COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

VISION AND MISSION OF THE INSTITUTE

VISION

The Institute strives to inculcate a sound knowledge in engineering along with realised social responsibilities to enable its students to combat the current and impending challenges faced by our country and extend their expertise to the global arena.

MISSION

To impart high quality education and training to its students to make them World-class engineers with a foresight to the changes and problems, and pioneers to offer innovative solutions to benefit the nation and the world at large.

COIMBATORE INSTITUTE OF TECHNOLOGY

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DEPARTMENT OF CHEMICAL ENGINEERING

VISION AND MISSON OF THE DEPARTMENT

VISION

Create Chemical Engineers by nurturing innovation, critical thinking, and entrepreneurial spirit to offer solutions to the growing needs of the society.

MISSION

1. To provide academic and research proficiency to pursue a successful career in the field of chemical engineering
2. To nurture critical thinking among students and enable them to offer innovative solutions for a sustainable environment
3. To promote entrepreneurial spirit among the young minds

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DEPARTMENT OF CHEMICAL ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVE (PEO)

1. Students will exhibit professional knowledge in understanding of chemical processes, design and development of chemical equipment's in process & chemical industries.
2. Students will be able to perform industrial solutions for engineering and handle problems of process industries relevance to society.
3. Students can adapt to changes in technologies through continuous education and will be able to contribute to national and global economic growth with socially responsible practices.

PROGRAMME OUTCOME (PO)

1. Apply knowledge of mathematics, physical science and chemical engineering fundamentals to solve complex engineering problems.
2. Identify and analyze chemical engineering problems to improve the efficiency of processes and quality of products in chemical industry.
3. Design innovative process for complex chemical engineering systems and provide solutions to meet specified needs with appropriate consideration for public health & safety, culture, society and the environment.
4. Conduct investigations using research methodology, analysis and interpretation of results to derive scientifically sound conclusions.
5. To apply appropriate techniques and engineering software / tools for design & analysis of the process.
6. Apply contextual knowledge in designing systems, components or processes to meet societal needs in the field of chemical engineering.
7. Demonstrate professional skills and contextual reasoning to assess environmental & societal issues for sustainable development.
8. Apply ethical principles, commit to professional ethics and responsibilities, norms of practices.
9. Work effectively as an individual, as a member / leader in diverse teams and in multidisciplinary environments.
10. Communicate information and able to write technical reports & presentations.
11. Demonstrate and apply engineering & management principles in their own / team projects in multidisciplinary environment.

12. Recognize the need for, and have the ability to engage in independent and lifelong learning broadest context of technological change.

PROGRAMME SPECIFIC OUTCOME (PSO)

1. Understand and apply working knowledge of chemical engineering principles and applications.
2. Implement the inter-perceptional skills of individuals in technical profession.

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B.Tech. CHEMICAL ENGINEERING

Curriculum from the Academic Year - 2019

SUBJECTS OF STUDY

Semester III

Course Code	Course Name	L	T	P	C	CAT
19CEM31	Differential Equations and Boundary Value Problems	2	1	0	3	BS
19CH31	Mechanics of Solids	3	0	0	3	ES
19CH32	Fluid Mechanics	2	1	0	3	PCC
19CH33	Chemical Engineering Thermodynamics	2	1	0	3	PCC
19CH34	Environmental Science	3	0	0	3	PCC
19CH35	Chemical Process Calculations	2	1	0	3	PCC
19HSS01	Science of Creativity and Professional Ethics	1	0	0	1	HS
19CHL36	Computer Laboratory (Programming for problem solving)	0	0	2	1	ES
19CHL37	Electrical and Electronics Engineering Laboratory	0	0	2	1	ES
	One Credit Course	1	0	0	1	
19HOC31	Communication Skills for Engineers - I*	0	0	2	1	EEC
	TOTAL CREDITS				**23**	

