sums

Course Content

Module 1: Calculus: (6 lectures)

Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Module 2: Calculus: (6 lectures)

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima.

Module 3: Sequences and series: (10 lectures)

Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

Module 4: Multivariable Calculus (Differentiation): (8 lectures)

Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.

Module 5: Matrices (10 lectures)

Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.

Suggested Text/Reference Books

(i) Thomas, G.B. & Finney, R.L. (2002). *Calculus and Analytic geometry*, 9th Edition, Pearson, Reprint.
(ii) Kreyszig, Erwin. (2006). *Advanced Engineering Mathematics*. 9th Edition, John Wiley & Sons.
(iii) Veerarajan, T. (2008). *Engineering Mathematics for first year.* Tata McGraw-Hill, New Delhi.
(iv) Ramana, B.V. (2010). *Higher Engineering Mathematics*, Tata McGraw Hill New Delhi, 11th Reprint.
(v) Poole, D. (2005). *Linear Algebra*: *A Modern Introduction*, 2nd Edition, Brooks/Cole.
(vi) Bali, N.P. &Goyal, Manish. (2008). *A text book of Engineering Mathematics*. Laxmi Publications, Reprint.
(vii) Grewal, B.S. (2010). *Higher Engineering Mathematics*. Khanna Publishers, 36th Edition.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	1	1	2	1	1	1	2	2	2	2	2
CO2	2	3	3	2	2	1	2	-	2	3	2	2	2	1	1
CO3	3	2	2	2	1	-	2	1	-	-	2	3	1	2	2
CO4	2	2	2	2	2	2	-	2	2	3	1	3	2	2	3
CO5	2	2	2	3	1	1	1	-	2	1	1	2	1	3	2
Average	**2.4**	**2.2**	**2.4**	**2.2**	**1.4**	**1.2**	**1.7**	**1.3**	**1.7**	**2**	**1.6**	**2.4**	**1.6**	**2**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Engineering Graphics & Design

Course Code: 105105

Semester: 1st

Credits -3

L	T	P
1	0	4

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand about engineering drawing applications and its importance in society.
CO2	Learn about the visual aspects of engineering design.
CO3	Understand the engineering graphics standards.
CO4	Understand the concept of solid modeling techniques.
CO5	Apply the computer-aided geometric design in engineering

Course Content

Module 1:

Introduction to Engineering Drawing covering, Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales;

Module 2:

Orthographic Projections covering, Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes;

Module 3:

Projections of Regular Solids covering, those inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

Module 4:

Sections and Sectional Views of Right Angular Solids covering, Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)

Module 5:

Isometric Projections covering, Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;

Module 6:

Overview of Computer Graphics covering, listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids];

Module 7:

Customization& CAD Drawing consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;

Module 8:

Annotations, layering & other functions covering applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory including sketching of perspective, isometric, multi view, auxiliary, and section views. Spatial visualization
exercises. Dimensioning guidelines, tolerance techniques; dimensioning and scale multi views of dwelling;

Module 9:

Demonstration of a simple team design project that illustrates Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerance; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying color coding according to building drawing practice; Drawing

sectional elevation showing foundation to ceiling; Introduction to Building Information Modeling (BIM).

References Books:

1. Gill, P.S.(2001).*Engineering Drawing*. S.K; Kataria and Sons,Ludhiana.
2. Bhatt, N.D.(2012).*Engineering Drawing*. Charotar Book Stall, Tulsi Sadan, Anand.
3. French, T.E. and Vierck. C.J.(1993).*Graphic Science*. McGraw-Hill, New York.
4. Zozzora, F.(1958).*Engineering Drawing*.McGraw Hill, NewYork.

(Corresponding set of) CAD Software Theory and User Manuals

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	1	2	1	2	2	1	1	1	2	1	1
CO2	2	1	2	1	2	1	1	2	2	1	1	-	1	2	2
CO3	2	2	2	2	1	2	1	2	2	1	-	1	2	1	1
CO4	1	2	1	2	1	1	2	2	2	2	1	1	1	2	2
CO5	1	2	1	2	2	1	2	1	2	1	1	1	1	2	2
Average	**1.75**	**1.75**	**1.75**	**1.75**	**1.25**	**1.5**	**1.25**	**2**	**2**	**1.25**	**1**	**1**	**1.5**	**1.5**	**1.5**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Physics (Electromagnetism) Lab
Course Code: 105108
Semester: 1st

L T P

Credits: 02 **0 0 4**

Course Outcomes: On successful completion of this course, the students would be able to :

CO	Statement
CO1	Apply knowledge gained through Experiments on electromagnetic induction and electromagnetic breaking.
CO2	Understand the use of LC circuit and LCR circuit.
CO3	Design Resonance phenomena in LCR circuits
CO4	Assess Magnetic field from Helmholtz coil.
CO5	Understand Measurement of Lorentz force in a vacuum tube

Course Content

Choice of experiments from the following:

- Experiments on electromagnetic induction and electromagnetic breaking;
- LC circuit and LCR circuit;
- Resonance phenomena in LCR circuits;
- Magnetic field from Helmholtz coil;
- Measurement of Lorentz force in a vacuum tube.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	2	2	2	2	2	2	2	2	2	3	2	3
CO2	1	1	2	1	1	1	2	1	2	2	-	2	2	3	2
CO3	2	1	2	2	2	2	1	-	2	2	2	3	2	3	2
CO4	1	1	2	1	1	2	-	2	1	-	2	2	2	2	2
CO5	1	1	1	2	1	-	1	2	-	2	1	3	3	3	3
Average	**1.5**	**1**	**2**	**1.5**	**1.5**	**1.5**	**1.25**	**1.7**	**1.7**	**2**	**1.5**	**2.4**	**2.4**	**2.6**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name : Basic Electrical Engineering Lab

Course code : A103102

Semester: 1st

Credits -1

L	T	P
0	0	2

Course Outcomes: On completion of this course, the successful students will be able to:

CO	Statement
CO1	Understand the basic introduction of measuring instruments instruments – voltmeter, ammeter, multi-meter, oscilloscope etc.
CO2	Two Terminal Element Relationships for inductors and capacitors and analysis of magnetic circuits
CO3	Analysis of Single Phase AC Circuits, the representation of alternating quantities and determining the power in these circuits
CO4	Observe the different waveforms of transformer on CRO.
CO5	Evaluate the torque Speed Characteristic of separately excited dc motor and induction motor.

List of experiments/demonstrations:

- Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
- Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope). Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage. Resonance in R-L-C circuits.
- Transformers: Observation of the no-load current waveform on an oscilloscope (non-sinusoidal wave-shape due to B-H curve nonlinearity should be shown along with a discussion about harmonics). Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
- Three-phase transformers: Star and Delta connections. Voltage and Current relationships (line-line voltage, phase-to-neutral voltage, line and phase currents). Phase-shifts between the primary and secondary side. Cumulative three-phase power in balanced three-phase circuits.
- Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
- Torque Speed Characteristic of separately excited dc motor.

- Synchronous speed of two and four-pole, three-phase induction motors. Direction reversal by change of phase-sequence of connections. Torque-Slip Characteristic of an induction motor. Generator operation of an induction machine driven at super- synchronous speed.
- Synchronous Machine operating as a generator: stand-alone operation with a load. Control of voltage through field excitation.
- Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform (c) the use of dc-ac converter for speed control of an induction motor and (d) Components of LT switchgear.

Correlation of COs to the Program Outcomes (POs) and Program Specific Outcomes (PSOs) for Basic Electrical Engineering Lab

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	PO12	PSO1	PSO 2	PSO3
CO1	3	2	3	2	2	2	1	2	1	2	3	2	2	2	2
CO2	2	2	3	1	2	1	2	1	2	2	-	1	2	2	2
CO3	2	3	2	1	1	2	1	2	2	1	-	2	3	2	2
CO4	2	1	3	2	2	1	1	2	-	1	1	2	2	2	3
CO5	3	2	1	3	2	1	1	1	2	2	3	3	1	3	3
Average	**2.4**	**2**	**2.4**	**1.8**	**1.8**	**1.4**	**1.2**	**1.6**	**1.75**	**1.6**	**2.3**	**2**	**2**	**2.2**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Engineering Chemistry
Course Code: A100102
Semester: 2nd

Credits: 04

L T P
3 1 0

Course Outcomes: On successful completion of this course, the students would be able to :

CO	Statement
CO1	Demonstrate Schrodinger equation, Particle in a box solution and their applications for conjugated molecules and Nanoparticles,
CO2	Evaluate band structure of solids and the role of doping on band structures.
CO3	Distinguish the ranges of Vibrational and rotational spectroscopy of diatomic molecules, Applications, Nuclear magnetic resonance and magnetic resonance imaging
CO4	Rationalize periodic properties such as ionization potential, electro-negativity, Oxidation states and electro-negativity.
CO5	List the Thermodynamic functions: energy, entropy and free energy and also Estimations of entropy and free energies.

Course Content

Module 1: Atomic and molecular structure (12 lectures)
Schrodinger equation, Particle in a box solution and their applications for conjugated molecules and Nanoparticles, Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations, Molecular orbitals of diatomic molecules and plots of the multicenter orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

Module 2: Spectroscopic techniques and applications (8 lectures)
Principles of spectroscopy and selection rules, Electronic spectroscopy, Fluorescence and its applications in medicine, Vibrational and rotational spectroscopy of diatomic molecules, Applications, Nuclear magnetic resonance and magnetic resonance imaging, surface characterisation techniques, Diffraction and scattering.

Module 3: Intermolecular forces and potential energy surfaces (4 lectures)
Ionic, Dipolar and Vander Waals interactions, Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.

Module 4: Use of free energy in chemical equilibria (6 lectures)

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria, Water chemistry, Corrosion,Use of free energy considerations in metallurgy through Ellingham diagrams.

Module 5: Periodic properties (4 Lectures)
Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries

Module 6: Stereochemistry (4 lectures)
Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds

Module 7: Organic reactions and synthesis of a drug molecule (4 lectures)
Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

Suggested Text Books

i. Mahan, B. H. (1987). University chemistry.
ii. Sienko, M. J. & Plane, R. A. *Chemistry. (1979): Principles and* Applications. New York: McGraw-Hill.
iii. Banwell, C. N. (1966). *Fundamentals of Molecular Spectroscop.* New York, McGraw-Hill.
iv. Tembe, B. L., Kamaluddin & Krishnan, (2008). M. S. *Engineering Chemistry (NPTEL Web-book).*

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	3	2	1	2	-	2	2	2	2	2	2	2
CO2	3	3	3	2	2	1	-	1	2	3	2	3	3	3	3
CO3	2	3	3	2	2	2	1	-	1	2	1	2	2	3	2
CO4	2	3	2	3	1	-	2	2	2	3	2	3	2	1	3
CO5	3	2	2	2	2	2	1	2	-	3	-	3	2	2	2
Average	**2.4**	**2.6**	**2.4**	**2.4**	**1.8**	**1.5**	**1.5**	**1.6**	**2.2**	**2.6**	**2.2**	**2.6**	**2.2**	**2.2**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Mathematics –II (ODE & Complex Variables) (105201)

Credits -4 **L T P**
Semester II **3 1 0**

Course Outcomes: Onsuccessful completion of this course, the students would be able to:

CO	Statement
CO1	Demonstrate the methods of forming and solving Ordinary differential equations and Solve linear differential equations with constant and variable coefficients
CO2	Explain the concept of differential equations and classify the differential equations with respect to their order and linearity.
CO3	Solve first-order ordinary and exact differential equations and convert separable and homogeneous equations to exact differential equations by integrating factors.
CO4	Apply the method of undetermined coefficients to solve the non-homogeneous linear differential equations with constant coefficients.
CO5	Compare the Methods of Cauchy's Riemann Integral and Analytical methods .

Module 1: Multivariable Calculus (Integration): (10 lectures)
Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

Module 2: First order ordinary differential equations: (6 lectures)
Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Module 3: Ordinary differential equations of higher orders: (8 lectures)
Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

Module 4: Complex Variable – Differentiation: (8 lectures)
Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

Module 5: Complex Variable – Integration: (8 lectures)

Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula(without proof), Liouville's theorem and Maximum-Modulus theorem (without proof);Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, CauchyResidue theorem (without proof), Evaluation of definite integral involving sine and cosine,Evaluation of certain improper integrals using the Bromwich contour.

Suggested Text/Reference Books

1. Thomes, G.B.and Finney, R.L.(2010)*Calculus and Analytic Geometry*; Ninth Edition; Pearson Education
2. Kreyszig, E.(1998)*Advanced Engineering Mathematics*; Eighth Edition, Johnwiley and sons.
3. Grewal, B.S.(1965) *Higher Engineering Mathematics* ; Khanna Publishers, NewDelhi.
4. BabuRam(2009) *Advance Engineering Mathematics*; First Edition;PearsonEducation.
5. Richard Courant and Fritz John (2012) **Introduction to Calculus and Analysis, Volume II , V** Springer Publication
6. Harold M. Edwards (2013)*Advanced Calculus: A Differential Forms Approach*, Birkhauser.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PS0 3
CO1	2	1	2	2	2	2	2	2	2	2	2	2	3	2	3
CO2	1	1	2	1	1	1	2	1	2	2	-	2	2	3	2
CO3	2	1	2	2	2	2	1	-	2	2	2	3	2	3	2
CO4	1	1	2	1	1	2	-	2	1	-	2	2	2	2	2
CO5	1	1	1	2	1	-	1	2	-	2	1	3	3	3	3
Average	**1.5**	**1**	**2**	**1.5**	**1.5**	**1.5**	**1.25**	**1.7**	**1.7**	**2**	**1.5**	**2.4**	**2.4**	**2.6**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Programming for Problem Solving

Course Code: 102202

Semester: 2nd

Credits- 04 **L T P**

3 0 0

Course Outcomes: On successful completion of this course, the students would able to:

CO	Statement
CO1	Design the algorithms to write programs.
CO2	Apply arrays, pointers and structures to formulate algorithms and programs
CO3	Apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration
CO4	Implement conditional branching, iteration and recursion
CO5	Test and execute the programs and correct syntax and logical errors

Course Content

Unit 1: Introduction to Programming **(4 lectures)**
Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) - **(1 lecture).**
Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. **(1 lecture)**
From algorithms to programs; source code, variables (with data types) variables and memory Locations, Syntax and Logical Errors in compilation, object and executable code- **(2 lectures)**
Unit 2: Arithmetic expressions and precedence (**2 lectures**)

Unit 3: Conditional Branching and Loops **(6 lectures)**
Writing and evaluation of conditionals and consequent branching **(3 lectures)**
Iteration and loops **(3 lectures)**

Unit 4: Arrays **(6 lectures)**
Arrays (1-D, 2-D), Character arrays and Strings

Unit 5: Basic Algorithms **(6 lectures)**

Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of Equations, notion of order of complexity through example programs (no formal definition required)

Unit 6: Function **(5 lectures)**
Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference.

Unit 7: Recursion **(4 -5 lectures)**
Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Unit 8: Structure **(4 lectures)**
Structures, Defining structures and Array of Structures

Unit 9: Pointers **(2 lectures)**
Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

Unit 10: File handling (only if time is available, otherwise should be done as part of the lab)

Text/Reference Books
1. Byron Gottfried, Schaum's (1995), *Outline of Programming with C,* McGraw-Hill
2. E. Balaguruswamy (2005) Programming in ANSI C, Tata McGraw-Hill

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	1	-	-	1	2	2	2	1	2	1
CO2	3	2	2	2	3	1	-	1	2	1	2	3	2	2	3
CO3	3	2	3	3	2	2	-	-	2	2	1	2	2	2	3
CO4	3	2	2	2	2	3	-	-	3	3	3	3	3	1	2
CO5	3	2	2	3	3	2	1	1	2	3	2	2	3	3	3
Average	**2.8**	**2.0**	**1.8**	**2.4**	**2.4**	**1.8**	**1**	**1**	**2.0**	**2.2**	**2.0**	**2.4**	**2.2**	**2.0**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: English

Course Code: 100108

Semester: 2nd

Credit:- 02 **L T P**
2 0 0

Course outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Develop vocabulary and improve the accuracy in Grammar.
CO2	Apply the concepts of accurate English while writing and become equally at ease in using good vocabulary and language skills.
CO3	Develop and Expand writing skills through Controlled and guided activities.
CO4	Compose articles and compositions in English.
CO5	Become autonomous and self-directed English language learners.

Course Content

Unit 1: Vocabulary Building

The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, and standard abbreviations.

Unit 2: Basic Writing Skills

Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence, Organizing principles of paragraphs in documents, Techniques for writing precisely

Unit 3: Identifying Common Errors in Writing

Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés

Unit 4: Nature and Style of sensible Writing

Describing, Defining, Classifying, Providing examples or evidence, Writing introduction and conclusion

Unit 5: Writing Practices

Comprehension, Précis Writing, Essay Writing

Suggested Readings:

1. Swan, Michael. (1995). *Practical English*. OUP.
2. Wood, F.T. (2007). *Remedial English Grammar*. Macmillan.
3. Zinsser, W. (2001). *On Writing Well*. Harper Resource Book.
4. Lyons, L. H. & Heasly, B. (2006). *Study Writing*. Cambridge University Press.
5. Kumar, S & Lata, P. (2011). *Communication Skills*. Oxford University Press.
6. CIEFL, Hyderabad. *Exercises in Spoken English. Parts. I-III*. Oxford University Press.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	1	-	-	-	3	-	1	1	2	-
CO2	-	-	-	-	-	1	-	-	-	3	-	1	1	1	-
CO3	-	-	-	-	-	1	-	-	-	3	-	1	-	1	-
CO4	-	-	-	-	-	1	-	-	-	3	-	2	1	1	-
CO5	-	-	-	-	-	1	-	-	-	3	-	2	1	2	-
Average						1				3		1.4	0.8	1.4	

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Workshop Manufacturing Practices
Course Code: 105202

Semester: 2nd

L T P

Credits: 03 **1 0 4**

Course Outcomes: On successful completion of this course, the students would be able to:

CO	Statement
CO1	Apply the various manufacturing methods in different fields of engineering.
CO2	Learn about the different fabrication techniques.
CO3	Learn about the practices in manufacturing of simple components using different materials.
CO4	Understand the advanced and latest manufacturing techniques being used in engineering industry.
CO5	Prepare different sand molds for various parts

Course Content

Module 1: (3 lectures)
Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods

Module 2: (1 lecture)
CNC machining, Additive manufacturing

Module 3: (1 lecture)
Fitting operations & power tools

Module 4: (1 lecture)
Electrical & Electronics

Module 5: (1 lecture)
Carpentry

Module 6: (1 lecture)
Plastic moulding, glass cutting

Module 7: (1 lecture)
Metal casting

Module 8: (1 lecture)

Welding (arc welding & gas welding), brazing [More hours can be given to Welding for Civil Engineering students as they may have to deal with Steel structures fabrication and erection; 3D Printing is an evolving manufacturing technology and merits some lectures and hands-on training.]

Workshop Practice: (60 hours)

1. Machine shop - 10 hours
2. Fitting shop - 8 hours
3. Carpentry - 6 hours
4. Electrical & Electronics - 8 hours
5. Welding shop - 8 hours (Arc welding 4 hrs + gas welding 4 hrs)
6. Casting - 8 hours
7. Smithy - 6 hours
8. Plastic moulding & Glass Cutting -6 hours

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

References Books:-

1. Raghuwanshi, B.S.(2009*). A Course in Workshop Technology, Vol 1 & II*.Dhanpat Rai &Sons.
2. Jain, R.K.(2010*).Production Technology*.Khanna Publishers.
3. Singh, S.(2003).*Manufacturing Practice*.S.K. Kataria &Sons.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	3	3	2	3	3	3	3	2	2	3	3	2	3
CO2	2	1	2	2	3	1	3	2	2	3	1	2	2	2	2
CO3	2	1	3	1	2	3	3	3	2	2	2	3	2	1	2
CO4	1	2	1	2	1	2	3	1	3	2	1	2	1	2	3
CO5	2	3	2	2	2	3	2	3	3	3	2	2	3	3	2
Average	**2.4**	**2.6**	**2.6**	**2.6**	**2.4**	**2.6**	**2.8**	**3**	**2.6**	**2.4**	**2.4**	**2.4**	**2.8**	**2.2**	**2.6**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Engineering Chemistry Lab
Course Code: A100106
Semester: 2nd

L T P
Credits: 02 **0 0 4**

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Estimate rate constants of reactions from concentration of reactants/products as a function of time
CO2	Measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc
CO3	Apply the theoretical concepts for result analysis and interpret data obtained from experimentation
CO4	Identify the compound using a combination of qualitative test and analytical methods

Course Content

Choice of 10-12 experiments from the following:

1. Determination of surface tension and viscosity
2. Thin layer chromatography
3. Ion exchange column for removal of hardness of water
4. Determination of chloride content of water
5. Colligative properties using freezing point depression
6. Determination of the rate constant of a reaction
7. Determination of cell constant and conductance of solutions
8. Potentiometry - determination of redox potentials and emfs
9. Synthesis of a polymer/drug
10. Saponification/acid value of an oil
11. Chemical analysis of a salt
12. Lattice structures and packing of spheres
13. Models of potential energy surfaces
14. Chemical oscillations- Iodine clock reaction
15. Determination of the partition coefficient of a substance between two immiscible liquids
16. Adsorption of acetic acid by charcoal
17. Use of the capillary viscosimeters to the demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg .

The mapping of PO/PSO/CO attainment is as follows

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	3	2	1	2	-	2	2	2	2	2	2	2
CO2	3	3	3	2	2	1	-	1	2	3	2	3	3	3	3
CO3	2	3	3	2	2	2	1	-	1	2	1	2	2	3	2
CO4	2	3	2	3	1	-	2	2	2	3	2	3	2	1	3
CO5	3	2	2	2	2	2	1	2	-	3	2	3	2	2	2
Average	**2.2**	**2.6**	**2.2**	**2.2**	**1.8**	**1.5**	**1.5**	**1.6**	**1.7**	**2.6**	**1.8**	**2.6**	**2.2**	**2.2**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Programming for Problem Solving Lab

Course Code: 102203

Semester: 2nd

Credits- 02 **L T P**

0 0 4

Course Outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Create, read and write to and from simple text files.
CO2	Identify and correct logical errors encountered at run time
CO3	Apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration
CO4	Represent data in arrays, strings and structures and manipulate them through a program
CO5	Test and execute the programs and correct syntax and logical errors

Course Content

Tutorial 1: Problem solving using computers
Lab1: Familiarization with programming Environment

Tutorial 2: Variable types and type conversions
Lab 2: Simple computational problems using arithmetic expressions

Tutorial 3: Branching and logical expressions
Lab 3: Problems involving if-then-else structures

Tutorial 4: Loops, while and for loops
Lab 4: Iterative problems e.g., sum of series

Tutorial 5: 1D Arrays: searching, sorting
Lab 5: 1D Array manipulation

Tutorial 6: 2D arrays and Strings, memory structure
Lab 6: Matrix problems, String operations

Tutorial 7: Functions, call by value
Lab 7: Simple functions

Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numerical integration)
Lab 8 and 9: Numerical methods problems

Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions

Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structures

Tutorial 12: File handling
Lab 12: File operations

Text/Reference Books

1. Byron Gottfried, Schaum's (1995), *Outline of Programming with C,* McGraw-Hill
2. E. Balaguruswamy (2005) Programming in ANSI C, Tata McGraw-Hill.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	1	-	-	1	2	2	2	1	2	1
CO2	2	1	2	2	3	2	-	1	2	1	2	3	2	2	3
CO3	2	2	2	2	3	2	-	-	2	2	1	2	2	2	3
CO4	1	1	1	2	2	2	-	-	3	2	2	3	2	1	2
CO5	2	2	1	2	3	2	1	1	2	2	2	2	1	2	3
Average	**1.8**	**1.6**	**1.6**	**2**	**2.6**	**1.8**	**1**	**1**	**2**	**1.8**	**1.8**	**2.4**	**1.6**	**1.8**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name : English Lab

Course Code : 100109

Semester: 2nd

Credit :- 01

L	T	P
0	0	2

Course outcomes: On successful completion of this course, the students will be able to:

CO	Statement
CO1	Understand the importance of pronunciation and apply the same in day to day conversation
CO2	Apply verbal and non-verbal communication techniques in the Professional Environment
CO3	Develop coherence, cohesion and competence in Oral discourse.
CO4	Handle the interview process confidently.
CO5	Communicate contextually in specific personal and professional situations with courtesy.

Course Content

Oral Communication

(This unit involves interactive practice sessions in Language Lab)

- Listening Comprehension
- Pronunciation, Intonation, Stress and Rhythm
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	1	-	-	-	3	-	1	1	2	-
CO2	-	-	-	-	-	1	-	-	-	3	-	1	1	1	-
CO3	-	-	-	-	-	1	-	-	-	3	-	1	-	1	-
CO4	-	-	-	-	-	2	-	-	-	3	-	2	1	1	-
CO5	-	-	-	-	-	1	-	-	-	3	-	1	1	2	-
Average						1.2				3		1.2	0.8	1.4	

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Constitution of India

Course Code: 100304

Semester: 2nd

L T P

Credits: NC **3 0 0**

Course Outcomes: On successful completion of this course, the students will be able to :

CO	Statement
CO1	Explain the various dimensions of Indian political system.
CO2	Learn about the constitutional developments, composition, working of the constituent assembly and draft of the Indian constitution.
CO3	Illustrate fundamental rights, duties and directive principles of state policies.
CO4	Synthesize functioning of Indian government such as legislature, executives and judiciary.
CO5	Synthesize mechanism of human development through various agencies like women empowerment commission, CST commission, human rights commission etc.

Course Content

Module 1

Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution.

Preamble to the Indian Constitution Fundamental Rights & its limitations.

Module 2

Directive Principles of State Policy & Relevance of Directive Principles State Policy Fundamental Duties.

Union Executives – President, Prime Minister Parliament Supreme Court of India.

Module 3

State Executives – Governor Chief Minister, State Legislature High Court of State.

Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th & 91st Amendments.

Module 4

Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India.

Powers and functions of Municipalities, Panchyats and Co – Operative Societies.

Module 5

Scope & Aims of Engineering Ethics, Responsibility of Engineers Impediments to Responsibility.

Risks, Safety and liability of Engineers, Honesty, Integrity & Reliability in Engineering.

Text Books:

- Basu, Durga Das. (2012). *Introduction to the Constitution on India (Students Edn.)*. Prentice – Hall EEE
- Haries, C.E., Pritchard, M.S. & Robins, M.J. (2003). *Engineering Ethics*. Thompson Asia.

The mapping of PO/PSO/CO attainment is as follows

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO12	PSO 1	PSO 2	PSO3
CO1	1	2	1	1	-	1	2	2	1	-	1	1	1	1	2
CO2	1	1	-	1	-	2	2	2	2	1	2	1	1	1	2
CO3	1	2	2	1	1	1	2	2	2	1	2	2	-	2	2
CO4	2	2	2	2	1	1	2	2	1	2	2	2	1	2	2
CO5	2	1	1	2	1	1	2	1	1	1	2	2	1	2	2
Average	1.4	1.6	1.5	1.4	1	1.5	2	1.8	1.4	1.25	1.8	1.6	1	2	2

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Material and Energy Balance
Course Code: B106301
Semester: 3rd

Credits: 04 **L P T**
3 1 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Apply the knowledge of basic Chemical Engineering Calculations involving unitoperations
CO2	Apply material balance on Chemical processes with & without chemical reaction.
CO3	Use laws of thermo physics and thermo chemistry for applying energy balance on Chemical processes.
CO4	Learn the concept of humidity and usage of psychometric charts.
CO5	Learn about Internal energy, Enthalpy, Heat capacity of gases, liquids, and solids.

Course Content

Module1: Introduction 2 hrs

Role of chemical engineering in industry, Schematic flow sheets including symbols, Unit operations and unit processes with reference to MEB calculations.

Introduction to units systems, Units and dimensions, mole, Specific gravity, Specific volume, Concentrations, Stoichiometry of chemical equations, Mole fraction and weight fraction, Degrees of freedom.

Module2: Behavior of gas and liquid mixtures 14 hrs

Real gases, Bubble point and dew point temperatures, Henry's law, Duhring's plot. Saturation, Partial saturation, Relative saturation. Clausiusclapeyron equation, Cox chart and Duhring's plot.

Module 3: Material balance calculations 16 hrs

Law of conservation of mass and component. Simple mass balances, Material balance calculations without chemical reactions, Material balance calculations involving chemical reactions, Recycling, Bypass, Purge, Analysis of degree of freedom for material balance problems.

Module4: Energy balance calculations 16 hrs

Internal energy, Enthalpy, Heat capacity of gases, liquids, and solids, Latent heats, Heats of formation, combustion, reaction and dissolution, Enthalpy-concentration chart, Fuel heating value, Theoretical flame temperature, Energy balance calculations in unit operations and systems with and without chemical reactions, Humidity and humidity chart, Energy balance calculations in humidification and adiabatic cooling. Computer aided case studies of material and energy balances of various operations.

Suggested Text/Reference Books

1. Hougen, P.A., Watson, K.M., &Ragatz, R.A. (2018) *Chemical Process Principles Part–I: Material and Energy Balances*. CBS Publishers and Distributors Pvt Ltd.
2. Himmelbleau, D.M. & Riggs J.B. (2004). *Basic Principles and Calculations of Chemical Engineering*. Prentice Hall, 7th Edition.
3. Bhatt B.L.&Vora, S.M. (2004). *Stoichiometry*. Tata McGraw Hill Publishing Co. Ltd.
4. Felder, R. M. & Rousseau, R.W. (2004) Elementary *Principles of Chemical Processes*. John Wiley, 3rd Edition.
5. Reklaitis, G.V. (1983). *Introduction to Material and Energy Balances*. John Wiley.

6. Lewis, W.K., Radasch, A.H., & Lewis, H. C. (1954). *Industrial Stoichiometry Chemical Calculations of Manufacturing Processes*. McGraw Hill.
7. Hougen, O.A., Watson, K.M. &Ragatz, R.S. (2004). *Chemical Process Principles (Vol-I, 2nd Edition)*. CBS Publishers and Distributors Pvt Ltd.

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	1	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	2	1	2	2	-	1	-	1	1	1	2
CO4	1	1	1	2	1	1	1	1	1	1	1	-	1	1	1
CO5	1	1	1	2	1	1	1	1	2	1	1	1	1	2	2
Average	1.6	1.2	1	1.6	1,4	1.2	1.2	1.2	1.2	1	1	1	1	1.2	1.6

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Fluid Flow
Course Code: B106302
Semester: 3rd

Credits: 04 **L T P**
3 1 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Acquireknowledge about the basic principles of fluid mechanics.
CO2	Solve fluid flow problems with the application of the momentum and energy equations.
CO3	Identify the appropriate usage of ideal flow concepts, continuity equation and Bernoulli equation.
CO4	Solve the problems using methodical dimensional analysis.
CO5	Learn about the pipe flows as well as fluid machinery.

Course Content

Module 1: Indroduction 2 hrs
Concept of fluid, difference between solids, liquids and gases; ideal and real fluids, Introduction to fluid statics and fluid flow

Module2: Fluid Statics 4hrs
Normal forces in fluids, Manometers of different types, Forces on submerged bodies, Buoyancy and stability.

Module3: Fluid Properties 6 hrs
Concept of capillarity, vapour pressure, compressibility and bulk modulus, Newtonian and non-Newtonian Fluids, Nature of turbulence, Eddy Viscosity, Flow in Boundary Layers.

Module 4: Basic Equation of Fluid Flow 10 hrs
Momentum Balance, Continuity equation, Bernoulli's Equations, Navier Stokes Equations, Derivation and Application Dimensional Analysis of Fluid Flow Problems using Rayleigh method and Buckingham π method, Dimensionless numbers and their significance

Module 5: Flow of Incompressible Fluids 10 hrs
Concept of boundary layer, Laminar and Turbulent flow in pipes, Velocity distribution in pipes, Frictional Losses in pipes and fittings, effect of roughness, Fanning Equation, Estimation of Economic Pipe Diameter, Derivation of Hagen Poiseuille's equation and f =16/ Re.

Module6: Flow of compressible fluids 4 hrs
Compressible flow, basic equation, Mach number and its significance and isentropic flow through nozzles

Module7: Flow Measurement 6 hrs
In closed channels - Pitot tube, Orifice meter, venturimeter, Rotameter
In open channels- Notches, Weirs

Module8: Fluid Machinery 6 hrs
Classification and performance of Pumps, Positive displacement pumps and its types, Centrifugal pumps- characteristic curves, Net positive Suction Head and cavitation, Turbines, Compressors, Blowers, Selection and specification.

Suggested Text/Reference Books:

1. McCabe, W.L., Smith, J.C., & Harriot, P. (2005). *Module Operations of Chemical Engineering (7th Edition)*. McGraw Hill.

2. Backhurst, J.R., Harker, J.H., Coulson, J.F., & Richardson, J.M. (1999). *Chemical Engineering (Volume 1, 6th Edition)*. Butterworth Heinemann, 6th Edition.
3. Foust, A.S., Wenzel, L.A., Clump C.W. Maus L., & Anderson, L.B. (2008). *Principles of Module Operations (2nd Edition)*. John Wiley & Sons.
4. Raju, K.S. (2011). *Fluid Mechanics, Heat Transfer, and Mass Transfer: Chemical Engineering Practice*. John Wiley.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	1	1	1	1	2	1	1	-	-	1	1	2
CO2	2	1	1	2	2	2	1	1	1	-	-	-	1	1	1
CO3	1	1	1	2	1	1	2	2	-	1	-	1	1	1	2
CO4	2	2	1	2	2	1	1	2	-	1	1	1	1	1	1
CO5	1	1	1	1	1	1	2	1	1	1	1	1	1	2	1
Average	1.4	1.4	1	1.6	1.2	1.2	1.4	1.6	1	1	1	1	1	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

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Course Name: Ground Survey
Course Code: B106303
Semester: 3rd

Credits: 03 **L T P**
3 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Know about different types of surveys.
CO2	Describe the concepts and terminology in ground survey.
CO3	Use different types of surveying such as chain, prismatic compass, plane table, leveling and contouring.
CO4	Learn various concepts in contour mapping.
CO5	Solve simple earth work contouring calculations of areas and volumes.

Course Content

Module1: Introduction: Different types of surveys. 2 hrs

Module 2: Chain Surveying 4 hrs

Principal of chain surveying, description of different equipment, Methods of chaining & booking, selection of base line and stations, obstacles in chaining. Location of inaccessible points by chain, tape & ranging rods.

Module 3: Prismatic compass survey 4 hrs

Description of Prismatic & surveyors compass methods of traversing, local attraction and its elimination adjustment of closing error by graphical method.

Module4: Plane Table Survey 4 hrs

Description of different equipment, different methods of plane tabling, Strength of Fix, Two point and three point problems and their solutions.

Module5: Leveling 3 hrs

Description of Dumpy and Tilting levels & leveling staves, methods of leveling sensitivity of bubble tube, setting out grade lines permanent adjustment of above mentioned leveling instruments.

Module6: Contouring: 3 hrs

Setting out contour gradient, different methods of contouring. Simple earth work calculations of areas and volumes.

Suggested Text / Reference Books

1. Kanetkar, T.P, & Kulkarni. (2006), *Surveying and Leveling*. New Delhi: Laxmi Publications.
2. Punmia, B.C., Jain, A.K., & Jain, A.K. (2016). *Surveying - 1 & 2*, New Delhi: Laxmi Publications.
3. Agor, R. (1980).*A Textbook of Surveying and Levelling*. Khanna Publishers.
4. Singh, G. & Singh, J. (2008). *Surveying*. New Delhi: Khanna Publishers.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	1	1	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	2	1	1	1	1	2	1	-	1	-	1	1	1	2
CO4	1	2	1	1	1	1	1	1	-	1	-	-	1	1	1
CO5	1	1	1	1	2	1	2	1	1	1	1	1	1	2	1
Average	1.4	1.4	1	1.2	1.2	1.2	1.4	1.2	1	1	1	1	1	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Reservoir Engineering-I
Course Code: B106304
Semester: 3rd

Credits: 04 **L T P**
3 1 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Learn about scope of reservoir engineering, characteristics, classifications and properties of oil and gas
CO2	Know about definitions and their determination of reservoir rock properties, series and parallel combination of beds, fluid saturation, etc.
CO3	Know about the concept of effective and relative permeability, capillary pressure
CO4	Study the phase behavior of hydrocarbon, equilibrium ratio, fluid sampling, PVT properties determination, and their measurement, correlations, data reduction and applications.
CO5	Understand the principle of fluid flow in the porous media, linear, radial and spherical flow, steady and unsteady state flow.

Course Content

Module1: Introduction to Elements of Reservoir Engineering 2 hrs

Fundamentals of reservoir engineering and classification of petroleum reservoir.

Module 2: Reservoir Rocks 8 hrs

Characteristics of Reservoir Rocks, Classification and Nomenclature: Classic Reservoir Rocks, Carbonate Reservoir Rocks, Unconventional, Fractured And Miscellaneous reservoir Rocks, Marine And Non-Marine Reservoir Rocks, Concept of Shale Oil. Reservoir Rocks, Marine and Non-Marine Reservoir Rocks, Concept of Shale Oil.

Module3: Reservoir Rock Properties 6 hrs

Porosity, permeability determination, combination of permeability in parallel & series beds, porosity-permeability relationship, fluid Saturation determination and significance, effective and relative permeability, wet tability, capillary pressure characteristics, measurements and uses.

Module 4: Hydrocarbon Migration 6hrs

Geological framework of migration and accumulation, concept of hydrocarbon migration from source beds to the carrier beds, Carrier beds to the reservoir, Free path ways for migration, Short distance and long distance migration, Evidence for migration, Oil and gas seepages.

Module5: Entrapment of Hydrocarbons 8 hrs

Entrapment and accumulation of hydrocarbons, Classification and types of traps: Structural, stratigraphic and combination type of traps, Traps associated with salt domes.

Suggested Text / Reference Books:

1. Ahmed, T. (2006). *Reservoir Engineering Handbook*. Elsevier, 3rd Edition.
2. Slip Slider, H.C. (1983). *World Wide Practical Petroleum Reservoir Engineering Method*. Penn Well Publishing Company.
3. Gianluigi, C. (1994). *Principles of Petroleum Reservoir Engineering*. Elsevier.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	1	1	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	2	1	1	2	1	2	1	-	1	-	1	1	1	2
CO4	2	2	1	1	2	1	1	1	-	1	-	-	1	1	1
CO5	1	1	1	2	2	1	2	1	1	1	1	1	1	2	1
Average	1.4	1.4	1	1.4	1.6	1.2	1.4	1.2	1	1	1	1	1	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Thermodynamics
Course Code: B106305
Semester: 3rd

Credits: 04 **L T P**
3 1 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Apply the thermodynamic laws to chemical engineering processes.
CO2	Understand the thermodynamic principles for analysis of solutions, ideal solutions, their excess properties and residual properties.
CO3	Use thermodynamic principles for different types of chemical engineering systems such as vapor-liquid systems, liquid-liquid systems and solid-liquid systems.
CO4	Compare chemical reactions in relation to thermodynamic principles.
CO5	Solve problems involving more than one phase and chemical reactions through equilibria.

Course Content

Module 1: Brief Review 8 hrs
Review of First, Second and Third Law of Thermodynamics: First law of Thermodynamics, thermodynamics state and state functions, enthalpy, the steady state steady flow process, equilibrium, phase rule, reversible processes, Throttling process, Joule-Thomson coefficient, liquefaction of gasses, Standard heat of reaction, standard heat of formation, standard heat of combustion, flame temperature, enthalpy for phase change etc, Second law of thermodynamics, Heat engines, Entropy, Entropy changes of an ideal gas, Third law of thermodynamics.

Module 2: Volumetric Properties of Pure Fluids 6 hrs
PVT behaviour for an ideal gas, Virial equation of state, Applications of Virial equations, Cubic equation of state, Generalized correlations, Acentric factors.

Module3: Thermodynamic Properties of Fluid 6 hrs
Maxwell relations, Residual properties, two phase system, Thermodynamic diagram

Module 4: Equilibrium and Stability 6 hrs
Criteria of equilibrium, Chemical Potential, Application of equilibrium criteria, Clausiusclapeyon equation.

Module 5: Phase Equilibria 6 hrs
Fugacity, Determining of fugacity of pure substances, Fugacity in mixture, Ideal solution, Excess properties, and Liquid phase properties from VLE data, Activity coefficients, and coefficient equations.

Module6: Chemical Reaction Equilibria 8 hrs
Reaction ordinate for single & multiple reactions, condition of equilibrium for a chemical reactions, Standard states and G, Temperature dependence of the equilibrium constant , Estimation of equilibrium rate constant , Homogeneous gas phase reactions, Heterogeneous chemical equilibrium.

Suggested Text/Reference Books:

1. Smith, J.M., Van Ness, H.C., & Abbott, M.M. (2003). *Introduction to Chemical Engineering Thermodynamics (6th Edition).* McGraw Hill.
2. Rao, Y.V.C. (1997). *Chemical Engineering Thermodynamics (1st Edition).* Hyderabad: Universities Press (India) Ltd.
3. Kyle, B.G. (1999). Chemical and Process Thermodynamics (3rd Edition). Prentice Hall.

4. Denbigh, K.G. (1981). *Principles of Chemical Equilibrium (4th Edition*). Cambridge University Press.
5. Pitzer, K.S. (1995). *Thermodynamics (3rd Edition)*. McGraw Hill.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	2	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	2	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	2	2	1	1	2	2	1	1	1	1	1	1
CO5	2	1	1	2	1	1	2	1	1	1	2	1	1	2	1
Average	2	1.6	1	2	1.4	1.2	1.4	1.6	1.2	1	1.5	1	1	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Engineering and Solid Mechanics
Course Code: B106306
Semester: 3rd

Credits: 04 **L T P**
3 1 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand the basic concepts of rigid body kinematics.
CO2	Study the concept of stress and strain at a point and stress analysis in various Machine elements like thin cylinder, sphere, spring, beams and shafts.
CO3	Solve the problems related to Shear Force, bending moment, slope and deflections in different types of beams subjected to various types of loadings
CO4	Apply the knowledge of various theories of failures to design the various structuralComponents subjected to different types of loadings.
CO5	Learn the concept of buckling of slender, long columns subjected to axial loads andbe able to solve problems related to columns and struts,To understand the use of basic concepts ofResolution and composition of forces.

Course Content

Module 1: Introduction, Point Kinematics: Moving point in various coordinate systems (Cartesian, Cylindrical, Path) (6hrs)

Module 2: Rigid body kinematics: Translation and rotation, relative motion, angular velocity, General motion of a rigid body, General relative motion (6hrs)

Module 3: Equivalent force systems, Resultant forces, Linear and Angular Momentum, Laws of motion (Euler's Axioms), Free Body Diagrams, Dynamics of point mass models of bodies. (6hrs)

Module 4: Equilibrium of rigid bodies, distributed forces, Analysis of structures: Structs, Forces in Beams: Shear Force and Bending Moment (9 hrs)

Module 5: Frictional forces, Laws of Coulomb friction, impending motion (3hrs)

Module 6: Inertia tensor, Principal Moments of Inertia, Moment of momentum relations for rigid bodies, Euler's Equations of Motion (6hrs)

Module7: State of stress at a point, equations of motion, principal stress, maximum shear stress, Concept of strain, strain displacement relations, compatibility conditions, principal strains, transformation of stress/strain tensor, state of plane stress/strain. (6hrs)

Module 8: Uniaxial stress and strain analysis of bars, thermal stresses, Torsion of circular bars and thin walled members, Bending of straight/curves beams, transverse shear stresses, deflection of beams, Buckling of columns (6hrs)

Suggested Text / Reference Books:

1. Singh,B. (1999).*Applied Mechanics.* Kataria Publications.
2. Khurmi, R. S. (2007).*Engineering Mechanics (21st Edition).*Tata McGraw Hill.
3. Prasad,I.B.(1996). *Applied Mechanics(4th Edition).*Khanna Publications.
4. Shames,l.H. (2005).*Engineering Mechanics(4th Edition)*Prentice Hall of India Ltd.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	1	2	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	2	1	1	2	2	-	1	-	1	1	1	2
CO4	2	2	1	2	2	1	1	2	-	1	1	-	1	1	1
CO5	1	1	1	2	2	1	2	1	1	1	1	1	2	2	1
Average	1.8	1.4	1.2	1.4	1.4	1.2	1.4	1.6	1	1	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Fluid Flow & Strength of Material Laboratory
Course Code: B106307
Semester: 3rd

Credit: 01 **L T P**
0 0 2

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand the working of a centrifugal pump.
CO2	Understand Bernoulli's equation
CO3	Find the coefficient of discharge of fluids by venturimeter, orifice meter and V-notch etc.
CO4	Draw the stress-strain curves of different materials used in the field under different loading conditions
CO5	Learn the properties of materials that affect strength under various conditions.

List of Experiments

Part-A

1. Characteristic curves of a centrifugal pump.
2. Determination of stability of a floating body.
3. Verification of Bernoulli's equation for flow process.
4. Measurement of flow by a venturimeter
5. Measurement of flow by an orifice meter.
6. Measurement of flow by a rotameter
7. Measurement of flow by a V-notch in an open channel.
8. Measurement of losses in various fitting and valves.
9. Measurement of losses due to contraction and expansion.
10. Measurement of losses due to variation in cross section/ shapes
11. Verification of laminar/ turbulent flow regime in a flow process
12. Study of valves and fittings

Part-B

1. Determination of yield points, tensile strength and ultimate strength of mild steel specimen.
2. Determination of compressive strength of mild steel specimen.
3. Bending test of mild steel specimen.
4. Tensile test of a specimen of brittle material.
5. Torsion test of a mild steel specimen.
6. Determination of Brinell hardness of ductile and brittle materials.
7. Determination of Rockwell Hardness of a hard material.
8. Performance of Vickers's Hardness test.
9. Determination of Impact strength of a specimen.

At least five experiments should be conducted from each part.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	1	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	2	1	1	2	2	-	1	1	1	2	1	2
CO4	2	2	1	2	2	1	1	2	-	1	1	-	1	1	1
Average	1.7	1.2	1	1.7	1.5	1.2	1.2	1.5	1	1	1	1	1.2	1	1.5

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Environmental Studies
Course Code: A100302
Semester: 3rd

Credit-NC **L T P**
3 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study various environmental variables and interpret results.
CO2	Get elementary knowledge about the concept of Ecosystem in real life
CO3	Learn about solutions to environmental problems related to resource use and management.
CO4	Compare the results of scientific studies of environmental problems.
CO5	Acquire basic knowledge of the various types of pollutants and their effects on human life

Course Content

Module 1: Introduction: Definition and scope and importance of multidisciplinary nature of environment. Need for public awareness.

Module 2: Natural Resources: Natural Resources and associated problems, use and over exploitation, case studies of forest resources and water resources.

Module3: Ecosystems: Concept of Ecosystem, Structure, interrelationship, producers, consumers and decomposers, ecological pyramids-biodiversity and importance. Hot spots of biodiversity.

Module 4: Environmental Pollution: Definition, Causes, effects and control measures of air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measure of urban and industrial wastes. Role of an individual in prevention of pollution, Pollution case studies.

Module 5: Disaster Management : Floods, earthquake, cyclone and landslides.

Module6: Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns.Case studies. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.Wastelandreclamation.Consumerism and waste products.Environment Protection Act.Air (Prevention and Control of Pollution) Act.Water (Prevention and control of pollution) Act.Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation Public awareness.

Module7: Human Population and the Environment: Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health, Human Rights, Value Education, HIV/AIDS.Women and child Welfare.Role of Information Technology in Environment and human health.Case studies.

Suggested Text/Reference Books

1. Agarwal, K. C. (2001). *Environment Biology*. Bikaner: Nidi Publications Limited.
2. Jadhav, H. &Bhosale, V.M. (1995). *Environment Protection and Laws*. Delhi: Himalaya Publication House.

3. Rao, M. N. &Datta, A.K. (1987). *Waste Water Treatment.* Oxford & IBH Publications Co. Pvt. Ltd.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	2	1	1	2	2	-	1	-	1	1	1	2
CO4	2	2	2	2	2	1	1	2	-	1	-	-	2	1	1
CO5	1	1	2	2	1	1	2	1	1	1	1	1	1	2	1
Average	1.4	1.6	1.4	1.8	1.4	1.2	1.4	1.6	1	1	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Geology of Petroleum
Course Code: B106401
Semester: 4th

Credit: 03 **L T P**
3 0 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Acquireknowledge about the general properties of rock forming minerals and their identification
CO2	Learn the rock classification and its identification
CO3	Study the rock deposition and stratification
CO4	Acquire basic knowledge about the various geological structure and their recognition
CO5	Acquireknowledge about the exploration methods such as surface geological and geophysical methods

Course Content

Module 1: Minerals: 8 hrs
General properties; Classification of minerals and properties of common rock forming minerals.

Module2: Petrology: 8hrs
Rocks; Classification and description of some common rocks.

Module 3: Stratigraphy: 14 hrs
Principles of Stratigraphy; Concepts of paleontology; Fossils, their mode of preservation and significance as indices of age and climate; Concept of index fossils; Broad stratigraphic subdivisions and associated rock types of important coal belts and oil fields of India.

Module4: Structural Geology: 10 hrs
Interpretation of topographic maps; Attitude of planar and linear structures; Effects of topography on outcrops. Unconformities, folds, faults and joints - their nomenclature, classification and recognition. Forms of igneous intrusions - dyke, sill and batholiths. Effects of folds and fractures on strata and their importance in exploration activities.

Module5: Exploration: 8 hrs
Meaning, methods of exploration, surface geological methods- gravity methods, magnetic methods, geophysical methods-electrial resistivity methods, seismic, radiometric surveying.

Suggested Text/Reference Books:

1. Rutely, H.H. (2005). *Elements of Mineralogy*. McGraw Hill.
2. Krishnan, M. S. (2006). *Geology of India (6th Edition)*. CBS Publishers & Distributors Pvt Ltd.
4. Mukherjee, P.K. (2013). *Introduction to Geology*. World Press Private Limited.
5. Billings, M.P. (1972). *Structural Geology (3rd Edition)*. Prentice Hall.
6. Kearey, P. & Brooks, M. (1991). *An Introduction to Geophysical Exploration (2nd Edition)*. Wiley-Blackwell.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	1	1	2	2	1	1	2	-	2	2	1	1	1	1
CO5	1	1	1	2	1	1	2	1	1	1	1	1	1	2	1
Average	1.2	1.2	1	1.4	1.4	1.2	1.2	1.6	1	1.2	1.5	1	1	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Drilling Technology
Course Code: B106402
Semester: 4th

Credits: 03 **L T P**
3 0 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand the planning of the well
CO2	Acquire knowledge about the different operating systems of drilling rig
CO3	Know about the selection of proper bit compatible to the well
CO4	Acquire basic knowledge about rock through coring
CO5	Find the solutions of the different types of well problems

Course Content

Module1: Well Planning 4 hrs
Introduction to oil well drilling, drilling planning approaches.

Module2: Rotary Drilling Method 6 hrs
Rig parts, selection and general layout.

Module 3: Drilling Operations & Practices 6 hrs
Hoisting, circulation, Rotation, power plants and Power transmission, Rig wire line system handling & storage.

Module 4: Casing Design 6 hrs
Design of casing string, Liner Design and Setting, Casing landing practices, Buckling criteria and Calculation of well head loads. Casing while drilling.

Module5: Drill String 6 hrs
Parts, function and design.

Module 6: Drill Bits 4 hrs
Classification and design criteria of drag, rotary, roller, diamond and PDC bits.

Module 7: Coring 4 hrs
Different methods of core drilling.

Module8: Well Problems and Solutions 8 hrs
Fatigue failure, Pipe sticking, lost circulation, Sloughing shales, Swabbing, surge, gas cap drilling, Blow out and kick control.

Module9: Oil well fishing 4 hrs
Fish classification, tools and techniques.

Module 10: Basics of Drilling Fluids and Cementing 4 hr

Suggested Text / Reference Books:

1. Gatlin, C. (1960). *Petroleum Engineering: Drilling and Well Completion*. Prentice Hall.
2. Bourgoyane, A.T. (1986). *Applied Drilling Engineering*. (Spe Textbook Series, Vol 2). Society of Petroleum Engineers.
3. Adam, N.J. (1985). *Drilling Engineering: A complete Well Planning and Approach*. PennWell Books.
4.Rabia, H. (1986). *Oil Well Drilling*. Kluwer Law International.

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	2	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	2	2	1	1	2	-	2	2	1	1	1	1
CO5	2	1	1	2	1	1	2	1	1	1	1	1	2	2	1
Average	1.4	1.4	1	1.8	1.4	1.2	1.4	1.6	1	1.2	1.2	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Heat Transfer
Course Code: B106403
Semester: 4th

Credits: 04 **L T P**
3 1 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Acquire knowledge about the basic laws of heat transfer.
CO2	Solve problems involving steady and unsteady state heat conduction in simple geometries with and without heat generation.
CO3	Study the heat transfer in natural and forced convection.
CO4	Solve simple radiation heat transfer problems, condensation and boiling.
CO5	Understand the heat transfer processes involved in evaporation and heat exchangers.