Semester IV

Course Code	Course Name	L	T	P	C	CAT
19CH41	Biology for Chemical Engineers	3	0	0	3	ES
19CH42	Mechanical Operations	2	1	0	3	PCC
19CH43	Chemical Reaction Engineering - I	2	1	0	3	PCC
19CH44	Heat Transfer	2	1	0	3	PCC
19CH45	Mass Transfer - I	2	1	0	3	PCC
19CH46	Instrumental Methods of Analysis	3	0	0	3	PCC
19CHL47	Fluid Mechanics Laboratory	0	0	2	1	PCC
19CHL48	Technical Analysis Laboratory	0	0	2	1	PCC
	One Credit Course	1	0	0	1	
19HOC41	Communication Skills for Engineers - II*	0	0	2	1	EEC
	TOTAL CREDITS				**22**	

* Not to be counted for GPA. Pass is required.

Semester V

Course Code	Course Name	L	T	P	C	CAT
19CH51	Numerical Methods in Chemical Engineering	2	1	0	3	PCC
19CH52	Chemical Reaction Engineering- II	2	1	0	3	PCC
19CH53	Mass Transfer-II	2	1	0	3	PCC
	Elective - I	3	0	0	3	PEC
	Elective - II	3	0	0	3	PEC
19CHL56	Entrepreneurship Development	0	0	2	1	HS
19CHL57	Mechanical Operations Laboratory	0	0	2	1	PCC
19CHL58	Heat Transfer Laboratory	0	0	2	1	PCC
	One Credit Course	1	0	0	1	-
19CH68	Mini Project*	0	0	2	No Credit	EEC
19INT51	Internship-I#	0	0	2	1	EEC
19HOC51	Employability and Personality Development Skills-I*	0	0	2	1	EEC
	TOTAL CREDITS				**21**	

Internship - I to be completed during 4th semester vacation

* Mini Project will be evaluated in 6th Semester

Semester VI

Course Code	Course Name	L	T	P	C	CAT
19CH61	Process Dynamics and Control	2	1	0	3	PCC
19CH62	Chemical Process Industries	3	0	0	3	PCC
19CH63	Chemical Process Safety	3	0	0	3	PCC
	Elective - III	3	0	0	3	PEC
	Elective - IV	3	0	0	3	PEC
19CHL66	Chemical Reaction Engineering Laboratory	0	0	2	1	PCC
19CHL67	Mass Transfer Laboratory	0	0	2	1	PCC
	One Credit Course	1	0	0	1	-
19CH68	Mini Project	0	0	4	2	EEC
19INT61	Internship-II#	0	0	2	1	EEC
19HOC61	Employability and Personality Development Skills-II*	0	0	2	1	EEC
	TOTAL CREDITS				**22**	

Internship-II to be completed during 5th semester vacation

* Not to be counted for GPA. Pass is required.

Semester VII

Course Code	Course Name	L	T	P	C	CAT
19CH71	Transport Phenomena	2	1	0	3	PCC
19CH72	Process Economics and Technology Management	3	0	0	3	PCC
19CH73	Process Modeling and Simulation	2	1	0	3	PCC
19CH74	Electrochemical Engineering	3	0	0	3	PEC
	Elective - V	3	0	0	3	PEC/OEC
19CHL76	Process Equipment Design and Drawing	0	0	4	2	PCC
19CHL77	Process Control and Simulation Laboratory	0	0	2	1	PCC
19CH78	Project Work Phase - I	0	0	6	3	EEC
	TOTAL CREDITS				**21**	

Semester VIII

Course Code	Course Name	L	T	P	C	CAT
	Elective -VI	3	0	0	3	PEC
	Elective-VII	3	0	0	3	PEC
	Elective-VIII	3	0	0	3	PEC/OEC
19CH84	Project Work Phase - II	0	0	10	5	EEC
	TOTAL CREDITS				**14**	

Category : BS - Basic Science, HS - Humanities and Social Science, ES - Engineering Science, PCC - Professional Core Course, PEC - Professional Elective Course, OEC - Open Elective Course, EEC - Employability Enhancement Courses.