Course Content

Module1: Modes of Heat Transfer:

Conduction (8 hrs)

Fourier's law, one dimensional heat conduction through plane and composite structures having plane wall, spherical & cylindrical geometry. Steady state heat flow with heat source through plane wall and cylindrical surface. Thermal conductivity of materials. Insulating materials and critical thickness of insulation. Unsteady-state conduction; Lumped heat capacity system, semi-infinite solid and Heisler chart.

Convection (10 hrs)

Free and forced convection, Concept of thermal boundary layer, concept of overall heat transfer coefficient for laminar and turbulent flow, Heat transfer inside & outside tubes with significance of Nusselt, Prandtl, Reynolds, Biot, Fourier and Pecletnumbers.Modelling of convective heat transfer coefficient by using dimensional analysis for natural convection.

Radiation (6 hrs)

Distribution of radiant energy, Definition of emissivity, absorptivity, Reflectivity and transmissivity, concept of Black and Grey bodies, Planck's law of monochromatic radiation, Kirchhoff's law, Wien's displacement law, Stefan-Boltzmann law, definition of intensity of radiation. Radiation formula for radiation exchange between simple bodies, two parallel surfaces and between any source and receiver, radiation shields

Module2: Condensation and Boiling Heat Transfer (6 hrs)

Dropwise and Filmwise condensation of pure and mixed vapours, Convective, Nucleate & Film boiling, Theory and correlations, critical boiling flux

Module3: Heat exchangers (10 hrs)

Heat exchangers - double pipe heat exchanger, Shell-and-Tube heat exchangers, plate type heat exchanger, concept and calculation of log mean temperature difference, temperature correction factor for shell & tube exchangers, fouling factors, overall heat transfer coefficient Theory of Fins and their applications. Reboiler and Condensers, counter current dry contact Condenser, parallel current- wet contact Condenser.

Module4: Evaporators (8 hrs)

Various types of evaporators- Standard vertical tube evaporator, basket type vertical evaporator, forced circulation evaporator and horizontal tube evaporators. Single effect evaporators and multi-effect evaporators and its various types of feed arrangements, boiling point elevation, capacity and economy of evaporators. Evaporation under vacuum.

Suggested Text/Reference Books

1. Holman, J.P. (2010). *Heat Transfer*. McGraw Hill, 10th Edition.

2. McAdams, W.H. (1985). *Heat Transmission*. Kreiger Publishing Co, 3rd Edition.
3. Backhurst, J.R., Harker, J.H., Coulson, J.F., & Richardson J.M. (1999). *Chemical Engineering, Volume 1*. Butterworth Heinemann, 6th Edition.
4. McCabe, W. L., Smith, J.C., & Harriot, P. (2005). *Module Operations of Chemical Engineering*. McGraw Hill, 7th Edition.
5. Kern, D.Q. (1983). *Process Heat Transfer*. McGraw Hill.
6. Kreith, F., Manglik, R.M., & Bohn, M.S. (2010). *Principles of Heat Transfer*. Brooks Cole Thomson Learning Publication, 7th Edition.
7. Incopera, F.P., DeWitt, D.P., Bergman, T.L., &Lavine, A.S. (2011). *Fundamentals of Heat and Mass Transfer*. John Wiley, 7th Edition.
8. Geankopolis, C J. (2004). *Transport Processes and Separation Process Principles*. Prentice Hall of India, 4th Edition (Eastern Economy Edition).
9. Coulson, J. M. & Richardson, J. F. (1999). *Chemical Engineering, Volume 1*. Pergamon Press.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	2	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	2	2	1	2	2	-	1	-	1	1	1	2
CO4	2	1	1	2	2	1	1	1	1	1	1	-	1	1	1
CO5	2	1	2	2	2	2	1	2	2	2	1	1	1	2	1
Average	2	1.4	1.2	1.8	2	1.4	1.2	1.6	1.2	1.2	1	1	1	1.2	1.2

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Mass Transfer
Course Code: B106404
Semester: 4th

Credits: 04 **L T P**
3 1 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Apply the principles of mass transfer.
CO2	Understand the concepts of Diffusion and various laws governing diffusion in solids, liquids & gases.
CO3	Know about the concept of mass transfer coefficients in designing of co-current, counter-current & continuous-contact columns.
CO4	Acquire basic knowledge about the processes involving gas absorption, drying of solids, humidification operations
CO5	Acquire knowledge about dehumidification equipment , water cooling towers & spray chambers

Course Content

Module 1: Introduction (2 hrs)
Importance and classification of mass transfer operations in Chemical Engineering.

Module2: Diffusion (6hrs)
Diffusion in gases and liquids, Fick's First law of diffusion, Mass balance in simple situations - with and without chemical reaction.Diffusion in solids, diffusion through porous solids and polymers, unsteady state diffusion

Module3: Interphase Mass transfer (10 hrs)
Theories of Mass transfer, Individual and overall mass transfer coefficients, Convective mass transfer.

Module 4: Distillation (5 hrs)
Roult's law, ideal solutions, x-y & H-x-y diagrams, Flash vaporisation and condensation. Differential distillation, Batch distillation, Rayleigh equation, Steam distillation, Binary distillation, McCabe-Thiele and Ponchon-Savarit method, Total reflux, minimum and optimum reflux ratios, Efficiency – local, overall and Murphree efficiency.

Module5: Liquid-liquid extraction & Leaching (10 hrs)
Extraction equipment, equilibrium diagram. Choice of solvent. Single stage and multistage counter-current extraction with/without reflux. Continuous contact extractors. Leaching equipment and equilibrium. Single stage and multistage cross current and counter current leaching.

Module6: Other Mass Transfer Operations (15 hrs)

- **Adsorption** Types, nature of adsorbents, Adsorption equilibria- single species- Langmuir, Freundlich isotherms, Adsorption operations –single stage and multi stage, Adsorption column sizing
- **Crystallization** Equilibria and yields, Methods of forming nuclei in solution and crystal growth,equipments- vacuum crystallizer, Draft tube-baffle crystallizer.
- **Drying of solids** Rate of drying curves, Through circulation drying, Continuous drying, Types of dryers.

- **Humidification operations.**VLE& Enthalpy, Reference substance plots, vapour gas mixtures, concept of adiabaticsaturation, psychometric charts, adiabatic operations-humidification operations and watercoolingoperations.DehumidificationEquipments: water cooling towers & spray chambers

Suggested Text/Reference Books:

1. Treybal, R.E. (2001). *Mass Transfer Operations (3rd Edition)*. McGraw Hill.
2. Sherwood, T. K., Pigford, R.L., & Wilke, C.R. (1975). *Mass Transfer, Chemical Engineering Series*. McGraw Hill.
3. Backhurst, J.R., Harker, J.H., Coulson, J.F., & Richardson, J.M., (1999). *Chemical Engineering- Volume 1 (3rd Edition)*. Butterworth Heinemann.
4. Skelland, A.H.P. (1985). *Diffusional Mass Transfer*. Kreiger Publishing Co.
5. McCabe, W.L., Smith, J.C., & Harriot, P. (2005). *Module Operations of Chemical Engineering (7th Edition)*. McGraw Hill.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	2	2	1	2	2	-	1	-	1	1	1	2
CO4	2	2	1	2	2	1	1	2	1	1	1	-	1	1	1
CO5	1	1	1	2	1	1	2	1	1	1	1	2	1	2	1
Average	1.8	1.4	1	1.8	1.6	1.2	1.4	1.6	1	1	1	1.2	1	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Industrial Engineering and Management
Course Code: B106405
Semester: 4th

Credits: 03 **L T P**
3 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand the functions of engineering departments and organizations in industries.
CO2	Study the hierarchy principles and dimensions of planning functions and approaches for making decisions.
CO3	List the factors affecting the plant location and selection of area and plant layouts.
CO4	Acquire knowledge about the different methods and about the job selection, equipment and forms used for work measurement.
CO5	Know factors affecting the plant location, comparison of rural and urban sites-methods for selection

Course Content

Module 1: Introduction (2 hrs)
Definition and scope of industrial engineering, Functions of industrial engineering department and its organization, Qualities of an industrial engineer, concept of production and productivity.

Module 2: Concepts of Management (3 hrs)
Functions of Management, Evolution of Management Thought: Taylor's Scientific Management, Fayol's Principles of Management, Douglas Mc-Gregor's Theory X and Theory Y, Mayo's Hawthorne Experiments, Hertzberg's Two Factor Theory of Motivation, Maslow's Hierarchy of Human Needs – Systems Approach to Management.

Module 3: Designing Organizational Structures (3 hrs)
Concept, Importance and characteristics of organization, Types of organization - Project, matrix and informal organization. Span of control, Delegation of authority.

Module 4: Management Planning, Decision Making and Control (4 hrs)
Steps, hierarchy, principles and dimensions of planning function, Approaches to decision making, Decision support systems, Basic control process, control parameters, principles of control.

Module 5: Plant Location & Layout (7 hrs)
Definition, factors affecting the plant location, comparison of rural and urban sites-methods for selection. Plant layout: Needs for a good layout, Different types viz. Product, process and combination layouts, Introduction to layouts based on the GT, JIT and cellular manufacturing systems, Development of plant layout.

Module6: Productivity (2 hrs)
Definition, reasons for low productivity, methods to improve productivity, relation between work-study and productivity.

Module7: Work Analysis (7 hrs)
Definition need and scope of Work Analysis. Method-study: Definition, objectives, step-by-step procedure, questioning techniques, charts and diagrams for recording data. Principles of motion economy; Development and installation of new method. Work–measurement: Definition, various techniques of work-measurement such as work-sampling, stopwatch time study & its procedure, Job selection, Equipment and Forms used for work measurement, need for rating operator, methods of rating, allowances and their types, standard time. Standard data techniques.

Module8: Value Engineering (2 hrs)
Definition, Types of values, concept, phases and application of value engineering.

Suggested Text / Reference Books:

1. Hick, P.(1994).*Industrial Engineering & Management(2nd Edition)*.Tata McGraw Hill.
2. Miles,D.L. (1961).*Techniques of Value Analysis and Engineering.* McGraw Hill.
3. Nauhria,R.N.&Parkash, R. (2002). *Management of Systems*. Wheeler Publishers.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	1	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	1	1	1	2	2	-	1	-	1	1	1	2
CO4	1	2	1	1	2	1	1	2	1	1	1	-	1	1	1
CO5	1	1	1	2	1	1	2	1	1	1	1	2	1	2	1
Average	1.2	1.4	1	1.4	1.2	1.2	1.4	1.6	1	1	1	1.2	1	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Reservoir Engineering-II
Course Code: B106405
Semester: 4th

Credits: 04 **L T P**
3 1 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study hydrocarbon system phase behavior
CO2	Understand different types of reservoir fluids and their behavior.
CO3	Learn about various reservoir drives mechanics
CO4	Acquire knowledge about principles of Fluid Flow for steady state, semi steady state & non steady state conditions.
CO5	Know about the resource and reserve concept of reservoirs

Course Content

Module1: Reservoir Fluids 10 hrs

Phase behavior of hydrocarbon system, ideal & non ideal system, equilibrium ratios, reservoir fluid sampling, PVT properties determination, different correlations and laboratory measurements, data reduction, evaluation and application.

Module 2: Flow of Fluids Through Porous Media 12hrs

Darcy's law, single and multiphase flow, linear, radial & spherical flow, steady state & unsteady state flow, flow through fractures, GOR, WOR equations, Water and gas coning. Principles of Fluid Flow for steady state, semi steady state & non steady state conditions.

Module 3: Reservoir Drives 4hrs

Reservoir drive mechanics and recovery factors

Module 5: Reserve Estimation 8 hrs

Estimation of petroleum reserve, resource & reserve concept, latest SPE/ WPC/ IS classification, volumetric material balance.

Suggested Text / Reference Books:

1. Ahmed, T. (2006).*Reservoir Engineering Handbook (3rd Edition)*. Elsevier.
2. Slip Slider, H.C. (1983). *World Wide Practical Petroleum Reservoir Engineering Method.* Penn Well Publishing Company.
3. Gianluigi, C. (1994). *Principles of Petroleum Reservoir Engineering.* Elsevier.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	1	2	1	1	2	-	1	1	1	1	1	1
CO5	1	1	1	1	1	1	2	1	1	2	1	2	2	2	1
Average	1.4	1.6	1	1.2	1.4	1.2	1.4	1.6	1	1.25	1	1.25	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Essence of Indian Traditional Knowledge
Course Code: 100305
Semester: 4th

Credit: NC **L T P**
3 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Know about the basics of Indian traditional Knowledge in Modern scientific perspective.
CO2	Study basic principles of thought process. Reasoning and inference.
CO3	Understand Indian philosophical traditions. Indian linguistic Tradition, and Indian artistic tradition
CO4	Acquire knowledge about Indian perspective of modern scientific world.
CO5	Study sustainability at the core of Indian Traditional knowledge systems.

Course Content

Part -1

i. Basic Structure of Indian Knowledge system
ii. Modern Science and Indian Knowledge system
iii. Yoga and Holistic HealthCare
iv. Case studies

Suggested Text / Reference Books:

1. Fritz of Capra Too of Physics
2. Fritz of Capra The Wave of life
3. Yoga Sutra of Patanjali. *Ramakrishna Mission.* Kolkata.
4. Jha, R.N. (2016). *Science of Consciousness Psychotherapy and Yoga Practices.* VidyanidhiPrakashan, Delhi.
5. Sharma, P.B. (English translation) *ShodashangHridayam.*

Pedagogy: Problem based learning, group discussion, collaborative mini projects
Outcome: Ability to understand connect up and explain basics of Indian traditional Knowledge in Modern scientific perspective.

Part-2

i. PhilosophicalTradition
ii. Indian Linguistic Tradition (Phonology, morphology, syntax andsemantics)
iii. Indian Artistic Tradition
iv. Casestudies

Suggested Text / Reference Books:

1. Sivaramakrishnan, V. (2014).*Cultural Heritage of India-Course material*. Bhartiya Vaidya Bhawan Mumbai.
2. Chaterjee, S.C. (2015). *An introduction to Indian Philosophy*. Universityof Calcutta.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	1	1	1	2	-	1	1	1	1	1	1
CO5	1	1	2	1	1	1	2	1	1	2	1	1	2	2	1
Average	1	1.6	1.2	1.2	1.2	1.2	1.4	1.6	1	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Heat Transfer Laboratory
Course Code: B106407
Semester: 4th

Credit: 1 **L T P**
0 0 2

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Find the heat transfer coefficients of different common materials of different types.
CO2	List the heat losses and effect of insulation during the heat transfer.
CO3	Perform the operation of open pan / single effect / multi-effect evaporators.
CO4	Measure radiative heat transfer, condensation and boiling heat transfer.
CO5	Present their results in written form of report.

List of Experiments:

1. Determination of heat transfer coefficient for different types of heat transfer equipments.
2. Wilson Plots for unsteady state heat transfer in jacketed vessels.
3. Developing correlation of instantaneous heat transfer coefficients with time for steady deposition of scale on a heating surface.
4. Determination of heat losses from insulated pipes.
5. Performance characteristics of a shell and tube heat exchanger and an induced draft cooling tower.
6. Study and operation of long tube forced circulation and multiple effect evaporators.
7. Duhring's plot for solutions involving non-volatile solutes
8. To find the heat transfer coefficient of heat loss from a vertical cylinder by natural convection.
9. To find heat transfer coefficient for parallel flow and counter flow for double pipe heat exchanger.
10. To find heat transfer coefficient for heat loss.

The mapping of PO/PSO/CO attainment is as follo

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	2	1	2	1	1	2	-	1	1	1	1	1	1
CO5	2	1	1	2	1	1	2	1	2	2	1	2	2	2	1
Average	1.8	1.6	1.2	1.4	1.4	1.2	1.4	1.6	1.2	1.2	1	1.2	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Mass Transfer Laboratory
Course Code: B106408
Semester: 4th

Credit: 1 **L T P**
0 0 2

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Use the fundamental concepts of mass transfer and use those concepts to real engineering problems.
CO2	Learn the concepts of diffusion and various laws governing diffusion in solids, liquids & gases.
CO3	Operate equipment based upon processes involving gas absorption, drying of solids,adsorption, crystallization, distillation, liquid-liquid extraction and leaching

List of Experiments:

1. To find out the critical moisture content of the given material and to find out the equations for constant and falling rate period of drying.
2. Determination of liquid hold up in a packed column.
3. To find the mass transfer coefficient for the vaporisation of organic vapour to air.
4. To verify the Rayleigh's equation for batch distillation.
5. To find the height equivalent to a theoretical plate and height of a transfer unit for the packed distillation column under total reflux.
6. To find the yield of crystals using batch crystallizer
7. To find the efficiency of rotary drier using a granular solid
8. To find the efficiency of a distillation column.
9. To study the adsorption characteristics and plot adsorption isotherm.
10. To find the yield of a natural oil by leaching from biomass.
11. To study liquid-liquid extraction in a packed column.
12. To determine mass transfer coefficient from a wetted wall column.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	1	1	1	1	1
CO3	2	1	2	2	2	1	2	2	-	2	1	-	2	2	2
Average	2	1.6	1.2	1.6	1.6	1.4	1.4	1.6	1	1.5	1	1	1.4	1.4	1.6

The correlation levels are: “1” – Low Correlation, “2” – Medium Correlation, “3” – High Correlation and “-” indicates there is no correlation.

Course Name: Drilling Fluids and Cements
Course Code: B106503
Semester: 5th

Credits: 04 **L T P**
3 1 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Acquire knowledge about the basic functions of drilling fluids, the properties are responsible to achieve these functions and how to get the properties of mud.
CO2	Learn about the different types of drilling fluids, their advantages and disadvantages and different key factors that drive decisions about the selecting types
CO3	Study drilling fluid parameters.
CO4	Understand the different well cementing practices and their role in oil and gas well.
CO5	Know about the mechanism of well cementing and design procedure and calculate cement slurry, surface power and other requirements.

Course Content

A. Drilling Fluids:

Module1. Overview of Drilling Fluids: 6 hrs
Clay chemistry and its application to drilling fluids, Types of clays, hydration, flocculation, aggregation and dispersion.

Module 2. Classification, Types and applications of Drilling Fluids: 8 hrs
Water based, oil based, emulsion based, polymer based, Surfactant based, Foam based and Aerated drilling fluids.

Module 3. Drilling Fluid Characteristics: 6 hrs
Basic functions, properties, maintenance and treatments of drilling fluids.

Module 4. Drilling fluid calculations.

Module 5. Rotary Drilling Hydraulics: 6 hrs
Rheology of drilling fluids, Pressure loss calculations and Rig hydraulics.

B. Cements:

Module 1. Cementing, Cements & cement slurry: 10 hrs
Objectives of cementing, oil well cements, Classification of cement, Slurry design, Slurry additives, Factors influencing cement slurry design, Cementing equipments.

Module 2. Cementing Methods: 12 hrs
Primary cementing, Stage cementing, Liner cementing, Plugging, Squeeze Cementing techniques in practice. Deep well cementing, Characteristics of good quality cementation. Cementing calculations.

Suggested Text/Reference Books:

1. Gatlin, C. (1960). *Petroleum Engineering: Drilling and Well Completion*. Prentice Hall.
2. Azar, J. J. & Samuel, G.R. (2007). *Drilling Engineering.* Penn Well Corporation.
3. French Oil and Gas Industry Assn. (1982), *Drilling Mud and Cement Slurry Rheology Manual.* Gulf Publishing Company.
4. Smith, P.K. (1976).*Cementing (2nd Edition).* SPE Pulications.
5. Caenn, R. & Darley, H.C.H. (2011). *Composition and Properties of Drilling and Completion Fluids.* Gulf Professional publishing.
6. ASME Shale Shaker Committee. (2004). *Drilling Fluids Processing Handbook.* Gulf Professional publishing.

7. Azar, J.J, &Lummas, J.L. (1986). *Drilling Fluids Optimization: A Practical Field Approach.*Pennwell Books.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	2	1	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	2	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	2	1	1	1	2	2	1	1	2	2	1	1
CO5	2	1	2	2	2	1	2	1	1	2	2	1	1	2	1
Average	1.6	1.4	1.2	1.8	1.2	1.2	1.4	1.6	1.2	1.2	1.5	1.2	1.2	1.2	1.2

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Name: Process Instrumentation and Control
Course Code: B106504
Semester: 5th

Credits: 04 **L T P**
3 1 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Analyze first and second order systems
CO2	Study linear and non-linear systems.
CO3	Analyze various types of controllers (P, PI & PID) and their transfer functions.
CO4	Understand a given system for its frequency response and stability.
CO5	Know about the process, identification and control strategies such as cascade, ratio and feed forward control

Course Content

A: Instrumentation 4 hrs

Module 1: Classification of measuring instruments, Elements of measuring instruments, Static and dynamic characteristics of instruments, Error analysis. Instruments for the measurement of temperature,
Pressure, Liquid level, and moisture content, Instruments and sensors for online measurements.

B: Process Control

Module 1: Introduction 2 hrs

General Principles of process control, Time domain, Laplace domain and frequency domain dynamic and control.

Module 2: Linear Open loop Systems: 12 hrs

Laplace domain analysis of first and second orders systems, linearization,
Response to step, pulse, impulse and ramp inputs, Physical examples of first and second order systems such as thermocouple, level tank, U-tube manometer etc., Interacting and non-interacting systems distributed and lumped parameter systems, dead time.

Module 3: Linear Closed-loop Systems 10 hrs

Controllers and final control elements, Different types of control valves and their characteristics, Development of block diagram, Transient response of simple control systems, Stability in Laplace domain, Root locus analysis.

Module 4: Frequency Response 8 hrs

Frequency domain analysis, Control system design by frequency response, Bode stability criterion, Different methods of tuning of controllers.

Module 5: Process Applications 12 hrs

Introduction to advanced control techniques as feed forward, feedback, cascade, ratio, Smith predictor, Internal model control, Digital computer control, Direct digital control and supervisory control and data acquisition, Multivariable control, Applications to equipments such as heat exchangers, distillation columns, reactors etc.

Suggested Text/Reference Books:

1. Eckman, D.P. (1974). *Industrial Instrumentation.* Wiley Eastern.
2. Harriott, P. (2001). *Process Control*, McGraw Hill.

3. Patranabis, D. (2001). *Principles of Process Control (2nd Edition)*. McGraw Hill.
4. Pollard. (1971). *Process Control for Chemical and Allied Industries.* Butterworth Heinnemann.
5. Weber, T.W. (1988). *An Introduction to Process Dynamics & Control.*Kreiger Publishing Co.
6. Coughanour, D. R. (2009). *Process System Analysis & Control.* McGraw Hill.
7. Coughanour, D. R. & Leblanc, S. (2009). *Process System Analysis and Control (3rd Edition).* McGraw Hill.
8. Stephanopoulos, G. (1990). *Chemical Process Control - An Introduction to Theory and Practice (1st Edition).* Prentice Hall of India.
9. Peacock, D.G. & Richardson, J.F. (1994). Chemical Engineering, (Volume 3, 3rd Edition). Butterworth Heinemann.
10. Bequette, B.W. (2003). *Process Dynamics: Modeling, Analysis and Simulation.* Prentice Hall.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	1	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	2	1	2	1	2	2	-	2	-	-	1	1	2
CO4	2	2	1	2	2	1	1	2	2	1	1	1	1	1	1
CO5	2	1	1	2	2	1	2	1	1	1	2	2	2	2	2
Average	1.8	1.4	1.2	1.6	1.8	1.2	1.4	1.6	1.2	1,2	1.5	1.2	1.2	1,2	1.6

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Petroleum Refining and Engineering
Course Code: B106505
Semester: 5th

Credits: 04 **L T P**
4 0 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Acquire basic knowledge about the national energy scenario
CO2	Study the various petroleum resources, drilling techniques for obtaining crude petroleum & various regulations for crude oil production
CO3	Acquire knowledge about the various crudes & identify desirable properties of Petroleum fractions and testing methods.
CO4	Understand the various pretreatment and refining processes like distillation, extraction, de-waxing etc.
CO5	Know about the various conversion processes like cracking, reforming, alkylation, polymerization and is isomerization.

Course Content

Module 1: Introduction to petroleum industry: 2 hrs
World petroleum resources, petroleum industry in India. Origin, exploration, drilling and production of petroleum crudes, Transportation of crudes and products.

Module 2: Crude pretreatment: 16 hrs
Composition and classification of crudes, methods of evaluation: ASTM, TBP and EFV distillation. Properties and specifications of petroleum products such as LPG, gasoline, naphtha, kerosene, diesel oils, lubricating oils, waxes and the like.
Testing of petroleum products:
(i) Physical test: Density and specific gravity, viscosity.
(ii) Chemical test: Organic and inorganic constituents.
(iii) Flammability Test: Flash point, volatility.
(iv) Knock Rating Test: For Gasoline Octane Number.

Module 3: Separation Processes:
16hrs
Design and operation of topping and vacuum distillation units, Tube still furnaces, Solvent extraction processes for lube oil base stock and for aromatics from naphtha and kerosene steams, solvent dewaxing.

Module4: Conversion Process: 14 hrs
Thermal cracking, visbreaking and coking processes.
Catalytic cracking, reforming, hydroprocessing, alkylation, polymerization and isomerisation.
Safety and pollution considerations in refineries.

Suggested Text / Reference Books:

1. Nelson, W.L. (1985). *Petroleum Refinery Engineering (5th Edition)*. McGraw Hill.
2. Hobson, G.D. & Pohl. W. (1984). *Modern Petroleum Technology (5th Edition)*. John Wiley.
3. Guthrie, V.B. (1960). *Petroleum Products Handbook*. McGraw Hill.

4. Rao, B.K. (2009). *Modern Petroleum Refining Processes (5th Edition).* Oxford & IBH Publishing Co.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	1	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	1	1	1	2	2	-	1	2	-	2	1	2
CO4	2	2	1	2	1	1	1	2	1	2	1	1	1	1	1
CO5	1	1	2	2	1	1	2	1	1	1	1	1	1	2	1
Average	1.2	1.4	1.2	1.6	1.2	1.2	1.4	1.6	1	1.2	1.4	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course name: Chemical Reaction Engineering
Course Code: 106511
Semester: 5th

Credits: 04 **L T P**
3 1 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study the basic concepts of chemical reaction engineering and develop rate laws for homogeneous reactions
CO2	Design calculations of ideal reactors for single and complex reactions for isothermal and non-isothermal reactors.
CO3	Compare the relative performance of different reactors.
CO4	Draw various RTD curves and predict the conversion from a non-ideal reactor using tracer information.
CO5	Understand the optimal reactor configurations and operating policies for systems involving multiple reactions.

Course Content

Module 1: Introduction (8 hrs)

Introduction & Importance of Chemical Reaction Engineering, Kinetics of homogeneous reactions, Concepts of reaction rates, rate equation, rate constant, order & molecularity, Mechanism for Elementary & Non-elementary reaction.

Module 2: Design for Single Reactions (16 hrs)

Material balance equation for ideal batch reactor and its use for kinetic interpretation of data and isothermal reactor design for simple & complex rate equation.

Performance equations for CSTR and PFR and their use for kinetic interpretation and design.

Comparison of batch reactor, CSTR & PFR, Recycle reactor, concept of yield & selectivity.

Reactor combinations of CSTR and PFR

Module 3: Design for Multiple Reactions (8 hrs)

Quantitative treatment of Series & parallel multiple reaction in a batch reactor, CSTR & PFR, Concept of Product distribution for multiple reactions.

Module 4: Temperature & Pressure effects (8 hrs)

Concept of adiabatic & non-isothermal operations, Energy balance equation for Batch, CSTR & PFR and their application to design of reactors, optimal temperature progression, multiple steady states in CSTR.

Module 5: Non –Ideality (8 hrs)

Basics of non-ideal flow, residence time distribution, States of segregation.

Measurement and application of RTD, E-Age distribution function & F-curve and inter-relationship between them, Conversion in non-ideal reactors.

Suggested Text/Reference Books:

1. Levenspiel, O. (2004). *Chemical Reaction Engineering (3rd Edition*). John Willey.
2. Smith, J.M. (1981). *Chemical Engineering Kinetics (3rd Edition).* McGraw Hill.
3. Peacock, D.G. & Richardson, J.F. (1994). *Chemical Engineering, (Volume 3, 3rd Edition*). Butterworth Heinemann.

4. Walas, S.M. (1959). *Reaction Kinetics for Chemical Engineers (3rd Edition).* Tata McGraw Hill.
5. Denbigh, K.G. & Turner, J.C.R. (1984). *Chemical Reactor Theory - An Introduction (3rd Edition).* Cambridge University Press.
6. Fogler, H.S. (2006). *Elements of Chemical Reaction Engineering (4th Edition).* Prentice Hall.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	2	1	1	2	1	1	-	1	1	1	2
CO2	2	1	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	2	2	1	2	2	-	1	-	-	1	1	1
CO4	2	2	2	2	2	1	1	2	2	1	1	2	1	1	1
CO5	2	1	1	2	2	1	2	1	1	2	1	1	1	2	1
Average	2	1.4	1.2	1.8	2	1.2	1.4	1.6	1.2	1.2	1	1.2	1	1.2	1.2

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Name: Process Control Laboratory
Course Code: B106508
Semester: 5th

Credit: 01 **L T P**
0 0 2

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study the liquid level tank, interacting / non-interacting tank dynamics.
CO2	Solve the first order or higher order differential equations
CO3	Acquire basic knowledge about types of control valves.
CO4	Study of control valve characteristics.

List of Experiments:

1. Calibration of temperature, pressure, flow and composition measuring instruments.
2. Study of process dynamics of a liquid level tank
3. Study of process dynamics of interacting / non-interacting tank
4. Study of process dynamics of some processes.
5. Investigation of the operation of pneumatic and electronic controllers with proportional integral derivative action.
6. To determine the best setting of a controllers with controlling an actual process.
7. To solve first order or higher order differential equations with the help of an analog computer/ computer and to study control problems by simulation.
8. To control the level of liquid in the process tank using multi process trainer for different controller settings.
9. Study of control valve characteristics.
10. Study of Programmable Logic Control system.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	1	1	1	1	1
CO3	2	1	2	2	2	1	2	2	-	1	2	-	2	2	2
CO 4	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1
Average	1.5	1.5	1.25	1.5	1.5	1.25	1.25	1.2	1	1.4	1.4	1	1.2	1.2	1.5

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Name: Petroleum Engineering Laboratory
Course Code: 106512
Semester: 5th

Credit: 01 **L T P**
0 0 2

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Find the quality control of lubricating oils and explore its application.
CO2	Study the Petroleum Products and their applications in quality control.
CO3	Learn about Physical and thermal of crude oil.
CO4	Acquire knowledge about the crude oil distillation.

List of Experiments

1. Determination of viscosity of given petroleum fraction using viscometer.
2. Study of vapour pressure of gasoline using Reid Vapour pressure apparatus.
3. Determination of Aniline Point of given petroleum fraction.
4. Determination of density of petroleum fraction.
5. Determination of Smoke Point of Kerosene.
6. Determination of Flash and fire Point of given petroleum fraction.
7. Determination of Cloud and pour Point of given petroleum fraction.
8. Determination of Carbon Residue of given petroleum fraction using Rams Bottom Carbon Residue apparatus.
9. Determination of Calorific value of given petroleum fraction using Bomb Calorimeter.
10. Study of distillation of crude oil or mixture of petroleum fractions.
11. Determination of surface tension of given oil.
12. Study of softening point of bitumen.

The mapping of PO/PSO/CO attainment is as follows

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	2	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	2	2	1	1	2	-	1	1	1	1	1	1
Average	1.4	1.6	1.4	1.6	1.4	1.4	1.4	1.6	1	1	1.5	1	1.4	1.4	1.6

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Name: Chemical Reaction Engineering Laboratory
Course Code: 106513
Semester: 5th

Credit: 01 **L T P**
0 0 2

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study the reaction kinetics using various types of reactors such as batch, PFR and CSTR.
CO2	Find the residence time distribution for PFR and Packed Bed Reactor.
CO3	Know about the kinetic studies in a PFR followed by a CSTR.
CO4	Learn the temperature dependence of rate constant using CSTR.

List of Experiments

1. Kinetic studies in a Batch reactor
2. Kinetic studies in a Plug Flow reactor
3. Kinetic studies in a PFR followed by a CSTR
4. RTD studies in a PFR
5. RTD studies in a Packed Bed Reactor.
6. RTD studies in CSTRs in series
7. Studies on micellar catalysis
8. Study of temperature dependence of rate constant using CSTR.
9. Kinetic studies in sono-chemical reactor
10. Batch reactive distillation
11. Kinetics of photochemical reaction
12. Demonstration of heterogeneous catalytic reaction
13. Demonstration of gas-liquid reaction

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	2	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	2	2	1	1	2	-	1	1	1	1	1	1
Average	1.6	1.6	1.4	1.6	1.4	1.4	1.4	1.6	1	1	1.5	1	1.4	1.4	1.6

The correlation levels are: “1” – Low Correlation, “2” – Medium Correlation, “3” – High Correlation and “-” indicates there is no correlation.

Name: Offshore Drilling and Production Practices
Course Code: B106605
Semester: 6th

Credits: 04 **L T P**
3 1 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand the complexity of operating in a typical offshore environment in different parts of the world.
CO2	Study the types of offshore platforms.
CO3	Know about the installation of conductors, risers and landing bases up to the completion of drilling from different types of platforms in or stepwise manner.
CO4	Acquire knowledge about the storage and transportation of extracted petroleum.
CO5	Outline the challenges in deep water and their possible solutions.

Course Content

Module 1: Sea states and weather: 6 hrs
Meteorology, oceanography. Sea - bed soil condition. Wave condition. Wave - structure interaction.
Module 2: Off-shore structures: 12 hrs
Fixed platform, jack-up rig: design and operational features mobile units; semi-submersible, floating structures, description and installation, station keeping, mooring and dynamic positioning system.
Module 3: Off-shore drilling: 12 hrs
Well head and sea floor connection; conductor and riser. Off-shore well completion: Platform and sub-sea completion system, well control and work-over system.
Module 4: 10 hrs
Sub-sea technology in deep water – use of divers and robots. Off-shore production: Platform oil and gas processing, water and gas injection system.
Module 5: 8 hrs
Storage for oil; SPM & SBM system. Deep water technology: use of remote operating vehicle (ROV)

Suggested Text / Reference Books:

1. El-Reedy, M.A. (2012). *Offshore Structures: Design, Construction and Maintenance.* Gulf professional Publication.
2. Chakraborty, S.K. (2006). *Handbook of Offshore Engineering,Volume-I and II.* Elsevier.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	1	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	2	1	2	2	-	2	2	-	1	1	2
CO4	2	1	1	2	2	1	1	2	1	1	1	1	1	1	1
CO5	1	1	1	2	1	1	2	1	1	1	1	2	2	2	1
Average	1.4	1.2	1	1.6	1.6	1.2	1.4	1.6	1	1.2	1.4	1.2	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Name : Numerical Methods
Course Code :B106606
Semester: 6th

Credit: 04 **L T P**
3 1 0

Course Outcomes:
On successful completion of this course, the students will able to learn:

CO	Statements
CO1	Apply numerical methods to find solution of algebraic equations using different methods under different conditions, and numerical solution of system of algebraic equations
CO2	Use various interpolation methods and finite difference concepts to find roots of polynomial equations using numerical analysis.
CO3	Differentiate numerical integration and differentiation and Work out on numerical differentiation and integration whenever and wherever routine methods are not applicable
CO4	Explain how to interpolate the given set of values and the curve fitting for various polynomials
CO5	Work numerically on the ordinary differential equations using different methods through the theory of finite differences and Runge-Kutta method.

Course Content

Module 1: Introduction & Error analysis 5hrs
Introduction to Numerical methods and its significance in engineering, classification of errors, significant digits and numerical stability.

Module 2: Linear Algebraic Equations 7 hrs
Cramer's rule, Gauss Elimination and LU Decomposition, Gauss-Jordan elimination, Gauss-Seidel and Relaxation Methods.

Module 3: Non Linear Algebraic Equations 10 hrs
Single variable successive substitutions (Fixed Point Method), Multivariable successive substitutions, single variable Newton-Raphson Technique, Multivariable Newton-Raphson Technique.

Module 4: Eigen values and Eigen vectors of Matrices 6 hrs
FaddeevLeverrier's Method, Power Method.

Module 5: Function Evaluation 12 hrs
Least squares curve-fit (Linear Regression), Newton's interpolation formulae (equal intervals), Newton's Divided Difference Interpolation Polynomial, Lagrangian Interpolation Unequal intervals). Numerical Differentiation, Numerical Integration or Quadratures (Trapezoidal, Simpson's 1/3 and 3/8 rules), Extrapolation Technique of Richardson and Gaunt.

Module 6: Ordinary Differential Equations (ODE-IVPs) and partial differential Equations 8hrs
The Finite difference Technique, Runge-Kutta method

Suggested Text / Reference Books:

1Gupta, S.K. (2009). *Numerical Methods for Engineers (2nd Edition)*. New Age International Publishers.
2. Jain, M.K., Iyengar, S.R.K., &Jain, R.K. (2012).*Numerical Methods for Scientific and Engineering Computation.* New Age International.
3. Finlayson, B.A. (1980).*Nonlinear Analysis in Chemical Engineering.*MCGraw Hill

4. Villadsen, J. and Michelsen, M.L. (1978).*Solution of Differential Equation Models by Polynomial Approximation.* Prentice Hall.
5. Rice, R.G. & Do Duong, D. (1995).*Applied Mathematics and Modelling for Chemical Engineers.* John Wiley.
6. Sastry, S.S. (2005).*Introductory Methods of Numerical Analysis (4th Edition).* Prentice Hall of India.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	3	2	1	2	-	2	2	2	2	2	2	2
CO2	3	3	3	2	2	1	-	1	2	3	2	3	3	3	3
CO3	2	3	3	2	2	2	1	-	1	2	1	2	2	3	2
CO4	2	3	2	3	1	-	2	2	2	3	2	3	2	1	3
CO5	3	2	2	2	2	2	1	2	-	3	-	3	2	2	2
Average	**2.4**	**2.6**	**2.4**	**2.4**	**1.8**	**1.5**	**1.5**	**1.6**	**2.2**	**2.6**	**2.2**	**2.6**	**2.2**	**2.2**	**2.4**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course name: Mechanical Operations
Course Code: 106610
Semester: 6th

Credits: 04 **L T P**
3 1 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study the particulate solids characterisation and its screening.
CO2	Identify various processes related to solid particles such as agitation and mixing, size reduction, filtration, settling and fluidization.
CO3	Understand conveying of bulk solids, conveyors and conveyor selection.
CO4	Find capacity and effectiveness of a screen and calculation of average size of particle.
CO5	Acquire knowledge about the processes involving motion of particles through fluids though Sedimentation and Fluidization and the relevant equipment.

Course Content

Module 1: Characterization and Handling of Solids (8 hrs)

Characterization of solid particles: Shape, size, specific surface, Particle size distribution
Properties of particulate masses: Major distinctive properties, pressures in masses of particles, angle of internal friction, angle of repose.
Conveying of bulk solids: Basic idea of conveyor, conveyor selection, screw, belt, vibrating, continuous flow and pneumatic conveyors.
Storage and weighing: bulk storage, bin storage, feeders (vibrating hopper, screw feeder, belt feeder), batch and continuous weighing.

Module 2: Screening (4 hrs)

Capacity and Effectiveness of a screen, calculation of average size of particles in mixture by screen analysis, types of screens.

Module 3: Agitation and Mixing (8 hrs)

Agitation of low viscosity particle suspensions: axial flow impellers, radial flow impellers, close-clearance stirrer, unbaffled tanks, baffled tanks, basic idea for designing agitators. Power number, Froude number, power consumption in agitation.
Mixing of Solids: Types of mixers, various mixers for cohesive solids, power requirements, mixing index, axial mixing.
Mixers for free flowing solids: ribbon blenders, screw mixers, tumbling mixers import wheels, mixing index in blending granular solids, mixing index at zero time, rate of mixing.

Module 4: Size Reduction (6 hrs)

Principles of Comminution: Criteria for comminution, characteristics of products, Energy and Power requirements, Bond's, Rittinger's and Kick's Law and Work Index.
Size Reduction Equipment: Crushers, Grinders, and ultrafine grinders cutting machines, equipment operation.

Module 5: Filtration (8 hrs)

Classification of filters, various types of cake filters, principles of cake filtration, clarifying filters: liquid clarification, Gas cleaning, principles of clarification.
Filtration Equipment and centrifuges and their selection, Cross flow Filtration, micro filtration

Module 6: Settling (8 hrs)

Motion of particles through fluids: Terminal velocity, hindered settling, Stoke's law,
Gravity settling processes: Classifiers, clarifiers, thickeners, flocculation, rate of sedimentation
Centrifugal Settling processes: Cyclones, hydroclones, decanters, tubular, disk and nozzle discharge centrifugal sludge separators, Centrifugal class fitters, principles of centrifugal sedimentation.

Module 7: Fluidization (6 hrs)

Fluidization and fluidized bed, conditions for fluidization, Ergun equation and Kozeny-Carman equation, minimum fluidization velocity, types of fluidization, expansion of fluidized beds and particulate fluidization, continuous fluidization; industrial applications.

Suggested Text/Reference Books

1. McCabe, W. L., Smith, J. C., & Harriot, P. (2005). *Module Operations of Chemical Engineering (7th Edition).* McGraw Hill.
2. Foust, A.S., Wenzel, L.A., Clump, C.W., Maus. L., & Anderson, L. B. (2008). *Principles of Module Operations (2nd Edition).* John Wiley.
3. Harker, J. H., Richardson, J. F., &Backhurst, J. R. (2003). *Chemical Engineering (Volume 2, 5th Edition).* Butterworth-Heineman.
4. Badger, W.L. &Banchero, J.T. (1955). *Introduction to Chemical Engineering*. McGraw Hill.
5. Perry, R.H. & Green, D. W. (2008). *Chemical Engineers' Handbook (8th Edition)*. Mc-GrawHil.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	2	1	1	2	2	-	1	-	1	1	1	2
CO4	2	1	1	2	2	1	1	2		1	1	-	1	1	1
CO5	1	1	1	2	2	1	2	1	1	1	1	1	1	2	1
Average	1.6	1.2	1	1.8	1.6	1.2	1.8	1.6	1	1	1	1	1	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Name: Probability and statistics
Course Code: 106611
Semester: 6th

Credit: 04 **L T P**
3 1 0

Course Outcomes: On successful completion of this course, the students will able to learn:

CO	Statements
CO1	Describe the Probability and its distributions such as binomial distributions, poissondistribution and basic laws of total probability and compound probability in statistics.
CO2	Categorize appropriate sampling processes such as random sampling, large sample tests of means and proportion. *t*-student, (chi square) and *F* distributions (without derivation) and testing of hypothesis based on them. 2χ
CO3	Recall the methods of classifying and analyzing data relative to single variable and multiple variables.
CO4	Distinguish between the practical purposes of a large and a small sampleand Understand that correlation coefficient is independent of the change of origin and scale
CO5	Use different kinds of distribution of probability and statistics to solve real life problems like Discrete uniform, binomial, geometric, negative binomial, hyper geometric, Poisson.

Course Content

Module 1: Algebra of Sets: sets and classes, limit of a sequence of sets, rings, sigma-rings, fields, sigma-fields, monotone classes.

Module 2: Probability: Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, problems.

Module 3: Random Variables: Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, probability and moment generating function, median and quantiles, Markov inequality, Chebyshev's inequality, problems.

Module 4: Special Distributions: Discrete uniform, binomial, geometric, negative binomial, hyper geometric, Poisson, continuous uniform, exponential, gamma, Weibull, Pareto, beta, normal, lognormal, inverse Gaussian, Cauchy, double exponential distributions, reliability and hazard rate, reliability of series and parallel systems, problems.

Module 5: Function of a random variable, problems.

Module 6: Joint Distributions: Joint, marginal and conditional distributions, product moments, correlation and regression, independence of random variables, bivariate normal distribution, problems.

Module 7: Transformations: functions of random vectors, distributions of order statistics, distributions of sums of random variables, problems.

Module 8: Sampling Distributions: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions, problems.

Module 9: Descriptive Statistics: Graphical representation, measures of locations and variability.

Module 10: Estimation: Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions, problems.

Module 11: Testing of Hypotheses: Null and alternative hypotheses, the critical and acceptance regions, two types of error, power of the test, the most powerful test and Neyman-Pearson Fundamental Lemma, tests for one sample and two sample problems for normal populations, tests for proportions, Chi-square goodness of fit test and its applications, problems.

Suggested Text / Reference Books:

1. Rohatgi, V.K.,Saleh, A.K. Md. E.(2008).*An Introduction to Probability and Statistics(2nd Edition).* Wiley and sons.
2. Milton, J.S., Arnold J.C.(2017).*Introduction to Probability and Statistics(4th Edition)*. McGraw Hill Education.
3. Larson,H.J.(1969).*Introduction to Probability Theory and Statistical Inference(3rd Edition).*
4. Ross,S.M.(2013).*A First Course in Probability (9th Edition)*. Pearson Education India.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	1	1	2	1	1	1	2	2	2	2	2
CO2	2	3	3	2	2	1	2	-	2	3	2	2	2	1	1
CO3	3	2	2	2	1	-	2	1	-	-	2	3	1	2	2
CO4	2	2	2	2	2	2	-	2	2	3	1	3	2	2	3
CO5	2	2	2	3	1	1	1	-	2	1	1	2	1	3	2
Average	**2.4**	**2.2**	**2.4**	**2.2**	**1.4**	**1.2**	**1.7**	**1.3**	**1.7**	**2**	**1.6**	**2.4**	**1.6**	**2**	**2**

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Probability and statistics
Course Code: 106611
Semester: 6th

Credits: 04 **L T P**
3 1 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand skills in handling situations involving more than one random variable and functions of random variables.
CO2	Study sampling distributions and have acquired knowledge of statistical techniques useful in making rational decision in management problems.
CO3	Acquire knowledge about statistical methods designed to contribute to the process of making scientific judgments in the face of uncertainty and variation.
CO4	Know about sets of algebra and probability
CO5	Use application of probability and statistics in real life problems

Course Content

Module 1: Algebra of Sets: sets and classes, limit of a sequence of sets, rings, sigma-rings, fields, sigma-fields, monotone classes.

Module 2: Probability: Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, problems.

Module 3: Random Variables: Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, probability and moment generating function, median and quantiles, Markov inequality, Chebyshev's inequality, problems.

Module 4: Special Distributions: Discrete uniform, binomial, geometric, negative binomial, hyper geometric, Poisson, continuous uniform, exponential, gamma, Weibull, Pareto, beta, normal, lognormal, inverse Gaussian, Cauchy, double exponential distributions, reliability and hazard rate, reliability of series and parallel systems, problems.

Module 5: Function of a random variable, problems.

Module 6: Joint Distributions: Joint, marginal and conditional distributions, product moments, correlation and regression, independence of random variables, bivariate normal distribution, problems.

Module 7: Transformations: functions of random vectors, distributions of order statistics, distributions of sums of random variables, problems.

Module 8: Sampling Distributions: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions, problems.

Module 9: Descriptive Statistics: Graphical representation, measures of locations and variability.

Module 10: Estimation: Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions, problems.

Module 11: Testing of Hypotheses: Null and alternative hypotheses, the critical and acceptance regions, two types of error, power of the test, the most powerful test and Neyman-Pearson Fundamental Lemma, tests for one sample and two sample problems for normal populations, tests for proportions, Chi-square goodness of fit test and its applications, problems.

Suggested Text / Reference Books:

1.Rohatgi, V.K.,Saleh, A.K. Md. E.(2008).*An Introduction to Probability and Statistics(2nd Edition)*. Wiley.

2.Milton, J.S., Arnold J.C.(2017).*Introduction to Probability and Statistics(4th Edition)*. McGraw Hill Education.
3.Larson,H.J.(1969).*Introduction to Probability Theory and Statistical Inference(3rd Edition).*
4.Ross,S.M.(2013).*A First Course in Probability (9th Edition).* Pearson Education India.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	2	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	2	2	1	2	2	-	1	1	-	1	1	2
CO4	2	2	1	2	2	1	1	2	2	1	1	1	1	1	1
CO5	2	1	2	2	2	1	2	1	1	2	2	1	2	2	1
Average	2	1.6	1.2	1.8	2	1.2	1.4	1.6	1.2	1.2	1.4	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Mechanical Operations Laboratory
Course Code: 106612
Semester: 6th

Credit: 01 **L T P**
0 0 2

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study the concept of fluidization.
CO2	Acquire knowledge about the operating characteristics of crushing and grinding equipment
CO3	Understand various principles of the filtration and analyze working of filtration equipment.
CO4	Find the efficiency of various separating equipment.

List of Experiments

1. Verification of Stokes Law.
2. Screen analysis of given sample for its particle size distribution.
3. Determination of average size (different averages) from screen analysis.
4. Determination of variation in pressure drop & bed height With respect to superficial velocity for a bed of solids.
5. Determination of minimum fluidization velocity for a bed of solids.
6. Operating characteristics of crushing and grinding equipments (Jaw crusher, Roll crusher, Ball mill).
7. Evaluation of the filtration constants for $CaCO_3$ slurry in water and cake compressibility.
8. Determination of %age recovery of coal in froth from coal and sand mixture.
9. Determination of thickener capacity using batch sedimentation.
10. Determination of characteristics of centrifuge as a filter.
11. Determination of the separation efficiency of the classifier.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	2	1	1	2	2	-	1	1	-	1	1	2
CO4	2	2	1	2	2	1	1	2	-	2	1	1	2	2	1
Average	2	1.75	1	1.75	1.5	1.2	1,2	1.7	1	1.4	1	1	1.25	1.2	1.5

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Numerical Methods Laboratory
Course Code: B106609
Semester: 6th

Credit: 01 **L T P**
0 0 2

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Apply basics of numerical methods in real applications.
CO2	Evaluate roots of polynomial equations using numerical analysis.
CO3	Understand numerical integration and differentiation.
CO4	Know about the use of computer in numerical methods applications to solve engineering problems.
CO5	Know about Application of Newton's formula for numerical differentiation

List of Experiments

1. Solution of a system of linear equations in unknowns by Gaussian elimination.
2. Gauss-Seidel iterative method to solve a linear system of equations.
3. To find the inverse of matrix by Gauss-Jordan method.
4. Application of Faddeev- Leverrier's method.
5. Method for finding dominant Eigen value and corresponding Eigen vectors by power method.
6. Solution of nonlinear equation by Newton Raphson method.
7. Application of Newton's formulae for interpolation.
8. Application of Lagrange polynomial interpolation formula.
9. Application of Newton's formula for numerical differentiation.
10. Numerical integration by Trapezoidal rule.
11. Numerical integration by Simpson's rules.
12. Solution of an O.D.E. by RungeKutta Methods.
13. Application of finite difference technique.

The mapping of PO/PSO/CO attainment is as follow

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	2	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	1	-	1	1	1	1
CO3	2	1	1	2	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	2	2	1	1	2	-	1	1	1	1	1	1
CO5	2	1	1	2	2	1	2	1	1	2	1	1	2	2	1
Average	2	1.6	1	1.8	1.8	1.2	1.4	1.6	1	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course Name: Process Economics and Management
Course Code: B106701
Semester: 7th

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Investigate and prepare the balance sheet, income statement and estimation of capital investment, total product costs.
CO2	Acquire knowledge about the concept of interest cost, depreciation and taxes.
CO3	Outline profitability and replacement analysis.
CO4	Know about the general procedure for determining optimum conditions.
CO5	Study the concept of Intellectual Property Right (IPR) and patent system.

Course Content

Module 1: Cost Estimation 8 hrs

Factors affecting investment and production costs, Capital investments - fixed investments and working capital. Cost indices. Estimating equipment costs by scaling 6/10 factor rule. Methods for estimation capital investment. Estimation of total product cost. Different costs involved in the total product for a typical chemical process plant.

Module 2: Interest & Investment Costs 8 hrs

Types of interest (simple & compound interest), Nominal & Effective Rates of interest, Continuous interest, Present worth & discounts, perpetuities, capitalized costs, Interest & Investment costs. Taxes & Insurance: Types of taxes and tax returns, Property taxes, excise taxes, income taxes, Types of Insurance & Legal Responsibility.

Module 3: Depreciation 8 hrs

Purpose of Depreciation as cost, Types of Depreciation, Depletion, Service life., Salvage value, Present value, Methods of Determining Depreciation , Straight- line method, Declining Balance Method, Sum of the years Digits method, Sinking Fund Method, Single Unit & Group Depreciation.

Module 4: Profitability 10 hrs

Profitability Alternative Investments & Replacement: Profitability standards, Mathematical methods of profitability evaluation: Rate of return on investment, Discounted cash flow method, Net Present worth, Capitalised costs, pay out period. Determination of Acceptable investment, Alternatives when an investment must be made, Alternative analysis by method of return on incremental investment, Alternative analysis incorporating minimum return as a cost, Replacements, Balance sheets & Income statement.