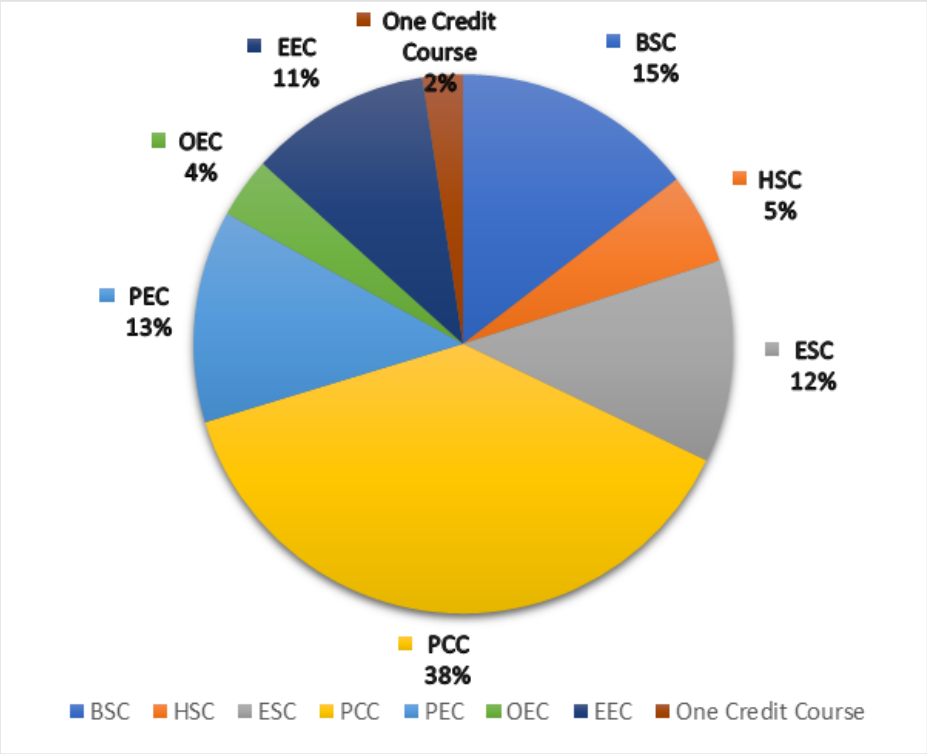
Total Credits

Semester	Credits
I	21
II	21
III	23
IV	22
V	21
VI	22
VII	21
VIII	14
TOTAL	**165**

Category Wise Credit Distribution

Curriculum Components	Sem-I	Sem-II	Sem-III	Sem-IV	Sem-V	Sem-VI	Sem-VII	Sem-VIII	Total
BS	12	9	3	-	-	-	-	-	24
HS	2	5	1	-	1	-	-	-	9
ES	6	6	5	3	-	-	-	-	20
PCC	-	-	12	17	11	11	12	-	63
PEC	-	-	-	-	6	6	3	6	21
OEC	-	-	-	-	-	-	3	3	06
EEC	1	1	1	1	2	4	3	5	18
One Credit Course	-	-	1	1	1	1	-	-	4
Total	21	21	23	22	21	22	21	14	165

CATEGORY WISE CREDIT DISTRIBUTON



LIST OF PROFESSIONAL ELECTIVE COURSES

S. No.	Course Code	Name of Subject	Credits
1.	19CHE01	Water Conservation and Management	3
2.	19CHE02	Sustainability Engineering	3
3.	19CHE03	Nanoscience and Nanotechnology for Chemical Science	3
4.	19CHE04	Polymer Science and Engineering	3
5.	19CHE05	Renewable Energy	3
6.	19CHE06	Advanced Separation Processes	3
7.	19CHE07	Environmental Pollution and Control	3
8.	19CHE08	Colloid and Interfacial Engineering	3
9.	19CHE09	Energy Management in Chemical Industries	3
10.	19CHE10	Biochemical Engineering	3
11.	19CHE11	Process Engineering	3
12.	19CHE12	Petroleum Refinery Engineering	3
13.	19CHE13	Drugs and Pharmaceuticals Technology	3
14.	19CHE14	Food Technology	3
15.	19CHE15	Piping and Instrumentation	3
16.	19CHE16	Process Automation	3
17.	19CHE17	Process Instrumentation	3
18.	19CHE18	Total Quality Management	3
19.	19CHE19	Optimization Methods	3
20.	19CHE20	Integrated Design of Chemical Processes	3
21.	19CHE21	Computer Aided Process Equipment Design	3
22.	19CHE22	Sugar Technology	3
23.	19CHE23	Energy Technology	3
24.	19CHE24	Petrochemicals Technology	3
25.	19CHE25	Fertilizer Technology	3
26.	19CHE26	Mineral Processing Technology	3
27.	19CHE27	Fluidization Engineering	3
28.	19CHE28	Pulp and Paper Technology	3
29.	19CHE29	Surface Coating Technology	3
30.	19CHE30	Heat Power Engineering	3
31.	19CHE31	Carbon Capture	3
32.	19CHE32	Material Science and Technology	3
33.	19CHE33	Bioprocess Technology	3
34.	19CHE34	Pilot Plant and Scale-up Methods	3

LIST OF ONE CREDIT COURSES

S. No.	Course Code	Title of the Course
		GROUP-I
		Personality and Skill Development Courses
1	19CHOC01	Critical Thinking
2	19CHOC02	Creativity & Innovation
3	19CHOC03	Leadership
4	19CHOC04	Emotional Intelligence
5	19CHOC05	Health and Lifestyle
6	19CHOC06	Psychology for Engineers
		GROUP-II
		Social Responsibility & Environment Audit Courses
7	19CHOC07	Fundamentals of Nanoscience
8	19CHOC08	An Introduction to Environmental Ethics
9	19CHOC09	Corporate Social Responsibilities
10	19CHOC10	Composite Material Preparation and Characterization
11	19CHOC11	Environmental Impact Assessment and Audit
		GROUP-III
		Control and Automation Courses
12	19CHOC12	Factory Automation
13	19CHOC13	Controller Tuning
14	19CHOC14	Neural Networks and Fuzzy Systems
15	19CHOC15	Internet of Things
16	19CHOC16	Process Automation and Fault Diagnosis
17	19CHOC17	Process Control in Petrochemical Industries
18	19CHOC18	Power Plant Instrumentation
19	19CHOC19	Industrial Automation
20	19CHOC20	Biomedical Instrumentation
		GROUP-IV
		Energy and Nano Technology Courses
21	19CHOC21	Energy Materials, Devices and Systems
22	19CHOC22	Surface Engineering of Nanomaterials
23	19CHOC23	Nano sensors : Basic components, Characterization and Application
24	19CHOC24	Nanopolymers : Synthesis, Characterization and Applications
25	19CHOC25	An approach to Nanotribology and Nanomechanics
26	19CHOC26	Nanomaterials and Nanofibers
27	19CHOC27	Biomass Conversion to Biofuels and Bioenergy
28	19CHOC28	Biofuel: Fate and Future
29	19CHOC29	Dimensional Analysis and Theory of Models
30	19CHOC30	Pinch Technology
31	19CHOC31	Drug Delivery Systems

S. No.	Course Code	Title of the Course
		GROUP-V
		Waste Treatment and Environment Science Courses
32	19CHOC32	Research Skills
33	19CHOC33	E-Waste Material Flow and Management Practices
34	19CHOC34	Chemicals in the Environment: Fate & Transport
35	19CHOC35	An Integrated approach for wastewater treatment
36	19CHOC36	Textile Effluents : Analysis and Treatment Methods
37	19CHOC37	Advanced Recycling and Recovery Technologies for E-Waste
		GROUP-VI
		Certification Courses
38	19CHOC38	NPTEL / MOOC Certification Courses (Chemical Engineering and Allied Courses)

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LIST OF OPEN ELECTIVES

DEPARTMENT OF CIVIL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19CEOE01	Town Planning and Architecture	3	0	0	3	All Branches
19CEOE02	Climate Change and Adaptation	3	0	0	3	All Branches
19CEOE03	Metro Systems and Engineering	3	0	0	3	All Branches
19CEOE04	Renewable Energy Sources	3	0	0	3	All Branches
19CEOE05	Principles of Sustainable Development	3	0	0	3	All Branches
19CEOE06	Disaster Management	3	0	0	3	All Branches