Module 5: Optimum Design 8 hrs

General procedure for Determining optimum conditions, Procedure with one variable, Procedure with Two or More variables, Break even chart for production schedule and its significance for optimum analysis. Examples of optimum design in a Chemical Process Plant.

Module 6: IPR and Patent Systems 7 hrs

Intellectual property, IPRs and its types, Patent claims, legal decision making process and ownership of tangible and intellectual property. Indian patent system, current IPR laws and legislations in India for IPR

Documents required for filing patent, infringement of patents and remedies

Suggested Text/Reference Books:

1. Peters, M.S. &Timmerhaus, K.D. (2003). *Plant Design and Economics for Chemical Engineers (4th Edition)*. McGraw Hill.
2. Ulrich, G.D. (1984). *A Guide to Chemical Engineering Process Design and Economics.* John Wiley.

3. Guthrie, K.M. (1974). *Process Plant Estimation, Evaluation and Control.* California: Craftsman Book Company.
4. Douglas. (1998). *Conceptual Design of Chemical Processes.* McGraw Hill.
5. Riestra, V. (1983). *Project Evaluation in Chemical Process Industries.* McGraw Hill.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	2	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	2	2	1	1	2	-	1	1	1	1	1	1
CO5	1	1	1	2	1	1	2	1	1	1	1	1	1	2	1
Average	1.4	1.6	1	1.8	1.4	1.2	1.4	1.6	1	1	1	1	1	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Oil and Gas Transportation System
Course Code: B106703:
Semester: 7th

Credits: 04 **L T P**
3 1 0

Course outcomes: On successful completion of this course, the students will able to:

CO	Statement
CO1	Study the transportation of petroleum & its products.
CO2	List and explain the various parameters related to oil transportation through pipeline.
CO3	Understand the flow of oil through pipeline.
CO4	Know about the control arrangement of pipelines.
CO5	Acquire knowledge about the distribution parameters of gas.

Course Content

Module 1: 8 hrs
Road and rail transport of crude oil & product. Tanker design, safety features. Oceanic transport of oil and liquefied natural gas: design of ocean going tankers and safety features.

Module 2: 10 hrs
Pipe line transport of oil and gas: Route selection, pipe line construction process and equipment: trenching, aligning, connecting pipes, corrosion protection, lowering & back filling.

Module 3: 8 hrs
Flow of oil and gas through pipelines. Pressure drop calculation, types, sizing and location of pumps and compressor. Instrumentation and control.

Module 4: 10 hrs
Flow measurement and control arrangement. Corrosion in pipelines: Types, chemical and electro-chemical process; coating, cathodic protection principle and design.

Module 5: 12 hrs
Pipe line branching: Gas distribution control. Offshore pipe line: Sag and overbend; stinger and riser, under-water welding.

Suggested Text / Reference Books:

1. Liu, H. (2003). *Pipeline Engineering (1st Edition).*CRC Press.
2. Antaki, G.A. (2003). *Piping and Pipeline Engineering: Design, Integrity and Repair (1st Edition).*CRC Press.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	2	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	2	2	1	1	2	-	1	1	1	1	1	1
CO5	1	1	1	2	1	1	2	1	1	1	1	1	1	2	1
Average	1.4	1.6	1	1.8	1.4	1.2	1.4	1.6	1	1	1	1	1	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course name: Natural Gas Engineering
Course Code: B106704
Semester: 7th

Credits: 04 **L T P**
4 0 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand the formation, composition and utilization of natural gas.
CO2	Compare the different natural gas processing processes.
CO3	Study the natural gas flow concept in pipeline and exposure of different flow measurement devices.
CO4	Acquire knowledge about the natural gas underground storage and converting the natural gas in different valuable products.
CO5	Know about the distribution parameters of gas.

Course Content

Module 1: Introduction 2 hrs

Composition, properties, fields & reserves in India and energy scenario; major NG producing industries of India and their contribution to Indian economy; techniques of utilization.

Module 2: Gas Processing 16 hrs

Conventional and advanced separation techniques; free liquid removal; low temperature separation; dehydration processes: chemical and refrigeration system. Natural gas sweetening: amine process; sulphur recovery; LPG, LNG & CNG systems. Specifications of NG for transportation in pipelines, NG Utilization**:** uses, underground storage, conservation & concept of peak shaving etc. CBM, NG hydrates & in-situ coal gasification, conversion of gas to liquid (GTL); NGL: process, system, storage, transportation and utilization.

Module 3: Transportation of NG 14 hrs

Compression calculations; gas stations & transmission; city gas distribution system; gas flow measurement: orifice meter, turbine meter, principles and performance; compressor sizing.

Module 4: Marketing, retailing and gas trading 16 hrs

Underground storage, System and production performance. CBM, NG hydrates & in-situ coal gasification, conversion of gas to liquid (GTL).

Suggested Text/Reference Books:

1. Bradley, H.B. (1987). *Petroleum Production Handbook.* SPE Publication.
2. Skimmer, D.R. (1982). *Introduction to Petroleum Production, Volume-1, 2 & 3.* Gulf Publishing.
3. Katz, D.L. & Lee, R.L. (1990). *Natural Gas Engineering-Production and Storage.* McGraw-Hill.
4. Kumar, S. (1987). *Gas production Engineering*. Gulf Publishing.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	1	-	1	1	1	1
CO3	1	1	1	2	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	2	2	1	1	2	-	1	1	1	1	1	1
CO5	2	1	1	2	1	1	2	1	1	2	2	1	2	2	1
Average	1.6	1.6	1	1.8	1.4	1.2	1.4	1.6	1	1.2	1.5	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Process Equipment Design
Course Code: 106712
Semester: 7th

Credits: 02 **L T P**
0 0 4

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study the mechanical design of process equipment.
CO2	List and discuss the various design parameters of process equipment.
CO3	Design of pressure vessels such as thin or thick walled, under pressure and load.
CO4	Design of heads and closures, supports.

Course Content

1. Process Design of Shell and Tube Heat Exchanger
2. Process Design of Condensers
3. Process Design of Agitated vessels. Introduction to plate heat exchangers and its design
4. Specification sheet for Heat exchangers.
5. Design of Sieve Tray Column and column internals
6. Design of Bubble Cap Column and column internals
7. Design of Packed Column and column internals
8. Specification sheet for fractionating column
9. Design of Homogeneous Reactors
10. Design of Heterogeneous reactors – Fixed bed
11. Design of Heterogeneous reactors – fluidised bed
12. Types of Flow Sheets
13. Overview of plant layout

Note: Student has to perform at-least 10 experiments.

Suggested Text/Reference Books:

1. Coulson, Richardson &Sinnott, R.K. (2005). *Chemical Engineering Volume-6 – An Introduction to Chemical Engineering Design (4th Edition).* Elseveir Butterworth Heinemann.
2. Perry, R.H. & Green, D.W. (2008). *Chemical Engineers' Handbook (8th Edition).* Mc-Graw Hill.
3. Coker, A.K. (2007), *Ludwig's Applied Process Design in Chemical & Petrochemical Plants- Vol 1 (4th Edition).* Gulf Publication- Butterworth Heinemann.
4. Siddiqui, S. (2010). *Ludwig's Applied Process Design in Chemical & Petrochemical Plants – Volume 2 (4th Edition).* Gulf Publication.
5. Ludwig, E.E. (2001). *Applied Process Design in Chemical & Petrochemical Plants- Vol 3 (3rd Edition).* Gulf Publication- Butterworth Heinemann.
6. Vilbrandt, F.C. & Dryden, C.E. (1959). *Chemical Engineering Plant Design (4th Edition).* McGraw Hill. Peters, M.S. &Timmerhaus, K.D. (2003). *Plant Design and Economics for Chemical Engineering (5th Edition).* McGraw Hill.
8. Molyneux, F. (1963). *Chemical Plant Design-I.* Butterworth Heinemann.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	3	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	3	2	1	1	2	2	-	1	1	-	1	1	2
CO4	2	2	3	2	2	1	1	2	-	2	1	1	2	2	1
Average	2	1.75	3	1.75	1.5	1.5	1.5	1.4	1	1.4	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Industrial Safety and Environment
Course Code: A105802
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study the properties, usage, and storage of water.
CO2	Know about properties and utilization of steam.
CO3	Acquire knowledge about mechanical equipment related to air.
CO4	Know about workplace to determine the existence of occupational safety and health hazards
CO5	Enhance their skill sets to deal with any situation in industry.

Course Content

Module 1: Meaning & need for safety.
Relationship of safety with plant design, equipment design and work environment. Safety measures in a manufacturing organization, safety and economics, safety and productivity. Employees participation in safety. Safety standards and legislation

Module 2: Industrial accidents:
Industrial accidents, their nature, types and causes. Assessment of accident costs; prevention of accidents. Industrial hazards, Hazard identification techniques, Accident investigation, reporting and analysis.

Module 3: Planning for safety:
Definition, purpose, nature, scope and procedure. Range of planning, variety of plans. Policy formulation and implementation of safety policies.

Module 4: Environment and need for environmental :
Meaning of environment and need for environmental control factors in industry. Effect of temperature, Illumination, humidity noise and vibrations on human body and mind. Measurement and mitigation of physical and mental "fatigue" Basics of environment design for improved efficiency and accuracy at work.

Module 5: Ventilation, Lighting and heat Control :
Ventilation and heat Control Purpose of ventilation. Physiology of heat regulation. Thermal environment and its measurement. Thermal comfort. Indices of heat stress. Thermal limits for comfort, efficiency and freedom from health risk. Natural ventilation. Mechanical ventilation. Air conditioning Process ventilation. Control of heat exposures: control at source, insulation, and local exhaust ventilation. Control of radiant heat, dilution ventilation. Local relief. Industrial Lighting: Purpose of lighting, benefits of good illumination. Phenomenon of lighting and safety. Lighting and the work. Sources and types of artificial lighting. Principles of good illumination. Recommended optimum standards of illumination. Design of lighting installation. Maintenance standards relating to lighting and colour.

Module 6: Noise & Vibrations:
Continuous and impulse noise. The effect of noise on man. Noise measurement and evaluation of noise. Noise isolation. Noise absorption techniques. Silencers vibrations: Effect, measurement and control measures.

Module 7: Environment Standards:

Introduction to ISO 14000; Environment standards for representative industries.

Module 8: Management of pollutants:

Air pollution -stack emissions, flaring and fugitive release.

Water pollution and wastewater management, and produced water management.

Oil spill management.

Waste management: drilling waste, rock cutting, oily sludge and others. Environmental management, monitoring, and impact assessment.

Occupational health and safety management, risk assessment and management: qualitative and quantitativeassessments.

Suggested Text / Reference Books:

1. Vasandhani, V.P. & Kumar, D.S. (2009). *Heat Engineering.* Metropolitan Book Co. Pvt. Ltd.
2. Crowl, D.A. &Louvar, J.F. (2011). *Chemical Process Safety-Fundamentals with Applications(3rd Edition).*Prentice Hall.
3. Peavy, H.S. & Rowe, D.R. (2017). *Environmental Engineering(1st Edition).* McGraw Hill.
4. Banerjee, S. (2003). *Industrial Hazards and Plant Safety(1st Edition).*Taylor & Francis.
5. Lees, F.P. (1996). *Prevention in Process Industries.* Butterworth.
6. Sanders, R.E. (2015), *Chemical Process Safety-Learning from Case Histories(4th Edition).*Oxford.
7. Perry, R.H. & Green, D.W. (2018). *Chemical Engineer's Handbook(9th Edition).* McGraw Hill.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	1	-	1	1	1	1
CO3	1	1	1	2	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	2	2	1	1	2	-	1	1	1	1	1	1
CO5	2	1	1	2	1	1	2	1	1	2	2	1	2	2	1
Average	1.6	1.6	1	1.8	1.4	1.2	1.4	1.6	1	1.2	1.5	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Oil and Well Testing Techniques
Course Code: 106803
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand drill stem testing, RFT, Wire-line testing.
CO2	Study flow of compressible fluid through porous media and solution techniques.
CO3	Acquire knowledge about pressure-transient tests, pressure draw-down.
CO4	Know about multi-rate test, reservoir limit test, Injection and fall-off test.
CO5	Draw different type curves, generation and interpretation. Gas well testing.

Course Content

Module 1 (6 hours)
Drill stem testing, RFT, Wire-line Testing: System Interpretation.

Module 2 (6 hours)
Flow of compressible fluid through porous media; Unsteady state, semi-steady state fluid flow equations, diffusivity equation. Solution techniques.

Module 3 (10 hours)
Pressure-transient tests: pressure draw-down, build-up test, interpretations; skin factor.

Module 4 (8 hours)
Multi-rate test, Reservoir limit test, Injection and fall-off test, interference testing, pulse testing.

Module 5 (10 hours)
Type curves: generation and interpretation. Gas well testing, fractured wells, dual porosity reservoirs.

Suggested Text / Reference Books:

1. Mathews, C.S. &Russel, D.G.(1986).*Pressure buildup and flow tests in wells*. Society of petroleum engineers.
2. Lee, J.A. (2014).*Gas Reservoir Engineering Wattenbarger*. Society of petroleum engineers.
3. Robert, C.(2020).*Advances in Well Testing*. Society of petroleum engineers.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	2	1	1	2	2	1	1	1	1	-	1	1	1	1
CO3	1	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	1	1	1	2	-	1	1	1	1	1	1
CO5	2	1	1	2	1	1	2	1	1	2	2	1	2	2	1
Average	1.2	1.6	1	1.8	1.2	1.2	1.4	1.6	1	1.2	1.5	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Petrochemical Technology
Course Code: B106601
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Outline the applications of hydrocarbons in various industries such as fertilizer, power generation, petrochemicals etc
CO2	Study manufacturing of fertilizers such as ammonia and urea.
CO3	Understand polymerization and their properties, applications and production technologies.
CO4	Acquire knowledge about the higher hydrocarbons and aromatics
CO5	Learn about the classification and production of synthetic detergents.

Course Content

Part - A

Module 1: 2 hrs
Introduction- Application of various components of Hydro Carbon, Major Industrial Application- Fertilizer, Power generation, Petrochemicals, Sponge iron, glass Industry, Ceramic Industry

Module 2: 4hrs
Gas For Fertilizer Plant- use of Methane; Reforming of Methane; shift Conversion of Synthesis gas; Air Separation (Making Oxygen and Nitrogen); Ammonia Synthesis.

Module 3: 6hrs
Urea Reaction in presence of Catalyst; G as for Petrochemicals - Use of Ethane; Cracking of Ethane to Ethylene.

Module 4: 10hrs
Polymerization; Properties, applications and production technologies of the following commodity polymers - Polyethylene, LLDPE, HDPE, polypropylene, polystyrene, PVC; Propane cracking; Market for polymers and application of polymer

Part – B

Module 5: 8hrs
C_3, C_4 and higher hydrocarbons C_3derivatives: Propane, propylene, Isopropyl alcohol, Acetone, Propylene oxide, Propylene glycol, Acrylonitrile, Acrylic acid C_4 derivatives: Butane, Butylene, Butylene oxide-glycol, Acetic acid from butane Higher Hydrocarbon derivatives: Separation of paraffins (Wax cracking)

Module 6: 8hrs
Petroleum Aromatics BTX Production:Naptha reforming, Paraxylene from Naptha Benzene derivatives: Phenol, Aniline, Benzoic acid , Styrene, Maleic anhydride. Toluene derivatives: Caprolactum, DMT, Terephalic acid, Phthalic anhydride. Xylene derivatives: Cumene, Naphthalene

Module 7: 10hrs
Dyes and pigments: Classification and production Synthetic Detergents: Classification, Manufacture of sulfonates -Keryl Benzene sulfonates (Surf)

Suggested Text / Reference Books:

1. Chaudhary, U. R.(2011).*Fundamentals of petroleum and petrochemical engineering(1st Edition)* CRC Press.
2. Mall, I. D.(2007).*Petrochemical processes technology* Macmillan india.
3. Maiti, S ,(1992). *Introduction to petrochemical*. Oxford & IBH Publishing Company .
4. Rao, B. K. B (2009)*Modern Petroleum refining processes (5th Edition).*Oxford & IBH Publishing Company.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	2	1	1	2	2	1	1	1	1	-	1	1	1	1
CO3	1	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	1	1	1	2	-	1	1	1	1	1	1
CO5	2	1	1	2	1	1	2	1	1	2	2	1	2	2	1
Average	1.2	1.6	1	1.8	1.2	1.2	1.4	1.6	1	1.2	1.5	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Enhanced Oil Recovery
Course Code: 106806
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study principles and Mechanism of terms related to oil recovery.
CO2	Know about water flooding and properties.
CO3	Understand various chemical flooding and their applications.
CO4	Study miscible displacement processes and their application.
CO5	Understand thermal recovery processes and their applications.

Course Content

Module 1 (6 hours)
Principles and Mechanism. Screening criteria, macroscopic displacement of fluids: Areal sweep efficiency. Vertical sweep efficiency Displacement efficiency, mobility ratio, well spacing.

Module 2 (8 hours)
Water flooding in reservoir: Equation of motion. Continuity, solution methods, Pattern flooding, recovery etc., permeability heterogeneity.

Module 3 (10 hours)
Chemical flooding: Polymer flood; mobility control in-situ permeability modification, foam flooding; WAG process. Surfactant flooding, miscellar/polymer flooding, micro emulation phase behavior, wettability modification, Alkaline flooding.

Module 4 (8 hours)
Miscible displacement processes – miscibility condition, high pressure gas injection, enriched gas injection, LPG flooding, carbon dioxide flooding, alcohol flooding.

Module 5 (8 hours)
Thermal Recovery processes: Hot water flooding, steam flooding, cyclic steam injection, in-situ combustion, air requirement; combustion front monitoring, microbial oil recovery.

Suggested Text / Reference Books:

1. Bradley, H. B.(1992).*Petroleum Engineering Handbook(3rd Edition)* Society of Petroleum Engineers.
2. Lake L.(1989).*Enhanced Oil Recovery*. Prentice Hall.
3. Green, D. W. &Willhite, G. P.(2018).Enhanced *Oil Recovery(3rd Edition).*Society of Petroleum Engineers.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	2	1	1	2	2	1	1	1	1	-	1	1	1	1
CO3	1	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	1	1	1	2	-	1	1	1	1	1	1
CO5	2	1	1	2	1	1	2	1	1	2	2	1	2	2	1
Average	1.2	1.6	1	1.8	1.2	1.2	1.4	1.6	1	1.2	1.5	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Well Logging
Course Code: 106807
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study about different well logging methods and role of mud logging in formation evaluation
CO2	Understand the borehole environment and its effect on log measurement.
CO3	Acquire knowledge about the different open hole well log and its principle, and application in reservoir characterization
CO4	Study advanced logging method
CO5	Know about different production logging tools and their application.

Course Content

Module 1:
Aims and objectives of well logging. Reservoir formations. Borehole conditions. Fundamental concepts in borehole geophysics physical properties of reservoir rocks. Formation parameters and their relationships: formation factor, porosity, permeability, resistivity, water and hydrocarbon saturations, and movable oil. Archie's and Humbles equations. [9]

Module 2:
Principles, instrumentation, operational procedures and applications of different geophysical logs: S.P., electrical, induction, nuclear, sonic, caliper, temperature, dip and direction. Natural gamma ray spectrometry log, nuclear magnetic log, litho density log, neutron activation technique, thermal neutron decay time log, chlorine and oxygen logs. [9]

Module 3:
Recording, transmission and processing of log data. Formation evaluation for hydrocarbons. Qualitative and quantitative interpretations of well log data. Overlays and cross-plots. Determination of reservoir parameters – porosity, resistivity, permeability, water and hydrocarbon saturation, movable oil. Lithology determination by neutron, density and sonic cross-plots, dual mineral method, triporosity method, litho porosity cross-plot (M-N plot), clean sand and shaly sand interpretations. [9]

Module 4:
Sub-surface correlation and mapping from log data. Delineation of fractures from logs. Production logging. Well logging for metallic and non-metallic minerals: radioactive and non-radioactive evaporates, coal, sulphur. Borehole geophysics for groundwater exploration. Effective pay thickness of an aquifer. Saline water-fresh water interface from log data. Determination of groundwater flow direction by logs. [9]

Module 5:
Theoretical computations of normal and lateral log responses. Identification and delineation of sub-surface formations from well log data. Calculation of reservoir parameters: formation factor, porosity, permeability, resistivity, water and hydrocarbon saturations, and movable oil. Subsurface correlation of formations and interpretation of field data. [9]

Suggested Text / Reference Books:

1. William, C.L., Gary, C.P.(2004).*Standard Handbook of petroleum and Natural Gas Engineering(2nd Edition)* Gulf Professional Publishing.
2.Helander, D.P.(1983).*Fundamentals Of Formation Evaluation*. Oil and gas consultants.
3. Dewan, J.T.(1983).*Essentials of Modern Open-Hole Log Interpretation'*.Pen Well Books.
4. Serra.O(1984).*Fundamentals of Well log Interpretation*. Elsevier Science Publisher.

New York.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	2	1	1	2	2	1	1	1	1	-	1	1	1	1
CO3	1	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	1	1	1	2	-	1	1	1	1	1	1
CO5	2	1	1	2	1	1	2	1	1	2	2	1	2	2	1
Average	1.2	1.6	1	1.8	1.2	1.2	1.4	1.6	1	1.2	1.5	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Non-Conventional Petroleum Resources
Course Code: 106808
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study Introduction and present status of coal bed methane
CO2	Acquire basic knowledge about hydro-fracturing of coal bed methane seam and its operation.
CO3	Study status of gas hydrates and knowledge of formation and properties of gas hydrates.
CO4	Understand formation, properties and drilling of shale gas.
CO5	Acquire knowledge about gas hydrates accumulation in porous media. Gas extraction from gas hydrates

Course Content

Module 1 (10 hours)
Introduction and present status of coal bed methane. Formation and properties of coal bed methane. Thermodynamics of coal bed methane. Drilling, completion and logging of coal bed methane wells.

Module 2 (8 hours)
Hydro-fracturing of coal bed methane seam. Production, installation and surface facilities. Well operation and production equipments. Treating and disposing produced water. Testing of coal bed methane wells.

Module 3 (10 hours)
Introduction and present status of gas hydrates. Formation and properties of gas hydrates. Thermodynamics of gas hydrates. Phase behavior of gas hydrates. Kinetics of gas hydrates. Drilling and completion of gas hydrates wells. Prevention and control of gas hydrates.

Module 4 (6 hours)
Gas hydrates accumulation in porous media. Gas extraction from gas hydrates. Uses and applications of gas hydrates.

Module 5 (8 hours)
Introduction and present status of shale gas. Formation and properties of shale gas. Drilling and completion of shale gas. Uses and applications of shale gas. Prevention and control of shale gas. Environmental issues in shale gas exploration. Future prospects of shale gas

Suggested Text / Reference Books:

1. Mavor, M. , Nelson C. R.(2011).*Coal Bed Reservoir Gas –in Place Analysis*. Nelson, Gas Research
Institute.
2. Saulsberry.J. L. & Paul, S.A (1996).*Guide to Coal Bed Methane Reservoir Engineering*.Gas Research Institute.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	2	1	1	2	2	1	1	1	1	-	1	1	1	1
CO3	1	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	1	1	1	2	-	1	1	1	1	1	1
CO5	2	1	1	2	1	1	2	1	1	2	2	1	2	2	1
Average	1.2	1.6	1	1.8	1.2	1.2	1.4	1.6	1	1.2	1.5	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Process Modeling and Simulation
Course Code: B106702
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study the concept of mathematical modeling and its analysis.
CO2	Understand the various laws for solution of mathematical modeling.
CO3	Compose mathematical models of typical chemical engineering systems such as reactors, columns, heat exchangers etc.
CO4	Acquire knowledge about simulation of chemical engineering problems involving lesser number of equations and variables.

Course Content

Module 1: Introduction 2 hrs
Definition of mathematical model, lumped parameter models, distributed parameter models, uses of mathematical models, scope of coverage, principles of formulation.

Module 2: Fundamental laws 14 hrs
Continuity equations, energy equations, equation of motion, equations of state, equilibrium, chemical kinetics.

Module 3: Mathematical Models for Chemical Engineering Systems 16 hrs
Series of isothermal constant holdup CSTRs, CSTRs with variable holdups, Two heated tanks, Non-isothermal CSTR, Single component vaporizer, Batch reactor, Ideal binary distillation column, Batch distillation with holdup, pH systems, Lumped parameter model of gas absorber, Model foe heat exchanger, Model for interacting & non-intracting tanks, Model for biochemical reaction.

Module 4: Simulation 16 hrs
Meaning of simulation, Simulation examples of isothermal CSTR, non-isothermal CSTR. Batch reactor.

Suggested Text / Reference Books:

1. Luyben, W.L. (1990). *Process Modeling Simulation and Control for Chemical Engineers.* McGraw Hill.
2. Rose, L.M. (1974). *The Application of Mathematical Modelling to Process Development and Design(1st Edition).*Applied Science Publisher Limited.
3. Bequette. (2003*). Process Dynamics- Modelling, Analysis and Simulation*. PHI.
4. Rase, H.F. (1997). *Chemical Reactor Design for Process Plants (Vol II, 1st Edition).* Case Studies and Design Data. John Wiley.
5. Morton, D.M. (1986). *Process Modelling(1st Edition).* Longman Publisher.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	2	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	3	2	1	1	1	-	-	1	1	1	1
CO3	3	1	1	2	3	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	2	3	1	1	2	-	2	1	1	1	1	1
Average	2.25	1.75	1	1.75	2.75	1.2	1.2	1.75	1	1.4	1	1	1	1	1.5

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Membrane Separation Processes
Course Code: 106809
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand the industrial chemical processes and mechanism of separation.
CO2	Study the membrane separation phenomena.
CO3	Learn about the adsorption process and its applications.
CO4	Know about the ion exchange process and its applications.
CO5	Outline the chromatography process and its applications.

Course Content

Module 1: Overview of membrane science and technology:
Classification of membrane and membrane based processes, Advantages of membrane processes, Membrane materials.

Module 2: Preparation and characterization of membranes:
Fundamental theory and application of membrane processes, Membrane modules, General method of membrane manufacture.

Module 3: Different membrane processes:
Reverse osmosis, Microfiltration, Ultra-filtration, Nano -filtration, Electro-dialysis, Dialysis, Per-evaporation, Gas separation, Membrane distillation, Liquid membrane technology, Transport through membrane, Membrane reactor, Membrane chromatography. Application of membranes: Application of membranes in bio-separation, Bio-catalytic membrane reactors, Biomedical application of membranes.