DEPARTMENT OF MECHANICAL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19MEOE01	Design of Experiments	3	0	0	3	All branches
19MEOE02	Engineering Optimization	3	0	0	3	All branches
19MEOE03	Engineering Polymers, Composites and Allied Manufacturing Processes	3 3	0 0	0 0	3 3	Mechanical Chemical & Civil
19MEOE04	Industrial Robotics	3	0	0	3	Mechanical EEE and ECE
19MEOE05	Business Process Re-engineering	3	0	0	3	All branches
19MEOE06	Engineering Economics and Financial Management	3	0	0	3	All branches

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19EEOE01	Energy Auditing	3	0	0	3	ECE, Mech, Chemical, Civil
19EEOE02	Solar and Wind Energy systems	3	0	0	3	ECE, Mech, Chemical
19EEOE03	Electrical Safety Procedures and Management	3	0	0	3	All Branches
19EEOE04	Energy Efficient Illumination Systems	3	0	0	3	All Branches
19EEOE05	Electric Vehicle Technology	3	0	0	3	All Branches except Civil & Chemical
19EEOE06	Energy Efficiency in Thermal and Electrical Utilities	3	0	0	3	EEE & Mechanical

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19ECEOE01	Signal Processing and its Applications	3	0	0	3	Chemical, Mechanical & Civil
19ECEOE02	Smart Sensors and IoT	3	0	0	3	All Branches
19ECEOE03	Consumer Electronics	3	0	0	3	Mechanical & Civil
19ECEOE04	Robotics	3	0	0	3	Mechanical, CSE & IT
19ECEOE05	Information Theory and Coding Techniques	3	0	0	3	All Branches
19ECEOE06	Wireless Sensor Networks	3	0	0	3	All Branches
19ECEOE07	Automotive Embedded Systems	3	0	0	3	All Branches
19ECEOE08	5G Technologies and Applications	3	0	0	3	All Branches
19ECEOE09	Vehicular Communication	3	0	0	3	All Branches
19ECEOE010	Sensing for Automotive Systems	3	0	0	3	All Branches

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19CSOE01	Customer Relationship Management	3	0	0	3	All Branches
19CSOE02	Fundamentals of Software Engineering	3	0	0	3	All Branches
19CSOE03	Internet Programming	3	0	0	3	All Branches
19CSOE04	Introduction to Data Warehousing and Data Mining	3	0	0	3	All Branches
19CSOE05	Introduction to Embedded Systems	3	0	0	3	All Branches

DEPARTMENT OF INFORMATION TECHNOLOGY

Course Code	Course Name	L	T	P	C	Eligible Branches
19ITOE01	Digital Computer Basics	3	0	0	3	Civil, Mech, Chem
19ITOE02	Programming in Java	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE03	Fundamentals of Database Systems	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE04	Cloud Computing Fundamentals	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE05	Information Security Fundamentals	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE06	Introduction to Human Computer Interaction	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
19ITOE07	Enterprise Resource planning Concepts	3	0	0	3	EEE, ECE, Mech, Civil & Chemical

DEPARTMENT OF CHEMICAL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
19CHOE01	Industrial Safety Engineering	3	0	0	3	All Branches
19CHOE02	Risk Analysis and Hazop	3	0	0	3	All Branches
19CHOE03	Green Technology	3	0	0	3	All Branches
19CHOE04	Corrosion Science and Engineering	3	0	0	3	All Branches
19CHOE05	Introduction to Chemical Engineering	3	0	0	3	All Branches
19CHOE06	Nanomaterial Synthesis and Characterization Laboratory	0	0	6	3	All Branches
19CHOE07	Multivariate Statistics Laboratory	0	0	6	3	All Branches

DEPARTMENT OF MATHEMATICS

Course Code	Course Name	L	T	P	C	Eligible Branches
19MOE01	Graph Theory & its Applications	3	0	0	3	All Branches
19MOE02	Methods of Applied Mathematics	3	0	0	3	All Branches
19MOE03	Linear and Non - Linear Programming	3	0	0	3	All Branches
19MOE04	Probability and Random Processes	3	0	0	3	All Branches

DEPARTMENT OF PHYSICS

Course Code	Course Name	L	T	P	C	Eligible Branches
19POE01	Introduction to Nanoscience and Nanotechnology	3	0	0	3	All Branches except IT
19POE02	Physics and Technology of Thin Films	3	0	0	3	Mechanical, EEE, Chemical & ECE
19POE03	Solar Cell Fundamentals and Materials	3	0	0	3	EEE, ECE & Chemical
19POE04	Advanced Material Processing Technologies	3	0	0	3	Mechanical & Chemical

DEPARTMENT OF CHEMISTRY

Course Code	Course Name	L	T	P	C	Eligible Branches
19COE01	Medical Nanotechnology	3	0	0	3	Chemical
19COE02	Advanced Drug Delivery Systems	3	0	0	3	Chemical
19COE03	Biosensors	3	0	0	3	Chemical, ECE & EEE
19COE04	Nanocomposites	3	0	0	3	Mechanical, Chemical & Civil
19COE05	Biorefinery	3	0	0	3	Mechanical & Chemical

DEPARTMENT OF HUMANITIES

Course Code	Course Name	L	T	P	C	Eligible Branches
19HOE01	Principles of Management	3	0	0	3	Common to all branches
19HOE02	Current Trends in Indian Economy	3	0	0	3	Common to all branches
19HOE03	Monetary Economics	3	0	0	3	Common to all branches
19HOE04	English for Academic Purposes	3	0	0	3	Common to all branches
19HOE05	English for Competitive Exams	3	0	0	3	Common to all branches
19HOE06	Life and Literature	3	0	0	3	Common to all branches

19CEM31 - DIFFERENTIAL EQUATIONS AND BOUNDARY VALUE PROBLEMS

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

Upon the completion of the course, the students will be able to

CO1 : *Analyse ordinary differential equations concepts in Modeling and solving physical problems.*

CO2 : *Demonstrate accurate and efficient use of numerical solutions of ordinary differential equations and their role in modern mathematics and applied contexts.*

CO3 : *Formulate concrete problems and finding the solutions of partial differential equations*

CO4 : *Solve the boundary value problems relevant to vibration of strings*

CO5 : *Familiarize finite difference approximation to get numerical solutions of partial differential equation*

ORDINARY DIFFERENTIAL EQUATIONS

Second and Higher order linear differential equations with constant coefficients -Cauchy-Euler equation, Cauchy-Legendre equation- Method of variation of parameters -System of simultaneous linear differential equations with constant coefficients. **(9)**

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

Numerical solution of first order ordinary differential equation: Taylor Series Method -Picard's Method - Euler's method -Modified Euler's method- Fourth order Runge- Kutta method-Milne's predictor and corrector method. **(9)**

PARTIAL DIFFERENTIAL EQUATIONS

Formation of partial differential equations - Solutions of first order non-linear partial differential equations (standard types) - Lagrange's linear equations -Second and higher order homogeneous linear equations with constant coefficients **(9)**

BOUNDARY VALUE PROBLEMS

Method of separation of variables -Vibration of strings - One dimensional wave equation - One dimensional heat flow equation with steady state and unsteady state solutions. **(9)**

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS

Difference Quotients - Graphical Representation of Partial Quotients - Classification - One dimensional Heat equation: Explicit formula (Bender Schmidt recurrence method) -One dimensional wave equation: Explicit formula **(9)**

TOTAL : 45

TEXT BOOKS

1. *B.S. Grewal, "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers-(2012).*
2. *B.V.Ramana, "Higher Engineering Mathematics", Kindle Edition (2018), Tata McGraw-Hill Publishing Company Limited, New Delhi.*