Suggested Text / Reference Books:

1. Seader, J.D. & Henley, E.J. (2006). *Separation Processes Principles*. John Wiley.
2. Rousseau, R.W. (1987). *Handbook of Separation Process Technology*. Wiley-Interscience.
3. Strathmann, H. (2004). *Ion-Exchange Membrane Separation Processes*. Elsevier Science.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	2	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	2	2	1	1	2	-	1	1	1	1	1	1
CO5	1	1	1	2	1	1	2	1	1	1	1	1	1	2	1
Average	1.2	1.6	1	1.8	1.4	1.2	1.4	1.4	1	1	1	1	1	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course name: Transport Phenomena
Course Code: B106603
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand transport of momentum, heat and mass.
CO2	Use shell energy balance and shell mass balance for solving specific problems of transport of momentum.
CO3	Acquire knowledge about fluid flow differential equations.
CO4	Study Inter phase transport.
CO5	Understand the analysis and analogies of momentum, heat and mass transfer.

Course Content

Module 1: Review 8 hrs

Transport of momentum, heat and mass by molecular motion-Newton's law of Viscosity, Fourier's law of heat conduction, Fick's law of diffusion.

Module 2: Transport properties 10 hrs

Viscosity, thermal conductivity and mass diffusivity. Emphasis on the analogy between momentum, heat and mass transfer with respect to transport mechanism and governing equations.

Module 3:
Development of mathematical models of transfer process by shell momentum balance 12 hrs

Shell energy balance and shell mass balance for solving specific problems of transport of momentum, heat and mass in laminar flow or in solids in one dimension.

Module 4: Development of general differential equations of fluid flow 8 hrs

Heat transfer and mass transfer and their applications in solving one-dimensional steady state and unsteady state problems of momentum, heat and mass transfer.

Module 5: Interphase transport 5 hrs

Interphase transport of Momentum, heat and mass and dimensionless correlations for each one of them.

Module 6: Transport Analysis 5 hrs

Momentum, heat and mass transfer analysis and analogies

Suggested Text / Reference Books:

1. Bird R.B., Stewart, W.E., & Lightfoot, E.N. (2005). *Transport Phenomena*. JohnWiley.
2. Geankoplis, C.J. (2003). *Transport Processes and Separation Process Principles (Includes Module Operations)(4th Edition)*. Prentice Hall.
3. Weity, J.R., Wilson, R.E., & Wicks, C.E. (2001). *Fundamentals of Momentum Heat and Mass Transfer(4th Edition)*. John Wiley.
4. Bennett, C.O. &Myres, J.E. (1982). *Momentum Heat and Mass Transfer(3rd Edition)*. McGraw Hill.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	1	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	2	2	1	2	2	-	1	2	-	1	1	2
CO4	2	2	1	2	2	1	1	2	2	2	1	1	1	1	1
CO5	2	1	2	2	2	1	2	1	1	1	1	2	2	2	1
Average	1.8	1.4	1.2	1.8	1.8	1.2	1.4	1.6	1.2	1.2	1.4	1.2	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course name: Reservoir Modeling & Simulation
Course Code: 106810
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Acquire knowledge about various model types
CO2	Study model equations and interpretation of data
CO3	Know about solution techniques, Analytical and numerical methods
CO4	Know about Stability criteria, iterative methods, IMPES & IMPIS methods
CO5	Acquire basic knowledge about Compositional simulation, Miscible displacement

Course Content

Module 1
(6hrs)
Model types: Physical, analog and mathematical. Single-phase, multi-phase in one, two and three dimension mathematical model for reservoir fluid flow. Grid blocks and Grid orientation.

Module 2 **(6 hrs)**
Model Equations: Black oil and composition models. Pseudo functions. Data Preparation: Rock, fluid, mechanical, production and validation.

Module 3 **(10 hrs)**
Solution Techniques: Analytical and numerical methods, explicit and implicit methods of discretization, finite-difference and finite element method, linearization, solution of simultaneous equations.

Module 4
(8hrs)
Stability criteria, Iterative methods, IMPES & IMPIS methods. Numerical dispersion. Grid and time step size selection. History matching: Manual and automated system Reservoir performance using simulation approach.

Module 5 **(10 hrs)**
Simulating special processes: Compositional simulation, Miscible displacement, chemical and polymer flooding, thermal recovery processes.

Suggested Text / Reference Books:

1. Ertenim, T., Abou-kassem, J.H. & King, G.R.(1992). *Basic Applied Reservoir Simulation*.
2. FanchiR. (1997).*Principles of Applied Reservoir Simulation*. Gulf Publication.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	1	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	2	2	1	2	2	-	1	2	-	1	1	2
CO4	2	2	1	2	2	1	1	2	2	2	1	1	1	1	1
CO5	2	1	2	2	2	1	2	1	1	1	1	2	2	2	1
Average	1.8	1.4	1.2	1.8	1.8	1.2	1.4	1.6	1.2	1.2	1.4	1.2	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course name: Pipeline Engineering
Course Code: 106811
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study theory and different formulae of the flow of fluids in oil / gas pipelines
CO2	Understand construction of pipelines, materials, project specifications, general equipment specifications.
CO3	Apply application of corrosion protection and control techniques
CO4	Know about hydrates, wax & scale - formation and prevention.
CO5	Acquire knowledge about city distribution network of oil / gas.

Course Content

Module 1: Objective and scope of pipeline as a means of fluid transportation with special reference to crude oil/gas/refined products, Economics of Pipeline transportation.
Module 2: Design of Pipeline: Factors influencing oil, gas and refined products as pipeline design; Hydraulic surge and water hammer; specific heat of liquids; river crossing; pipe size and station spacing etc.
Module 3: Theory and different formulae of the flow of fluids in oil/gas pipelines; basic equations for the flow of fluids through pipes; different flow equations for laminar and turbulent flow of compressible and incompressible fluids (Newtonian); Introduction to the flow of Non- Newtonian fluids through pipes; multiphase flow and loop pipelines.
Module 4: Construction of pipelines; materials; project specifications, general equipment specifications.
Module 5: Corrosion protection and Control; Design of cathodic protection system, Pipeline automation. Module 6: Offshore Pipeline: Design and control of Sag and Overbend; Description of stinger; and Riser, articulated stinger, construction of offshore pipeline.
Module 7: Hydrates, wax & scale - formation and prevention. Crude conditioning and use of additives to improve flow conditions.
Module 8: City distribution network of oil/gas. Lease and custody transfer.

Suggested Text / Reference Books:

1.Nayyar, M.L.(1992).*Piping Handbook(6th Edition).* Mc Graw-Hill.
2. Johan J. M.(1992) .*Piping Design Handbook(1st Edition).*CRCPress.
3. Luyben, W. L.(1989*). Process Modeling Simulation and Control for Chemical Engineers (2nd Edition).* Mc Graw Hill.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	1	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	1	1	1	2	-	2	1	1	1	1	1
CO5	1	1	1	2	1	1	2	1	1	1	1	2	2	2	1
Average	1.4	1.4	1	1.4	1.2	1.2	1.4	1.6	1	1.2	1	1.2	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Directional Drilling
Course Code: 106812
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand directional coordinates and techniques
CO2	Understand Three dimensional geometry of directional well profiles
CO3	Ability to check the profile of the progressive well and to correct the deflected well path
CO4	Acquireknowledge of well monitoring without interrupting the drilling progress
CO5	GainAwareness of different bottom drive drilling systems and their applications

Course Content

Module 1 (6 hrs)
Objectives, Types of deflection tools, tool orientation, Directional well profiles, Well path deflection & correction.

Module 2 (8hrs)
Positive displacement motors and Turbo-drills - motor description, Power calculation and applications.
Auto-track and verti-track system. Rotary Steerable motors, Geo-steering tools.

Module 3 (8hrs)
Horizontal well objectives and selection, Different profiles, Drilling techniques, Mud requirements & characteristics, casing and drill string requirements and completion programs.

Module 4 (8 hrs)
Slant Hole Drilling: Objectives and selections, Well profiles and applications. Down the Hole Well Surveying: Well surveying objectives, surveying methods, Surveying Analysis methods and calculations for well coordinates.

Module 5 (10 hrs)
Objectives of MWD/ LWD, MWD tools, Telemetry system and data interpretation. Directional Drilling Problems and Their Remedies.

Suggested Text / Reference Books:

1. Schlumberger. (2013).*Introduction to Directional Drilling* .
2. Neal J.A. (1985).*Drilling Engineering-A complete well planning approach*. Penn Well publishing Company Tulsa Okhlama.
3. Rabia, H. (2017).*Well Engineering and Construction.*

The mapping of PO/PSO/CO attainment is as follows:

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

Average	1.6	1.4	1	1.4	1.2	1.2	1.4	1.6	1	1.2	1	1.2	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Polymer Technology
Course Code: 106813
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Acquire knowledge about various types of Polymers, rubbers and elastomers, their characteristics and synthesis
CO2	Study the concept of polymerization methods and structure- property relationships of polymers.
CO3	Compare various processing & manufacturing techniques of polymers and their testing.
CO4	Acquire knowledge about various types of polymer with structure
CO5	Know about molecular weight of polymer

Course Content

Module 1 (6 hrs)
Introduction to polymer science, Classification of polymer structure Molecular weight, Chemical structure & Thermal transition.

Module 2 (8 hrs)
The synthesis of high polymers Step-growth polymerization. Chain growth polymerization. Polymerization techniques, Reactions of synthetic polymers, special topics in polymer, synthesis, Chemical structure determination.

Module 3 (10hrs)
Solution & solid-state properties, Viscosity & Rubber elasticity.

Module 4 (6hrs)
Degradation, stability & environmental issues, polymer additives, blends & composites.

Module 5 (8hrs)
Commodity thermoplastics &fibers, elastomers, thermosets, engineering &speciality polymers.

Suggested Text / Reference Books:

1. Sinha, R. (2002).*Outlines of Polymer Technology*.
2.Ghosh, P.(2001).*Polymer Science and Technology*. Tata McGraw Hill.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	1	1	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	2	1	1	2	-	2	1	1	1	1	1
CO5	1	1	1	2	1	1	2	1	1	1	1	2	2	2	1
Average	1.4	1.4	1	1.4	1.2	1.2	1.4	1.6	1	1.2	1	1.2	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Modern Separation Processes
Course Code: B106705
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand the industrial chemical processes and mechanism of separation.
CO2	Acquire knowledge about the membrane separation phenomena.
CO3	Study the adsorption process and its applications.
CO4	Acquire basic knowledge about the ion exchange process and its applications.
CO5	Know about the chromatography process and its applications.

Course Content

Module 1: Separation Processes (5 hours)

Industrial chemical processes, Mechanism of separation, separation power, selection of feasible separation processes.

Module 2: Membrane Separations (12 hours)

Membrane Materials, Membrane Modules, Transport in Membranes – Porous Membranes, Bulk Flow, Liquid Diffusion in Pores, Gas Diffusion, Nonporous Membranes, Solution-Diffusion for Liquid Mixtures, Solution-Diffusion for Gas Mixtures, Module Flow Patterns, Cascades, External Mass-Transfer Resistances, Concentration Polarization and Fouling.

Dialysis and Electrodialysis, Reverse Osmosis, Gas Permeation, Pervaporation, Ultrafiltration, Microfiltration.

Module 3: Adsorption, Ion Exchange, and Chromatography (15 hours)

Sorbents: Adsorbents, Ion Exchangers, Sorbents for Chromatography

Equilibrium Considerations: Pure Gas Adsorption, Liquid Adsorption, Ion Exchange Equilibria, Equilibria in Chromatography

Kinetic and Transport Considerations: External Transport, Internal Transport, Mass Transfer in Ion Exchange and Chromatography

Sorption Systems: Adsorption, Ion Exchange, Chromatography, Slurry Adsorption (Contact Filtration), Fixed-Bed Adsorption (Percolation), Thermal-Swing Adsorption, Pressure-Swing Adsorption, Continuous, Countercurrent Adsorption Systems, Simulated-Moving-Bed Systems, Ion-Exchange Cycle, Chromatographic Separations

Suggested Text / Reference Books:

1. Seader, J.D. & Henley, E.J. (2006). *Separation Processes Principles*. John Wiley.
2. Rousseau, R.W. (1987). *Handbook of Separation Process Technology*.Wiley-Interscience.
3. Strathmann, H. (2004). *Ion-Exchange Membrane Separation Processes*. Elsevier Science.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	1	1	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	2	1	1	2	-	2	1	1	1	1	1
CO5	1	1	1	2	1	1	2	1	1	1	1	2	2	2	1
Average	1.4	1.4	1	1.4	1.2	1.2	1.4	1.6	1	1.2	1	1.2	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Optimization Techniques
Course Code: B106706
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study optimization problem and interpret the results of a model and present the insights.
CO2	Understand about the engineering applications of optimization.
CO3	Know about optimization of a given single variable, constrained and unconstrained problems using various optimization techniques.
CO4	Optimize a given multivariable, constrained and unconstrained problems using various optimization techniques.
CO5	Solve linear programming problem.

Course Content

Module 1: Introduction: (5 hrs)
Engineering application of optimization, Design variables, constraints, objective function, variable bounds, statement and formulation of an optimization problem, Examples of chemical engineering Optimization problems, Classification of optimization problems, different optimization algorithms. Optimal Point: Local optimal point, global optimal point and inflection point.

Module 2: Single variable Optimization Techniques: (12 hrs)
1. Optimality criterion.
2. Bracketing method (Bounding phase method).
3. Region elimination methods (Internal halving method, Fibonacci search method, Golden section search method).
4. Point estimation method (Successive quadratic estimation methods).
5. Gradient-based methods (Newton-Raphson method, Bisection method, Secant, Cubic search method.)
6. Root finding using optimization techniques.

Module 3: Multivariable Optimization Techniques: (12 hrs)
1. Optimality criterion – Hessian Matrix and its use in optimization
2. Unidirectional search method.
3. Direct search method (Evolutionary method, Hooke-Jeeves Pattern Search method, Powell's conjugate direction method)
4. Gradient-based methods (Steepest descent method, Newton's method, Marquardt's methods)

Module 4: Constrained Optimization Algorithms: (12 hrs)
1. Kuhn - Tucker conditions and Transformation method (penalty function method)
2. Direct search for constrained minimization (variable elimination method, complex search method)

Module 5: Linear Programming: (7 hrs)
Linear programming problems, Degeneracy, Simplex method of linear programming, dual phase simplex method.

Suggested Text / Reference Books:

1. Deb, K. (2005). *Optimization for Engineering, Design Algorithms and Examples*. Prentice Hall of India.
2. Edgar, T.I., Himmelblau, D.M., &Lasdon L.S. (2001). *Optimization of Chemical Processes*. McGraw Hill.
3. Rao, S.S. (2009). *Engineering Optimization Theory and Practice(4th Edition).*John Wiley.
4. Ray, W.H. and Szekely, J. (1973). *Process Optimization with Applications to Metallurgy & Chemical Engineering*. Wiley Interscience.
5. Beveridge, S.G. and Schechter R.S. (1973). *Optimization: Theory & Practice.* McGraw Hill.
6. Grewal, B.S. (1991). *Numerical Methods in Engineering and Science*. Khanna Publishers.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	2	2	1	1	2	1	1	-	1	1	1	2
CO2	3	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	3	1	1	2	3	1	2	2	-	1	-	-	1	1	2
CO4	3	2	1	2	2	1	1	2	-	1	1	1	1	1	1
CO5	2	1	1	2	2	1	2	1	1	2	2	2	2	2	1
Average	2.6	1.6	1	1.8	2.2	1.2	1.4	1.6	1	1.25	1.5	1.25	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Energy Engineering
Course Code: B106708
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Know about the various conventional solid fossil fuels energy resources and their effective utilization.
CO2	Study naturally occurring petroleum and its products upon refining and their commercial applications.
CO3	Acquire knowledge about various naturally occurring and synthesized gaseous fuels and efficient utilization.
CO4	Know about various types of liquid and gaseous fuel burners and applying combustion principles for solution of problems based upon combustion.
CO5	Study the energy demand, energy crisis and identify available nonconventional (renewable) energy resources and techniques to utilize them effectively.

Course Content

Module 1: Introduction: 2 hrs
Energy crisis in the world and position in India

Module 2: Conventional Sources of Energy:

Solid Fuels: 10 hrs
Principal solid fuel-coal, origin, composition and classification of coal, origin, composition and classification of coals, analysis and properties of coal, characteristics and distribution of Indian coals, coal preparation, Storage of coal, coal carbonization, briquetting, gasification and liquefaction of solid fuels.

Liquid Fuels: 12 hrs
Petroleum and Related Products:
Introduction: Origin, occurrence and reserves, reserves, Production and consumption, classification and characteristics of Petroleum properties and characteristics, petroleum refining in India.
Refining Unit Processes: Cracking, thermal cracking, catalytic cracking, hydrocraking, reforming thermal and catalytic reforming, alkylation, and polymerization, Isomerization.
Petroleum Products - Naphtha, motor gasoline, aviation gasoline, kerosene, diesel oil, gas oils, fuel oils, lubricants, petroleum waxes, Petroleum coke.

Gaseous Fuels: 6hrs
Types, natural gas, methane from coal mines, producer, water carburettor, water, coal, blast furnace and refinery gases, gases from biomass, LPG, gasification of coal and oil, purification of gaseous fuels.

Module 3: Combustion Process and Appliances: 6 hrs
Nature and types of combustion processes, mechanism of combustion reaction, spontaneous ignition temperature, gas and oil burners, coal burning equipments, fluidized bed combustion.

Module 4: Furnaces: General classification and description of different types of furnaces with special reference to furnaces used in ceramic, petroleum and pharmaceutical industries.

Module 5: Non- Conventional Sources of Energy: 12hrs

Nuclear energy: - Nuclear reactions, fuel materials, moderators and structural materials, reactors Energy by bio-processes-bio-gas Solar Energy - Photovoltaic cells, solar collectors, wind, tidal and geothermal energy, biofuels.

Suggested Text / Reference Books:

1. Samir Sarkar. (2003). *Fuels and Combustion (2nd Edition).*Orient Longman.
2. Gupta, O.P. (1997). *Elements of Fuels, Furnaces and Refractories.* Khanna Publications.
3. Wilson, P.J. & Wells, G.H. (1950). *Coal, Coke and Coal Chemicals*. McGraw Hill.
4. Griswold, J. Fuels. (2006). *Combustion and Furnaces*. McGraw Hill.
5. Francis, W. & Peters M.C. (1980). *Fuels and Fuel Technology: A Summarized Manual(2nd Edition).*Pergarmon Press.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	2	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	2	2	1	1	2	-	1	1	1	1	1	1
CO5	1	1	1	2	1	1	2	1	1	2	2	2	1	2	1
Average	1.4	1.6	1	1.8	1.4	1.2	1.2	1.6	1	1.25	1.5	1.25	1	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Petroleum Engineering System Design
Course Code: B106709
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Compare and select well and rig profile.
CO2	Learn the design of cementing operation for drilling.
CO3	Understand the specification of optimum separation process.
CO4	Study sucker-rod pumping production system.
CO5	Know about sucker rod pumping system and gas lift production system.

Course Content

Module 1: 8 hrs
Choice of well profile: drill string and casing design. Rig choice for load and installed power for a drill well.

Module 2: 10 hrs
Design of cementing operation for a drilling. Specification of casing head and well head system.

Module 3: 12 hrs
Specification of optimum separation process and system for a given type of oil production.

Module 4: 10 hrs
Design of sucker-rod pumping production system.

Module 5: 8 hrs
Design of gas-lift production system for continuous and intermittent gas-lift systems.

Suggested Text / Reference Books:

1. Golan, M. & Whitson, H.C. (1991).*Well Performance (2nd Edition).*Prentice Hall.
2. Beggs, D.H. (2008).*Production Optimization Using Nodal Analysis(1st Edition)*. Oil & Gas Consultants International andPetroskills publications.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	3	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	2	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	2	2	1	1	2	-	1	1	1	1	1	1
CO5	1	1	1	2	1	1	2	1	1	2	2	2	1	2	1
Average	1.6	1.6	1.4	1.8	1.4	1.2	1.2	1.6	1	1.25	1.5	1.25	1	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Process Plant Design
Course Code: B106710
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study the mechanical design of process equipment.
CO2	List the various design parameters of process equipment.
CO3	Understand pressure vessels such as thin or thick walled, under pressure and load.
CO4	Design of heads and closures, supports.

Course Content

Module 1. Mechanical Design of Process Equipment: Introduction, Classification of pressure vessels, pressure vessel codes and standards, Fundamental Principles and equations review. (5 hours)

Module 2. Design Considerations: Design Pressure, Design Temperature, Materials of construction, Weld joint efficiency, corrosion allowance, Design loads. (5 hours)

Module3. Design of thin walled vessels under Internal Pressure: Cylindrical and spherical vessels. (5 hours)

Module 4. Design of heads and closures – design of flat head, conical head, dished heads, hemispherical and elliptical heads. (5 hours)

Module 5. Design of thick walled vessels under Internal Pressure. (5 hours)

Module 6. Design of Vessels subject to External Pressure: Cylindrical & spherical vessels, Stiffening rings, vessel heads. (5 hours)

Module 7. Design of vessels under combined loading: Dead Weight, wind load. (5 hours)

Module 8. Design of supports: Skirt support, lug support. (5 hours)

Suggested Text / Reference Books:

1. Brownell, L.E. & Young, E.H. (1959). *Process Equipment Design*. Wiley Interscience.
2. Bhattacharya, R.C. (1985). *An Introduction to Chemical Equipment Design- Mechanical Aspects (1st Edition)*CBS Publication.
3. Mahajani V.V. &Umarji S.B. (2009). *Joshi's Process Equipment Design (4th Edition)*. Macmillan Indian Ltd.

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	3	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	3	2	1	1	2	2	-	1	1	-	1	1	2
CO4	2	2	3	2	2	1	1	2	-	2	1	1	2	2	1
Average	2	1.75	3	1.75	1.5	1.5	1.5	1.4	1	1.4	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Plant Utilities
Course Code: 106814
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understandvarious sources of water and their treatment, cooling water and various fuels.
CO2	Draw Flow diagram for demineralization of water, ion and cation exchanger
CO3	Acquire knowledge about steam generation and its distribution.
CO4	Know about classification of fuels, solid (coal), liquid and gaseous fuel and their properties.
CO5	Acquire knowledge of various utility equipment of plant.

Course Content

Module 1. Water (08 hrs)
Sources of water, Types of water, Raw water and treated water – Soft water and DM water, Quality of water (temporary and permanent hardness), COD, BOD, PH, TDS, Treatment of water – filtration and bleaching, Storage of water

Module 2. Demineralization of Water (10 hrs)
Flow diagram for demineralization of water, ion and cation exchanger, regeneration of ion & cation exchanger, degasser, reaction with resins (cation and anion resins)

Module 3. Steam Generation (10 hrs)
Saturated and superheated steam, quality of steam, simple numericals related to the enthalpy changes using steam tables and mollier diagrams, non-condensables in steam.

Module 4. Fuels (06 hrs)
Classification of fuels, solid (coal), liquid and gaseous fuel and their properties.

Module 5. Steam Distribution (04 hrs)
Specification of steam pipe, layout of piping, steam trap, steam ejectors

Module 6. Cooling water (10 hrs)
Cooling towers, recycling of water, principles, details of problems like scaling, use of inhibitors like sodium hexameta phosphate, sodium triphosphate etc.
Types of cooling towers-induced draught, forced draught.

Module 7. Utility Equipment (16 hrs)
- Boilers: Coalfired, oil fired, Babcox, water tubes and fire tube - Cochran, Lancashire,
- Compressors: Centrifuge, reciprocating
- Blowers: Centrifuge, reciprocating
- Refrigeration, absorption, compression and vapor compression.

Suggested Text / Reference Books:

1.Jain, P.C. (2004).*Engineering Chemistry.*
3.Timmerhaus, P. (2017).*Plant Economics(5th Edition).*McGraw Hill Publication.
4.Ludvig, E.(1964).*Applied Process Design for Chemical and Petrochemical Plants(4th Edition).*Gulf Publishing, Houston.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	1	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	1	1	1	2	1	-	1	-	-	1	1	2
CO4	2	2	1	1	2	1	1	2	-	1	1	1	1	1	1
CO5	1	1	1	2	1	1	2	1	1	2	1	1	2	2	1
Average	1.4	1.2	1	1.4	1.4	1.2	1.4	1.4	1	1.25	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course name: Coal Bed Methane and Gas Hydrates
Course Code: 106815
Semester: Professional Elective Course

Credits: 04 **L T P**
40 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Know about formation and properties of coal bed methane. Present status of coal bed methane
CO2	Know hydro-fracturing of coal, seam activation of well
CO3	Acquire knowledge about drilling and completion of gas hydrate wells. Prevention & control of gas hydrates. Gas hydrates accumulation in porous medium
CO4	Know about gas hydrates accumulation in porous medium. Gas extraction from gas hydrates.
CO5	Understand the uses and application of coal bed methane and gas hydrates.

Course Content

Module 1:
Formation and properties of coal bed methane. Present status of coal bed methane. Formation and properties of coal bed methane. Exploration & Evaluation of coal bed methane. Drilling, completion and logging of coal bed methane wells. Hydro-fracturing of coal, seam activation of well. Testing of coal bed methane wells.

Module 2:
Introduction and present status of gas hydrates. Formation and properties of gas hydrates. Exploration and evaluation of gas hydrates.

Module 3:
Drilling and completion of gas hydrate wells. Prevention & control of gas hydrates. Gas hydrates accumulation in porous medium. Gas extraction from gas hydrates. Uses and application of gas hydrates.

Suggested Text / Reference Books:

1. John, C.(2003). *Natural Gas Hydrates. A guide for engineers(3rd Edition)*.Gulf Publications.
2. Ali, F., Jones, S. A. &Meldau R. F.(1997).*Practical Heavy Oil Recovery*.SPE.
3. Downey, M. W., Morgan, W. A. &Threet, J. C. (2001).*Petroleum Provinces of Twenty First Century*. American Association of Petroleum Geologists.
4. Warner, H.R. (2007).*Emerging and Peripheral Technologies(6th Edition)*.Petroleum Engineering Handbook.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	1	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	1	-	1	-	-	1	1	2
CO4	2	2	1	1	2	1	1	2	-	1	1	1	1	1	1
CO5	1	1	1	2	1	1	2	1	1	2	1	1	2	2	1
Average	1.4	1.2	1	1.4	1.4	1.2	1.4	1.4	1	1.25	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Name: Oil & Gas Marketing and Resource Management
Course Code: 106816
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Know about formation and properties of coal bed methaneand present status of coal bed methane
CO2	Understand hydro-fracturing of coal, seam activation of well
CO3	Acquire knowledge about drilling and completion of gas hydrate wells. Prevention & control of gas hydrates. Gas hydrates accumulation in porous medium
CO4	Know about gas hydrates accumulation in porous medium. Gas extraction from gas hydrates.
CO5	Understand the uses and applications of coal bed methane and gas hydrates.

Course Content

Module I. Introduction: The development of Oil & Gas Industry, Structure of Oil & Gas Industry, Introduction to Indian Oil & Gas Industry, India hydrocarbon vision 2050. Petroleum resource classification, Analysis of resource management. [8]

Module II. Natural Gas: What is Natural Gas, Measuring Natural Gas, Pipeline quality Natural Gas. Demand, Supply & Storage of Natural Gas: Gas Production, Sources of demand in India, Supply system, Pipeline operations & network, Storage of Natural Gas, Liquified Natural Gas Plant & Operations, Gas Scale pattern in India, Gas regulations in India, Gas trading, gas pricing. [8]

Module III. Coal Bed Methane: Introduction, Present status of Coal Bed Methane, CBM storage and scale, CBM pricing in India. Crude Oil: Crude oil specification, measuring/Custody transfer of crude Oil, Crude Oil transportation, Crude Oil production in Indi, Crude Oil Refineries, products from Crude Oil. [8]

Module IV. International & National Institutions of Oil & Gas: OPEC, OECD, OIDB, DGH, PNGRB, CHT, PII, PPAC, PCRA. Petroleum Contracts: NEPL- Role & Background, Types of Contracts and fiscal components, production sharing contracts in India, Crude Oil trading and pricing, CBM Contracts and Shale Gas Contracts. [8]

Module V. Trade practices & Taxation: Norms on various trade practices, Element of Petroleum Development Policy, Financial and taxation issues. Risk Management: Source of risk, managing risks by risk reduction, diversification, and uncertainty and decision analysis by decision tree. [8]

Suggested Text / Reference Books:

1.Werner,S.(2016). *Managing Human Resources in the Oil & Gas.* PennWell Corp.
2. Colombano, A.(2017).*Petroleum Refining & Marketing.*

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	1	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	1	-	1	-	-	1	1	2
CO4	1	2	1	1	2	1	1	2	-	1	1	1	1	1	1
CO5	1	1	1	2	1	1	2	1	1	2	1	1	2	2	1
Average	1.4	1.2	1	1.4	1.4	1.2	1.4	1.4	1	1.25	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Chemical Technology
Course Code: 106817
Semester: Professional Elective Course

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Know about Extraction of oils, Hydrogenation of oils.
CO2	Acquire knowledge about types of pulp and manufacture of paper.
CO3	Acquire knowledge about manufacture of Soda ash by Solvay process and modified Solvay process.
CO4	Know about types of Portland cement, manufacture of Portland cement.
CO5	Understand manufacture of ammonia and urea.

Course Content

Module1. Oils and Fats (08 hrs)
Introduction, Extraction of oils, Hydrogenation of oils.

Module 2. Sugar (08 hrs)
Introduction, Juice extraction, defacation, concentration, refining

Module3. Paper &Pulp (06 hrs)
Introduction, Criteria for getting good quality paper, Types of pulp and Manufacture of paper by fourdrinier machine

Module4. Sulphuric Acid (06 hrs)
Introduction, Grades of sulphuric acid, Manufacture of sulphuric acid by contact process.

Module5. Soda Ash Industry (06 hrs)
Manufacture of Soda ash by Solvay process and Modified Solvay process.

Module 6. Glass (04 hrs)
Introduction, Different types of glasses, raw materials required by glass industry, Manufacture of glass.

Module 7. Cement Industry (04 hrs)
Types of Portland cement, Manufacture of Portland cement.

Module 8. Fertilizer Industry (08 hrs)
Introduction, NPK, Manufacture of ammonia and urea, superphosphate and triple super phospate, mixed fertilizers, complex and compound fertilizers.

Module 9. Polymer Industry (08 hrs)
Definition of polymerisation, Types of polymerization, Manufacture of polyethylene, polyvinylchloride, semi-synthetic polymers and synthetic polymers.

Module 10. Industrial Gases (06 hrs)
Manufacture of Carbon-dioxide, Nitrogen and Oxygen.

Suggested Text / Reference Books:

1. Waddams, A.L. (1980). *Chemicals from Petroleum(4th Edition)*. Gulf Publishing Company.
2. Lewis, F.H. &Matar, S. (1981). *From Hydrocarbon to Petrochemicals*. Gulf Publishing Co.
3. Rao, B.K.B. (1998). *A Text on Petrochemicals(2nd Edition)*.Khanna Publishers.
4. Mall, I.D. (2007). *Petrochemical Process Technology*. Macmillan India Limited.
5. Lowenheim, F.A. & Moran, M.K. (1975). *IndustrialChemicals(4th Edition)*. John Wile.
6.Shreeve, T.A. (2017).*Chemical process Technology (5th Edition)*.Mc Graw Hill Publication.
7.Dryden,(2005).*Outlines of Chemical Technology* .East west press publication.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	1	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	1	1	1	2	1	-	1	-	-	1	1	2
CO4	2	2	1	1	1	1	1	2	-	1	1	1	1	1	1
CO5	1	1	1	2	1	1	2	1	1	2	1	1	2	2	1
Average	1.2	1.2	1	1.4	1.2	1.2	1.4	1.4	1	1.25	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Web Designing and Development
Course Code: A102702
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand web theory to basic programming techniques.
CO2	Use fundamental skills to maintain web server services required to host a website.
CO3	Use scripting languages and web services to transfer data and add interactive components to web pages.
CO4	Create and manipulate web media objects using editing software
CO5	Learn the language of the , HTML, CSS

Course Content

Module 1:

Introduction to HTML: HTML Common tags- List, Tables, images, forms, Frames; Cascading Style sheets; Introduction to JavaScript: Scripts, Objects in Java Script, Dynamic HTML with Java Script XML: Document type definition, XML Schemas, Document Object model, Presenting XML, Using XML Processors: DOM and SAX

Module 2:

Java Beans: Introduction to Java Beans, Advantages of Java Beans, BDK Introspection, Using Bound properties, Bean Info Interface, Constrained properties Persistence, Customizes, Java Beans API, Introduction to EJB's Web Servers and Servlets: Tomcat web server, Introduction to Servelets: Lifecycle of a Serverlet, JSDK, The Servelet API, The javax.servelet Package, Reading Servelet parameters, and Reading Initialization parameters. The javax.servelet HTTP package, Handling Http Request & Responses, Using Cookies-Session Tracking, Security Issues

Module 3:

Introduction to JSP: The Problem with Servelet. The Anatomy of a JSP Page, JSP Processing. JSP Application Design with MVC Setting Up and JSP Environment: Installing the Java Software Development Kit, Tomcat Server & Testing Tomcat

JSP Application Development: Generating Dynamic Content, Using Scripting Elements Implicit JSP Objects, Conditional Processing – Displaying Values Using an Expression to Set an Attribute, Declaring Variables and Methods Error Handling and Debugging Sharing Data between JSP pages, Requests, and Users Passing Control and Date between Pages – Sharing Session and Application Data – Memory Usage Considerations

Module 4:

Database Access: Database Programming using JDBC, Studying Javax.sql.* package, Accessing a Database from a JSP Page, Application – Specific Database Actions, Deploying JAVA Beans in a JSP Page, Introduction to struts framework. One android application development

Suggested Text / Reference Books:

1.Bates C. (2000). *Web Programming. building internet applications(3rd Edition)*.WILEY Dreamtech.

2.Naughton,P. &Schildt, H. (1999) .*The complete Reference Java 2(3rd Edition)*.Osborne Publisging.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	1	1	1	2	2	1	1	1	-	-	1	1	1	1
CO3	3	1	1	1	2	1	2	1	-	1	-	-	1	1	2
CO4	2	2	1	1	1	1	1	2	-	1	1	1	1	1	1
CO5	2	1	1	2	1	1	2	1	1	2	1	1	2	2	1
Average	2.2	1.2	1	1.4	1.4	1.2	1.4	1.4	1	1.25	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

Course name: Computer Aided Design
Course Code: 105939
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Attain knowledge in art and design analysis, follow social and technological developments and propose contemporary approach to new research subjects.
CO2	Interrelate and interpret the past, today and future of design.
CO3	Think and express themselves in two and three dimensions.
CO4	Know basic concepts of visual realization, hidden line removal.
CO5	Acquire knowledge about process planning, tool path generation and verification, Design and Enggapplications.

Course Content

Module1: Introduction
Overview of conventional design & manufacturing process, computer's role in design, benefits of computer application, relation of CAD with CAM, history of CAD development, current trends in CAD.

Module2: CAD Hardware & Software
Central processing unit, memory, input & output devices, types of computer systems, computer programming, general information of various software for CAD, types of file formats & their exchange, graphics standards**.**

Module3: Geometric Modeling
Curve representation methods, surface representation methods, half spaces, boundary representation (B-rep), sweep representation, constructive solid geometry (CGS), solid manipulations, modeling facilities desired.

Module4: Transformations
Translation, rotation, scaling symmetry, reflection, homogeneous transformations, orthographic projections, axonometric projections, oblique projections, perspective transformation.

Module 5: VisualRealization
Basicconceptsofvisualrealization,hiddenlineremoval,hiddensurfaceremoval,shadingsurfacesandsolids visibility techniques, sorting coherence, hidden line removal for curved surface.

Module 6: CADandCAMintegration
Introduction, part production cycle, manufacturing system, process, integration requirements, process planning, tool path generation and verification, Design and Engg. applications.

Module7: Introductionto ReverseEngineeringand Rapid Prototyping

Module 8: Introduction to Design and Engineering Applications
Geometry and mass property formulations.
Practice on Drafting and Modeling systems: Basic geometric commands, layers, display control commands, editing, dimensioning, solid modeling on available CAD packages.

Suggested Readings / Reference Books:

1. Groover&Zimmer.(2003).*CAD/CAM(1st Edition)*.PrenticeHall.
2. Zeid,I.(2019).*CAD/CAM.TheoryandPractice(2nd Edition)*.McGrawHill.
3. Mortenson,M.E. (2006).*GeometricModeling.*

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	1	2	1	2	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	1	2	1	2	1	-	1	-	-	1	1	2
CO4	2	2	1	1	1	1	1	2	-	1	1	1	1	1	1
CO5	2	1	2	2	1	1	2	1	1	2	1	1	2	2	1
Average	1.8	1.2	1.6	1.4	1.4	1.2	1.4	1.4	1	1.25	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation.

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Course name: Operation Research
Course Code: A105804
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study the role of operations research in decision-making, and its applications in industry and formulate and design real-world problems through models & experiments
CO2	Know about various types of deterministic models like linear programming, transportation model etc.
CO3	Acquire knowledge about various types of stochastic models like waiting line model, project line model, simulation etc.
CO4	Compare the relationship between a linear program and its dual and perform sensitivity analysis.
CO5	Understand different decision making environments and apply decision making process in the real world situations.

Course Content

Module 1: Introduction:
Origin & development of OR and its role in solving industrial problems: General approach for solving OR problems. Nature and characteristic feature of OR. Use and limitation of OR. Classification of mathematical models:

Module 2: Deterministic Models:
Formulation of deterministic linear mathematical models : Graphical and simplex techniques for solution of linear programming problems, Big M method and two phase method, Introduction to duality theory and sensitivity analysis : transportation models, test for optimality, degeneracy in transportation. Assignment problems (Hungarian method) travelling salesman problems, and sequencing models; Introduction to goal programming; Solution techniques of linear goal programming problems.

Module 3: Probabilistic Models:
Decision making: various decision making environments. Maximum and minimum models; Introduction to decision tree. Game theory: Solution of simple two person zero-sum games: Examples of simple competitive situation.

Module 4: Simulation:
Concept general approach and application. Use of Monte-Carlo simulation technique to queuing and inventory problems.

Module 5: Dynamic Programming:
Introduction to deterministic and probabilistic dynamic programming. Solution of simple problems. Advantages of dynamic

Module 6: Queuing theory:
Types of queuing situation: Queuing models with Poisson's input and exponential service, their application to simple situations.

Module 7: Replacement Models :
Replacement of items that deteriorate, Replacement of items whose maintenance and repair costs increase with time, replacement of items that fail suddenly; replacement of items whose maintenance costs increase with time and value of money also changes, individual replacement policy, group replacement policy.

Module 8: Inventory models:
Classification of inventory control models: Inventory models with deterministic demand, inventory models with probabilistic demand, and inventory models with price breaks. Advantages and disadvantage of inventory

Module 9: Network models:

PERT & CPM introduction, analysis of time bound project situations, construction of net works, identification of critical path, slack and floats, crashing of network for cost reduction, resource leveling and smoothening.

Suggested Text / Reference Books:

1. Wagner,H.M.(1980).*Principles of Operations Research(2nd Edition)*. Prentice Hall.
2. Gupta,P.K. &Hira,D.S.(1976).*Operations Research.(5th Edition)*.S. Chand & Co.
3. Taha.(1919).*Introduction to Operation Research(10 th Edition)*.Pearson Education.
4.Hiller, F.S. &Liberman,G.I.(2017).*Introduction to Operation Research(10th Edition)*.Holden Ray.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	2	2	1	1	2	1	1	-	1	1	1	2
CO2	2	2	2	1	2	2	1	1	1	-	-	1	1	1	1
CO3	2	1	2	1	2	1	2	2	-	1	-	-	1	1	2
CO4	3	2	2	1	2	1	1	2	1	2	1	1	2	1	1
CO5	2	1	1	2	2	1	2	1	2	1	1	1	1	2	1
Average	2.2	1.4	1.6	1.4	2	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course name: Organizational Behavior
Course Code: A102405
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, the students willbe ableto:

CO	Statement
CO1	Study the complexities associated with management of individual behavior in the organization.
CO2	Compare different models used to explain individual behavior related to motivation and rewards.
CO3	Identify various dimensions of personality. Job satisfaction, Perception and learning.
CO4	Study group dynamics and demonstrate skills required for working in groups.
CO5	Identify the various leadership styles and the roles of the leaders in decision making process.

Course Content

Module-I

Organizational Behavior: What managers do, Definition of OB, contributing disciplines to OB, challenges and opportunities for OB. Foundations of Individual behavior- biographical characteristics, ability, and learning. Values, Attitudes, Personality and Emotions, Perception

Module-II

Motivation: Concept, Theories of Maslow, Herzberg, mcclelland, Porter & Lawler Model, Application of Motivation Concept. Job Satisfaction Foundations of Group Behaviour: Group formation, development and structure, Group Processes, Group Decision- making Techniques, Work Teams.

Module-III

Interpersonal Skill-Transactional analysis, Life Positions, Johari Window. Leadership: Concept, theories, styles and their application. Power and Politics in Organization

Conflict Management, Stress Management, Crisis Management, Organizational Change & Development, Innovation, Creating a learning Organization, Organizational Culture, Organizational Effectiveness.

Suggested Text / Reference Books:

1. Nelson, D. L &Quick,J.C.(2000*).OrganisationalBehavior(3rd Edition)*.Thomson Learning.
2. Pareek, U.(2004).*Understanding OrganisationalBehaviour.(2nd Edition)*.Oxford University Press. New Delhi.
3. Robbins, S.P.(2018).*OrganisationalBehaviour(18th Edition)*. Prentice Hall of India.New Delhi.
4. Hellgiegel, D. &SlocumJ.W.(2010).*OrganisationalBehaviour*.Thomson Learning.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	1	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
Average	1.4	1.4	1.6	1.4	1.6	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course name: Mobile Application and Development
Course Code: A102513
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Install and configure Android application development tools.
CO2	Design and develop user Interfaces for the Android platform.
CO3	Save state information across important operating system events.
CO4	Apply Java programming concepts to Android application development.
CO5	Know about apple IOS development, Android development, Shell Development,

Course Content

Module1. Introduction: Mobile operating system, Operating system structure, Constraints and Restrictions, Hardware configuration with mobile operating system, Features: Multitasking Scheduling, Memory Allocation, File System Interface, Keypad Interface, I/O Interface, Protection and Security, Multimedia features.

Module 2: Introduction to Mobile development IDE's, Introduction to Work light basics, Optimization, pages and fragments , Writing a basic program- in Work light Studio, Client technologies, Client side debugging, Creating adapters, Invoking adapters from Work light Client application, Common Controls, Using Java in adapters, Programming exercise with Skins, Understanding Apache Cordova, Offline access, Encrypted cache deprecated, Using JSON Store

Module 3: Understanding Apple iOS development, Android development, Shell Development, Creating Java ME application, Exploring the Work light Server, Working with UI frameworks, Authentication, Push notification, SMS Notifications, Globalization, Web View overlay , Creating Authentication application: development for Apple iOS by using a login module, Device Analytics, Work light Server Administration

Module 4. Android: Introduction to Android, Architecture, memory management, communication protocols, application development methods, deployment. Case Study: Design and development of Application using mobile application development platforms e.g. Work Light, Kendo, Appcon, Xcode, Xpages Unit VI: iOS: Introduction to iOS, Architecture, memory management, communication protocols, application development methods, deployment. Case Study: Design and development of Application using mobile application development platforms e.g. Work Light, Kendo, Appcon, Xcode, Xpages

Suggested Text / Reference Books:

1. Lee,H.(2012). *Eugene ChuvyrovBeginningWindowsPhone App Development*.
2. Schiller,J.*MobileCommunications (2nd Edition).* Addison-Wesley.
3. Stojmenovic&Cacute.(2002).*Handbook of Wireless Networks and Mobile Computing*. Wiley.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	2	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	1	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
Average	1.8	1.4	1.2	1.4	1.2	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course name: Management Information System
Course Code: A105920
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Relate the basic concepts and technologies used in the field of management information systems.
CO2	Compare the processes of developing and implementing information systems.
CO3	Outline the role of the ethical, social, and security issues of information systems.
CO4	Translate the role of information systems in organizations, the strategic management processes, with the implications for the management.
CO5	Acquire knowledge about Phases in Decision making process,

Course Content

Module 1: INTRODUCTION
Organization and management, Management classification and Functions, Organizational structure, scalar point, span of control, Unity of command. Organizational systems, Open and Closed system, Application of systems concept to an organization, Information system, characteristics of MIS.

Module 2: INFORMATION SYSTEM AND CONTROL:
Definition of information, Components of Information system, Evolution of Information systems Technology – The First generation, The Second generation, The Third generation, The fourth generation and Information systems today, Computer Hardware, A sample program, Data Representation, File processing and database processing. Case studies. Enterprise Information systems – Applications and goals. Information system control.

Module 3: DECISION MAKING:
Phases in Decision making process, Behavioral models of decision maker classical Economic model, Administrative Model. Methods for decisions among alternatives, optimization techniques, pay off matrices, decision trees, Utility and Inference curves, statistical Technologies, Mini case studies.

Module 4: DECISION SUPPORT SYSTEMS:
Characteristic of DSS, classes of DSS, Expert system cases, computer based decision support system, developing and implementing application system
- life cycle approach, [prototyping approach, Quality assurance and evaluation of Information systems. Future development and Impact of Information Technology on organization and Society.

Suggested Text / Reference Books:

1.Mudrick, Ross &Clagget.(1987).*Information systems for Modern Management* .Prentice Hall.
2.Davis&Olson.(1984). *Management Information systems(2nd Edition)*.McGraw Hill.
3.Kroenke&Hatch.(2016).*Management Information System*.Mitchell.
4.StevenAlter.(2003).*Information System(4th Edition).* Pearson Education.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	2	2	1	1	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	1	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
Average	1.8	1.4	1.2	1.4	1.2	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course name: Human Resource Management
Course Code: A102602
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Contribute to the development, implementation, and evaluation of employee recruitment, selection, and retention plans and processes.
CO2	Administer and contribute to the design and evaluation of the performance management program.
CO3	Develop, implement, and evaluate employee orientation, training, and development programs.
CO4	Facilitate and support effective employee and labor relations in both non-union and union environments.
CO5	Research and support the development and communication of the organization's total compensation plan.

Course Content

MODULE-1: Introduction: Meaning, scope, objectives and importance of Human Resource Management, Personnel Management, its functions, policies & roles, organizing the Human Resource Management department in the organization, Human Resource Management practices in India, HR audit.
Procurement and Placement: Need for Human Resource Planning; Process of Human Resource Planning; Methods of Recruitment; Psychological tests and interviewing, Meaning and Importance of Placement and Induction, Employment Exchanges (Compulsory Notification of vacancies) Act 1959, The Contract Labor (Regulation & Abolition) Act 1970.
MODULE-2: Training & Development: Principles of Training and Development; Difference between Training and Development; Promotion: Promotion-Merit v/s seniority wise; Performance Appraisal, Career Development & Planning.
Job analysis & Design: Job Analysis and its Principle: Job Specification & Job Description, Difference between Job Specification Job Description
Job Satisfaction: Meaning, objectives and importance Job satisfaction;
MODULE-3: Motivation: Factors affecting motivation, Motivation Theory: Maslow‟s Motivation Theory, Hertzberg Hygiene Theory; Workers ' Participation in the organization, Quality of work life.
Bonus and Incentives: Meaning, objectives and importance of Bonus and Incentives.
The Wage Act and Compensation Function: Basic concepts in wage administration, company‟s wage policy, Issues in wage administration, Payment of Wages Act-1936, Minimum Wages Act-1961.
MODULE-4: Integration and Human Relation: Meaning, objectives and importance of Integration in industry. Human Relations and Industrial Relations; Difference between Human. Relations and Industrial Relations, Factors required for good Human Relation Policy in Industry;
Employees Grievances: Employee Employer relationship Causes and Effects of Industrial disputes;, Administration of Discipline, Absenteeism, Labor Turnover, Changing face of the Indian work force and their environment, Importance of collective Bargaining; Role of trade unions in maintaining cordial Industrial Relations.

MODULE-5: Welfare of Employees: Welfare of Employees and its Importance; Fringe & retirement terminal benefits, administration of welfare amenities, Meaning and Importance of Employee Safety, Accidents-Causes & their Prevention, Safety Previsions under the Factories Act 1948;, Social security, Family Pension Scheme, ESI act 1948, Future challenges for Human Resource Management

Suggested Text / Reference Books:

1. Chhabra,T.N.(2014). *Human Resource Management(1st Edition)*.Dhanpat Rai & Co.
2. Flippo,L.B. Flippo, (1961).*Principles of personnel Management(2nd Edition).* Mc Graw-Hill.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	1	2	2	1	1	2	1	1	1	-	-	1	1	1	1
CO3	1	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	1	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
Average	1.2	1.4	1.2	1.4	1.2	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course name: Data ware Housing & Data Mining
Course Code: 102617
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand the functionality of the various data mining and data warehousing component.
CO2	Study the strengths and limitations of various data mining and data warehousing models.
CO3	List the analyzing techniques of various data.
CO4	Acquire knowledge about different methodologies used in data mining and data ware housing.
CO5	Compare different approaches of data ware housing and data mining with various technologies.

Course Content

Module 1: Need for strategic information, difference between operational and Informational data stores Data warehouse definition, characteristics, Data warehouse role and structure, OLAP Operations, Data mart, Different between data mart and data warehouse, Approaches to build a data warehouse, Building a data warehouse, Metadata & its types.

Module 2: Data Pre-processing: Need, Data Summarization, Methods. Denormalization, Multidimensional data model, Schemas for multidimensional data (Star schema, Snowflake Schema, Fact Constellation Schema, Difference between different schemas.Data warehouse architecture, OLAP servers, Indexing OLAP Data, OLAP query processing, Data cube computation

Module 3: Data Mining: Definition, Data Mining process, Data mining methodology, Data mining tasks, Mining various Data types & issues. Attribute-Oriented Induction, Association rule mining, Frequent itemset mining, The Apriori Algorithm, Mining multilevel association rules.]

Module 4: Overview of classification, Classification process, Decision tree, Decision Tree Induction, Attribute Selection Measures. Overview of classifier's accuracy, Evaluating classifier's accuracy, Techniques for accuracy estimation, Increasing the accuracy of classifier. Introduction to Clustering, Types of clusters, Clustering methods, Data visualization & various data visualization tools

Suggested Text / Reference Books:

1.Berson, (1997).*Data Warehousing, Data Mining &Olap by Berson*.TataMcgraw- Hill.
2. Han J., Kamber M. and Pei J.(2007).*Data mining concepts and techniques(3rd Edition)*. Morgan Kaufmann Publishers.
3. Pudi V., Krishana P.R.(2009). *Data Mining Oxford University press.*
4. Adriaans P., Zantinge D.(1996).*Data mining*.Pearson education press
5. Pooniah P.(2001) *Data Warehousing Fundamentals*.WilleyinterscienceePublication.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	2	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	1	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
Average	1.8	1.4	1.2	1.4	1.2	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course name: Computer Network
Course Code: 102611
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Discuss the fundamental concepts of computer networking
CO2	Acquire knowledge about the basic terminology of the computer networking area.
CO3	Study advanced networking concepts, preparing the student for entry Advanced courses in computer networking.
CO4	Acquire knowledge about basic computer network technology.
CO5	Identify the different types of network topologies and protocols.

Course Content

Module 1: Data Communication Components
Representation of data and its flow Networks, Various Connection Topology, Protocols and Standards, OSI model, Transmission Media, LAN: Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN, Techniques for Bandwidth utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts on spread spectrum.

Module 2: Data Link Layer and Medium Access Sub Layer
Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols -Pure ALOHA, Slotted ALOHA, CSMA/CDCDMA/CA

Module 3: Network Layer
Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols.

Module 4: Transport Layer
Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm

Module 5: Application Layer
Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts of Crypto graphy.

Suggested Text / Reference Books:

1.Forouzan,B.A.(2000).*Data Communication and Networking(4th Edition*). McGraw-Hill.
2.Stallings,W.(2017).*Data and Computer Communication(10th Edition).* Pearson PrenticeHall India.
3. Tanenbaum,A.S.(2013).*Computer Networks(5th Edition).*Pearson New International Edition.
4.Stevens,W. R. Stevens.(2011).*TCP/IP Illustrated(2nd Edition).* Pearson Education India.

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CO1	2	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	2	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	1	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
Average	1.8	1.4	1.2	1.4	1.2	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Refrigeration and Air Conditioning
Course Code: A105605
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand the air refrigeration, vapour compression refrigeration, different types of refrigerants, vapour absorption and steam jet refrigeration system.
CO2	Know about the working of single stage, multistage and cascade refrigeration.
CO3	Evaluate cooling and heating load and design of HVAC system.
CO4	Develop and design RAC system and evaluate different expansion and control devices and air-conditioning systems.
CO5	Apply the knowledge of psychrometry to various psychro metric processes.

Course Content

Module 1: Basic Concept:
Natural and Mechanical refrigeration, Application of Refrigeration, Units of refrigeration and Coefficient of performance, Refrigeration effect, cooling capacity and COP of a refrigerator, Heating effect, Heating capacity and COP as heat pump, Reversed Carnot cycle and its limitations

Module 2: Bell Coleman Cycle and Aircraft Refrigeration:
Bell Coleman Cycle and its analysis, optimum COP and pressure ratio, Necessity of air craft refrigeration - air cycle refrigeration systems and their comparison.

Module 3: Vapour Compression Refrigeration Cycle:
Vapour compression cycle on P-V, P-H and T-S diagrams, Deviation of actual cycle from theoretical cycle, Compressor capacity and volumetric efficiency, Analysis of theoretical and actual vapour compression cycles, Effect of suction pressure, Discharge pressure, Subcooling, super heating and pressure drop in valves on performance and cooling capacity.

Module 4: Vapour Absorption Refrigeration Cycle (No Mathematical Analysis):
Principle of absorption system, components of the system, Desirable properties of absorption system refrigerant and absorbent, Aqua - ammonia absorption refrigeration system, Lithium Bromide - water absorption system, Theory of mixtures, temperature concentration and enthalpy concentration diagrams, Comparison between absorption and compression systems, Electrolux refrigeration system.

Module 5: Refrigerants:
Classification and nomenclature of refrigerants, Desirable thermodynamic, chemical and physical properties of refrigerants, Comparative study of commonly used refrigerants and their fields of application, Azeotropes, Effect of moisture and oil miscibility, Refrigerants dying agents and antifreeze solution, Leak detection and charging of refrigerants, Environmental aspects of conventional refrigerants, Ecofriendly refrigerants and action plan to reduce ecological hazards.

Module 6: Non - Conventional Refrigeration Systems (No Mathematical Analysis):
Steam Jet Refrigeration, Cascade Refrigeration System, Mixed Refrigeration Systems, Vortex Tube Refrigeration, Thermoelectric cooling, Linde and Claude cycles, Cryogenics and its engineering applications.

Module 7: Air Conditioning Concept and Applications:
Psychometric properties of air, Dry bulb, wet bulb and dew point temperatures, Relative and specific humidity, Degree of saturation adiabatic saturation temperature, Enthalpy of air and water vapours, Psychometric chart. Human requirement of comforts, Effective temperature and comfort charts, Industrial and comfort air conditioning.

Module 8: Psychometric Processes:
Sensible heating and cooling, Cooling with dehumidification, Heating with dehumidification, by-pass factor, chemical dehumidification, adiabatic mixing, air washer.

Module 9: Calculations for Air –conditioning Load and for Rate and state of Supply Air:
Sources of heat load, sensible and latent heat load, sensible heat factor, apparatus dew point temperature, Rate and state of supply - air for air- conditioning of different types of premises.

Module 10: Refrigeration Controls:
General aspects, Hand expansion valve, Automatic expansion valve, Thermostatic expansion valve, Capillary tube, Low side float, High side float, Solenoid valves.

Module 11: Measurement Instruments - Air Conditioning:
Measurement of humidity, Measurement of infiltration, Measurement of pressure, Measurement of air flow, Measurement of temperature.

Module 12: Application of Refrigeration and Air Conditioning:
Food preservation, Cold storage, Refrigeration method for trucks and trailors, Water coolers, Desrert cooler, Ice system of air conditioning, Air conditioning of theatres

Suggested Text / Reference Books:

1. Arora,C.P. (2017).*Refrigeration and Conditioning(3rd Edition)*.Tata McGraw Hill.
2. Prasad , M.(1985).*Refrigeration and Conditioning (3rd Edition)*.Wiley Eastern Limited.
3. Jordon &Priester.(1991).*Refrigeration and Conditioning*.Prentice Hall of India.
4. Stoecker,W.F.(1983).*Refrigeration and Conditioning(2nd Edition)*.McGraw Education.
5. Rajput, R.K.(2013).*Refrigeration and Conditioning*.Khanna Publications.

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CO1	2	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	2	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	1	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
Average	1.8	1.4	1.2	1.4	1.2	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name**: Non-conventional Energy Resources**
Course Code: A105902
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understandthe generation of electricity from various Non-Conventional sources of energy.
CO2	Estimate the solar energy, Utilization of it, Principles involved in solar energy collection and conversion of it to electricity generation.
CO3	Understandthe concepts involved in wind energy conversion system by studying its components, types and performance.
CO4	Acquire knowledge about ocean energy and the operational methods of their utilization.
CO5	Acquire the knowledge on Bio-mass, Tidal and Wave Energy, Geothermal energy.

Course Content

Module 1: Introduction **(4 hours)**
Renewable and non-renewable energy sources, their availability and growth in India: energy consumption as a measure of Nation, s Development: strategy for meeting the future energy requirements.

Unit-2: Solar Energy **(6hours)**
Solar radiations-beam and diffused radiations; earth sun angles, attenuation and measurement of solar radiations; Optical properties of materials and selective surfaces.

Unit-3: Solar Energy Equipments (8hours)
Principles, introduction to different types of collectors, flat plate, cylindrical and parabolic collectors; Solar energy storage systems-their types, characteristics and capacity; solar ponds. Application of solar energy in water, space and process heating, solar refrigerant and air conditioning; water desalination and water pumping; Solar thermal power generation; solar cells and batteries.

Unit-4: Wind Energy **(4hours)**
Principle of wind energy conservation; basic components of wind energy conversion systems; wind mill components, various types and their constructional features; wind data and site selection considerations.

Unit-5: Direct Energy Conversion Systems (6hours)
i) Magneto Hydrodynamic (MHD) Generators; Operating principle, types and working of different MHD system –their relative merits; MHD materials and production of magnetic fields ii) Thermo-Electric Generators; Thermo-electric effects and materials; thermoelectric devices and types of thermo-electric generators; thermo-electric refrigeration iii) Thermionic Generators; Thermionic emission and materials; working principle of thermionic convertors iv) Fuel Cell; Thermodynamic aspect; types, components and working of fuel cell. Performance, applications and economic aspects of above mentioned direct energy conversion systems.

Unit-6: Bio-Mass **(4hours)**
Concept of bio-mass conversion, photo-synthesis and bio-gasification; bio gas generators and plants, their types constructional features and functioning; fuel properties of bio gas and community bio gas plants.

Unit-7: Geothermal **(2 hours)**

Sources of geothermal energy types, constructional features and associated prime movers.

Unit-8: Tidal and Wave Energy (4hours)

Basic principles and components of tidal and wave energy plants; single basin and double basin tidal power plants; conversion devices, Advantages/disadvantages and applications of above mentioned energy systems.

Suggested Text / Reference Books:

1. Prakash,J.&Garg,H.P.(2017).*Solar Energy Fundamentals and Applications (1st Edition).*Tata McGraw-Hill.
2. Sukhatme,S.P. Solar Energy.(1984).*Principles of thermal collection & storage* .Tata McGraw- Hill.
3. Chang,D.B.(2013).*Solar Engineering of Thermal Process Energy conversion*.Prentice Hall.

The mapping of PO/PSO/CO attainment is as follows:

PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	2	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	2	2	1	1	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
Average	1.8	1.4	1.2	1.4	1.2	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Course Name: Solar Energy
Course Code: 105942
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Study solar constant, spectrum of sun, diurnal variation of direct sunlight
CO2	Understand the effect of Selective Absorber Surface, Selective Windows Facing Selective Surface
CO3	Acquire knowledge about speaking Effect of Back up Demands, Energy Storage, Hydro storage,
CO4	Understandvarious applications of solar energy.
CO5	Understand solar energy conversion to electricity.

Course Content

Module 1: Solar Flux and Weather Data: Introduction, Solar Constant, Spectrum of sun, Diurnal Variation of Direct Sunlight, Height variation of direct sunlight. Standard Atmosphere, Zenith Distance Flux Variation, Geographical distribution of sun-shine and effects of weather on Solar Flux. Introduction to solar Flux observation, Instruments such as pyranometer, Phyrheliometer and Sunshine Recorder, Correlation between direct and total Insulation, Solar flux variation dynamic, Correlation of sunshine with Wind Velocity, Environmental Thermal Infrared Flux and ETIR Model.

Module 2: Solar Availability: Introduction, Zenith Distance Vs time, Time of sunrise and sun-set fully Tracking collector, Variation of flux curves with latitude and geometry, Introduction to Fixed Flat plate (horizontal, latitude Tilted, fixed latitude + 15°, Vertical South-facing, Seasonally Tilted) N-S and horz, east west tracking and N-S polar east west tracking, East west horz and N-S tracking, Comparison of theoretical curves with observation, Comparison of daily output; Peak flux Vs Average flux,

Module 3. Heat Transfer in Solar Collectors: Introduction, Heat Losses in a Distributed Collector system. The Liquid Transfer Module System, Solar Heat Availability, Fluid Mechanics, Fluid Properties, Temperature Rise, Solar Flux, Pressure Drop Relations, Reynolds Number, Ratio of Power Expended to Power Generated, Magnitude of Power Output/Input Ratio, Parametric Relationships for Fluid Transfer, Variation of Output/Input Ratio with Solar Flux. Air-Transfer Systems.

Module 4: Flat-Plate Collectors: Introduction, Basic Collector Configurations, Diurnal Temperature, Profile, ThermalInertia U-Factor, Collector Heat Balances. Sample Calculation, Surface Temperature. Efficiency versus-Temperature Curves, General Properties of efficiency Vs Change and Temperature, The Bare Collector; Single –Window Collector, Double Window Collector Improvement of Performance, Geometrical Suppression of Convection, Window Temperature. Effect of Selective Absorber Surface, Selective Windows Facing Selective Surface Combination of Absorber and selective windows, Problems.

Module 5: Energy Storage: Introduction, Basic System Diagram, Peaking Effect of Back up Demands, Energy Storage, Hydro storage, Chemical Batteries, Flywheels, Chemical Storage, Compressed Air, Biological Storage, Thermal Storage, Sensible-Heat Storage, Latent-Heat Storage, Salt Eutectics, Zoned Thermal Storage Fluid Tank, Rock Thermal Storage Tank, Farm Thermal Storage Tank.

Module 6: Application of Solar Energy: (History and Survey Application) Community Heating & Cooling system, Solar Water pumping, solar gas absorption refrigeration, MEC Cooling system, Two stage evaporative cooling etc.

Module 7: Direct Conversion to Electricity: Introduction, Direct conversion by Means of Solar Cells, Silicon Cells, Manufacture of Silicon Cells, Ribbon Silicon Cells, Polycry silicon cells, Cadmiumsulfide Solar Cells, Manufacture of Cadmium Sulfide Cells Gallium Arsenide Solar Cells, Thermal Behaviors of Solar Cells Cooled Solar Cells for Concentrating System. Thermo-electric Solar Cells, Thermonic Solar Cells, Phase-Change Thermal Direct Conversion, Problems.

Suggested Text / Reference Books:

1.Meinel,A.B.&Meinel,M. P.(1976).*An Introduction to Applied Solar Energy*.Addison Wesley Educational Publishers.

2. Kreider,J. F.&KreithF. K. Kreith.(1981).*Hand Book of Solar Energy*.McGraw Hill.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	2	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
Average	1.4	1.4	1.2	1.4	1.2	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

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Course Name: Total Quality Management
Course Code: A105918
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Acquire knowledge about the dimensions of product quality or service quality for the same.
CO2	Understand the various philosophiesrelated to Quality Management.
CO3	Draw and justify the Pareto chart to prioritize the defects.
CO4	Know about the four levels of benchmarking and / or enlist and brief seven step benchmarking model.
CO5	Know about the advanced techniques of TQM

Course Content

Module 1: Quality and Total Quality Management, Excellence im manufacturing/service, factors of excellence, relevance of TQM. benefitsofTQM.
Module 2: Concept and definition of quality, total quality control (TQC) and Total Quality Management (TQM), salient features of TQC and TQM. Total Quality ManagementModels,
Module 3: Just-in-time (JIT): Definition: Elements, benefits, equipment layout for JIT system, Kanban system MRP (Material Requirement planning) vs JIT system, Waste elimination, workers involvement through JIT: JIT cause and effect chain, JIT implementation, Role of JIT in lean manufacturing.
Module 4: Customer Satisfaction: data collection and complaint, redressalmechanism.
Module 5: Planning Process: Policy development and implementation, plan formulation and implementation.
Module 6: Process Management: Factors affecting process management, Quality function development (QFD), and quality assurancesystem.
Module 7: Total Employees Involvement (TEI): Empowering employees: team building, quality circles, reward and Recognition, education and training, Suggestionschemes.
Module 8: Problems solving Defining problem, Problem identification and solving process, QCtools.
Module 9: Benchmarking definition, concept, process and types ofbenchmarking.
Module 10: Quality Systems: Concept of quality system standards: relevance and origin of ISO 9000, Benefits, Elements of ISO 9001, ISO 9002, ISO9003.
Module 11: Advanced techniques of TQM: Design of experiments: failure mode effect analysis: Taguchi methods

Suggested Text / Reference Books:

1. Raju,S.(2014).*Total Quality Management(1st Edition)*. Tata McgrawHill.
2. Zairi.M.(1991).*TQM for engineers (1st Edition)*.AdityaBooks.
3.Hradeskym, J.L.(2017).*Total Quality Management Handbook*.McGrawHill.
4. Dalela&Saurabh.(1999).*ISO 9000 quality System*.standardPublishers.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	2	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
Average	1.4	1.4	1.2	1.4	1.2	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

HYDROLOGY & WATER RESOURCES ENGINEERING
Course Code: A101403
Semester: Open Elective Group
Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand the interaction among various processes in the hydrologic cycle.
CO2	Calculate the average annual rainfall of any area using the rain gauge data and inter-relations of various parameters as infiltration, evapo transpiration etc
CO3	Learn the various component of hydro graphs and able to estimate the runoff.
CO4	Find the water requirement for different crops and able to proposed appropriate method of applying water.
CO5	Learn about the various components of irrigation systems.

Course Content:

Module I: Introduction - Hydrologic Cycle, History of Hydrology, Water-Budget Equation, , World Water Balance, Applications in Engineering, Sources of Data.
Precipitation - Forms of Precipitation, Characteristics of Precipitation in India, Measurement of Precipitation, Rain Gauge Network, Mean Precipitation over an Area, Depth Area-Duration Relationships, Maximum Intensity/Depth-Duration-Frequency Relationship, Probable Maximum Precipitation (PMP), Rainfall Data in India.
Module II: Abstractions from precipitation - Evaporation Process, Evaporimeters, Analytical Methods of Evaporation Estimation, Reservoir Evaporation and Methods for its Reduction, Evapotranspiration, Interception, Depression Storage, Infiltration, Infiltration Capacity, Measurement of Infiltration, Modelling Infiltration Capacity, Classification of Infiltration Capacities, Infiltration Indices.
Runoff - Runoff Volume, SCS-CN Method of estimating runoff volume, Flow Duration Curve, Flow-Mass Curve, Hydrograph, Factors Affecting Runoff Hydrograph, Components of Hydrograph, Base Flow Separation, Effective Rainfall, Unit Hydrograph Surface Water Resources of India, Environmental Flows.
Module III: Water withdrawals and uses – Water for Energy Production, Water for Agriculture, Water for Hydroelectric Generation; Flood Control. Analysis of Surface Water Supply, Water Requirement of Crops- Crops and Crop Seasons in India, Cropping Pattern, Duty And Delta; Quality of Irrigation Water; Soil-Water Relationships, Root Zone Soil Water, Infiltration, Consumptive use, Irrigation Requirement, Frequency of Irrigation; Methods of Applying Water to The Fields: Surface, Sub-Surface, Sprinkler and Trickle / Drip Irrigation.

Distribution systems - Canal Systems, Alignment of Canals, Canal Losses, Estimation of Design Discharge. Design of Channels- Rigid Boundary Channels, Alluvial Channels, Kennedy's and Lacey's Theory of Regime Channels. Canal Outlets: Non-Modular, Semi-Modular And Modular Outlets.

Module IV: Water Logging: Causes, Effects And Remedial Measures. Lining of Canals, Types of Lining. Drainage of Irrigated Lands: Necessity, Methods.

Damsandspillways-
embankmentdams:Classification,designconsiderations,estimationandcontrolofseepage, slopeprotection.Gravitydams:forcesongravitydams,causesoffailure,stressanalysis,elementaryandpractical profile. Arch and buttress dams. Spillways: components of spillways, types of gates for spillway crests; Reservoirs-Types,capacityofreservoirs,yieldofreservoir,reservoirregulation,sedimentation,economicheight of dam, selection of suitablesite.

Suggested Text / Reference Books:

1. Subramanya,.K. (1994). *Engineering Hydrology.* Mc-GrawHill.
2. Muthreja, K. N. (1987). *Applied Hydrology*. Tata Mc-GrawHill.
3. Subramanya, K.*(1990).Water Resources Engineering through Objective Questions*. Tata McGraw Hill.
4. Asawa, G. L. (2006).*Irrigation Engineering*. Wiley Eastern.
5. Mays, L.W. (2009).*Water Resources Engineering.* Wiley Eastern.

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	2	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
Average	1.4	1.4	1.2	1.4	1.2	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

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DISASTER PREPAREDNESS & PLANNING
Course Code: A101405
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	**Statement**
CO1	Identify various types of disasters, their causes, effects & mitigation measures.
CO2	Demonstrate the understanding of various phases of disaster management cycle and create vulnerability and risk maps.
CO3	Understand the use of emergency management system to tackle the problems.
CO4	Discuss the role of media, various agencies and organizations for effective disaster management.
CO5	Design early warning system and understand the utilization of advanced technologies in disaster management.

Course Content:

Module I: Introduction to Disaster Management: Define and describe disaster, hazard, vulnerability, risk-severity, frequency and details, capacity, impact, prevention, mitigation.
Disasters: Identify and describe the types of natural and manmade disasters, hazard and vulnerability profile of India, mountain and coastal areas, Factors affecting vulnerability such as impact of development projects and environment modifications (including dams, land-use changes, urbanization etc.), Disaster impacts (environmental, physical, social, ecological, economic etc.); health, psycho-social issues; demographic aspects (gender,age,special needs), Lessons and experiences from important disasters with specific reference to civil engineering.

Module II :Disaster Mitigation and Preparedness: Disaster Management Cycle-its phases; prevention, mitigation, preparedness, relief and recovery; structural and non structural measures; Preparedness for natural disasters in urban areas.
RiskAssessment:Assessmentofcapacity,vulnerabilityandrisk,vulnerabilityandriskmapping,stagesindisaster recoveryandassociatedproblems;UseofRemoteSensingSystems(RSS)andGISindisasterManagement,early warningsystems.

Module III : **Post disaster response**: Emergency medical and public health services; Environmental post disaster response (water, sanitation, food safety, waste management, disease control, security, communications); reconstruction and rehabilitation; Roles and responsibilities of government, community, local institutions, role of agencies like NDMA, SDMA and other

International agencies, organizational structure, role of insurance sector, DM act and NDMA guidelines.

Module IV: Integration of public policy: Planning and design of infrastructure for disaster management, Community based approach in disaster management, methods for effective dissemination of information, ecological and sustainable development models for disaster management.

Suggested Text / Reference Books:

1. www.http//ndma.gov.in
2. http://www.ndmindia.nic.in
3. Iyengar. (2006). *Natural Hazards in the Urban Habitat*. C.B.R.I., Tata McGraw Hill.
4. Natural Disaster management, Jon Ingleton (Ed), Published by Tudor Rose, Leicester92.
5. Singh, B.K. (2008). *Handbook of disaster management: Techniques & Guidelines.*RajatPublications.
6. Singh, R.B. (2006). *Disaster Management* .Rawat Publications
7. ESCAP: Asian and the Pacific Report on Natural Hazards and Natural DisasterReduction

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PO/PSO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	1	1	1	2	1	1	-	1	1	1	2
CO2	2	2	2	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
Average	1.4	1.4	1.2	1.4	1.2	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

UTILIZATION OF ELECTRICAL ENERGY AND TRACTION
Course Code: 103708
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand the applications of utilization of electrical heating
CO2	Learn about the various welding processes
CO3	Design indoor and outdoor illumination
CO4	Explain the applications of refrigeration and air conditioning
CO5	Explain the applications and utilization of electric traction.

Course Content:

Module 1: Electric Heating
Advantages and methods of electric heating, Resistance heating, Electric arc heating, Induction heating, Dielectric heating.

Module 2: Electric Welding
Electric Arc Welding, Electric Resistance welding, Electronic welding control.

Module 3: Electrolyte Process
Principles of electro deposition, Laws of electrolysis, applications of electrolysis.

Module 4: Illumination
Various definitions, Laws of illumination, requirements of good lighting, Design of indoor lighting and outdoor lighting systems.

Module 5: Refrigeration and Air Conditioning
Refrigeration systems, domestic refrigerator, water cooler, Types of air conditioning, Window air conditioner.

Module 6: Electric Traction –I
Types of electric traction, systems of track electrification Traction mechanics-types of services, speed time curve and its simplification, average and schedule Speeds Tractive effort, specific energy consumption, mechanics of train movement, coefficient of adhesion and its influence.

Module 7: Electric Traction –II
Salient features of traction drives, Series –parallel control of dc traction drives (bridge transition) and energy saving Power Electronic control of dc and ac traction drives, Diesel electric traction.

Suggested Text / Reference Books:

1. Partab, H. (1985). *Art and Science of Electrical Energy*. Dhanpat Rai & Sons, Delhi.
2. Partab. H. (1985). *Modern Electric Traction*. Dhanpat Rai & Sons, Delhi.
3. Wadhwa, C.L. (2018). *Generation, Distribution and Utilization of Electrical Energy*. New Age International Publications, Delhi.

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CO2	2	2	2	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
Average	1.4	1.4	1.2	1.4	1.2	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

POWER PLANT ENGINEERING
Course Code: 103616
Semester: Open Elective Group

Credits: 04 **L T P**
4 0 0

Course Outcomes: On successful completion of this course, students will be able to:

CO	Statement
CO1	Understand the basic operating principle of steam, hydro, nuclear and diesel power plants.
CO2	Select the appropriate site and essential features for setting up hydro plants.
CO3	Calculate the performance of gas turbine
CO4	Calculate the performance of diesel power plant
CO5	Understand the basics of pollution control methods.

Course Content

Module 1: Steam Generators, Condensers and Turbines:
Classification of steam generators, selection, operation of locomotive, Babcock Wilcox, Cochran boilers, Types of condensers, effect of air in condensers, Dalton's law of partial pressure, cooling water calculations, steam nozzles, types of steam turbine efficiencies, compounding, governing and control.

Module 2: Steam Power Plant:
Classification, Operation, Description of Rankine cycle, Regenerative cycle, Reheat-Regenerative Cycle, Binary Vapour Cycle, Selection of plant site and its layout, coal handling system, combustion system, Fluidized bed combustion, Ash handling, Feed pumps, Heat exchangers, Economizers, Super heaters, Reheaters, Air preheaters, Feed water heaters, Evaporators.

Module 3: Hydro-Electric Power Plants:
Hydrological Cycle, Hydrograph, Flow duration curve, Selection of site, Essential features, Classification of hydro plants, Selection of water turbines for hydro power plant, Automatic and remote control of hydro station, layout of hydro power plant.

Module 4: Nuclear power plants:
Nuclear physics, Binding energy, Radio active decay. Fertile material, Mass defect, Nuclear reactions type and application, Generation of nuclear energy by fission, Nuclear reactors. Site selections, safety measures, plant layout, Fusion reaction, Future of nuclear power.

Module 5: Gas Turbine:
Elements of gas turbines, Open and closed cycles for gas turbines, Performance terms, Thermal refinement to gas turbines cycle, Plant layout, applications, gas turbines Cycle calculations.

Module 6: Diesel Power Plants:
Classifications of IC Engines and their performance, Four stroke and two stroke diesel engines, combustion phenomenon; Essential components, Celane number, knocking, super charging, operation and layout of diesel power plant.

Module 7: Combined Operation of Different Power Plants:
Advantages of combined operation of plants, load division between power stations, coordination of different types of Power Plants.

Module 8: Pollution Control:
Pollution from thermal & nuclear plants, Particulate emission and control, electrostatic precipitator, solid waste disposal.

Suggested Text / Reference Books:

1. Bhatnagar, U.S., Gupta, O.V. &Soni, M.L. (1987). *A course in Electrical Power*. Dhanpat Rai & Sons.
2. Sharma, P.C. (2001). *Power Plant Engineering*. Kataria& Sons.
3. Skrotzki, B.G.A. &Vapot, W. A. (1960). *Power Station Engineering and Economy*. TMH.
4. Rajput, R.K. (2016). *Power Plant Engineering*. Luxmi Publications.
5. EI Wakit, M.M. (2017). *Power Plant Engineering*. Mc Graw Hill.

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CO2	2	2	2	1	1	2	1	1	1	-	-	1	1	1	1
CO3	2	1	1	1	1	1	2	2	-	1	-	-	1	1	2
CO4	1	2	1	1	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	1	2	1	1	2	1	2	1	1	1	1	2	1
Average	1.4	1.4	1.2	1.4	1.2	1.2	1.4	1.6	1.2	1.2	1	1	1.2	1.2	1.4

The correlation levels are: "1" – Low Correlation, "2" – Medium Correlation, "3" – High Correlation and "-" indicates there is no correlation

Total Number of Course	61
Number of Theory Course	45
Number of Practical Course	16
Total number of noncredit courses	05
Total Number of Credits	**188**

Annexure-4

ACADEMIC INSTRUCTIONS

Attendance Requirements

A student shall have to attend 75% of the scheduled periods in each course in a semester; otherwise he / she shall not be allowed to appear in that course in the University examination and shall be detained in the course(s). The University may condone attendance shortage in special circumstances (as specified by the Guru Kashi University authorities). A student detained in the course(s) would be allowed to appear in the subsequent university examination(s) only on having completed the attendance in the program, when the program is offered in a regular semester(s) or otherwise as per the rules.

Assessment of a course

Each course shall be assessed out of 100 marks. The distribution of these 100 marks is given in subsequent sub sections (as applicable).

	Internal (40)						**External (60)**	**Total**
Components	**Attendance**	**Assignment**			**MST1**	**MST2**	**ETE**	
		A1	A2	A3				
Weightage	10	10	10	10	30	30	60	
Average Weightage	10	10			20		60	100

Passing Criteria

The students have to pass both in internal and external examinations. The minimum passing marks to clear in examination is 40% of the total marks.