REFERENCES

1. *Srimanta Pal and Suboth.C.Bhunia, Engineering Mathematics, Oxford University Press, New Delhi, 2015.*
2. *Brian Bradie, "A Friendly Introduction to Numerical Analysis", Pearson Education, Asia, New Delhi, 2007.*
3. *S.S.Sastry, "Introductory Methods of Numerical Analysis", 5th Edition (2012), Prentice Hall India Learning Private Limited.*

19CH31 - MECHANICS OF SOLIDS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students will able to

CO1 : *Compute stresses due to axial forces, thermal stresses, complex stresses and stresses due to suddenly applied loads and impact loads.*

CO2 : *Illustrate Bending moment and Shear Force diagram for determinate beams.*

CO3 : *Calculate stress related to bending, shear and torsion.*

CO4 : *Have the knowledge of theory of columns.*

CO5 : *Calculate member forces for trusses.*

CONCEPT OF STRESS AND STRAIN

Simple stresses and strains at a point -Normal and shear Stresses - Hook's Law - Young's modulus - Bars subjected to axial Forces - simple problems. Thermal stresses - Simple statically indeterminate problems like compound bars - Elastic constants - modulus of rigidity - Bulk modulus - Relationships. **(9)**

TRANSVERSE LOADING ON BEAMS

Beams - support conditions - types of beams - transverse loading on beams - shear force and bending moment in beams - analysis of cantilevers, simply supported beams and over hanging beams - relationships between loading, S.F and B.M. in beams and their applications -S.F and B.M. diagrams. **(9)**

STRESSES IN BEAMS

Theory of simple bending - assumptions and derivation of bending equation - analysis of stresses in beams - loads carrying capacity of beams - proportioning of beam sections - leaf springs - flitched beams - shear stress distribution in beams - determination of shear stress in rectangular beams. **(9)**

TORSION

Torsion of solid and hollow circular shafts - Power transmitted through shafts - closed coiled helical springs - springs constants - springs in series and springs in parallel. **(9)**

COLUMNS AND PLANE TRUSSES

Axially loaded short columns - columns of unsymmetrical sections - Euler's theory of long columns - critical loads of prismatic columns with different and conditions - Rankine's empirical theory. Analysis of statically determinate plane trusses - Method of Joints and method of sections. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Bansal R.K., Strength of Materials, Fifth Edition, Laxmi Publications Pvt. Ltd, New Delhi, 2012.*
2. *Sadhu Singh, Strength of Materials, Tenth Edition, Khanna Publications, New Delhi, 2012.*

REFERENCES

1. *Khurmi R.S., Strength of Materials, Third Edition Reprint, S.Chand and Company Ltd, 2015.*
2. *Singh J.P., Mechanics of Solids, Fourth Edition, Khanna Publications, New Delhi, 2005.*

19CH32 - FLUID MECHANICS

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of course, students will be able to

CO1 : *Apply the basic concepts of fluid mechanics and to solve dimensional analysis problems.*

CO2 : *Solve problems related to mass, momentum and energy balances in fluid flow.*

CO3 : *Demonstrate the applications of flow statics, fluid flow phenomena.*

CO4 : *Design fluid flow reactors and solve problems on fluid flow measurements.*

CO5 : *Estimate the pump efficiency, head developed and pressure drop.*

BASIC CONCEPTS

Definition of a fluid - Shear stress in a moving fluid - difference between liquids and gases -compressible and incompressible fluids - Newtonian and non- Newtonian fluids - continuum concept of a fluid - properties of fluids - viscosity - compressibility - bulk modulus. Dimensional analysis and its applications in fluid flow. Statics of fluid systems-pressure - variation of pressure vertically in a fluid under gravity -General equation for the variation of pressure due to gravity in a static fluid - manometers: U-tube, differential and inclined manometers. **(9)**

FLUID DYNAMICS

Fluid flow - basic concepts - Reynolds experiment - laminar and turbulent flows - nature of turbulence. Basic concepts of Boundary layer. Equation of continuity and its applications -momentum equations - Euler's equation of motion -Bernoulli's theorem and its applications. **(9)**

INCOMPRESSIBLE FLUID FLOW

Flow in conduits -Shear stress distribution in a cylindrical tube -Friction factor-Fanning's equation - Applications -Laminar flow in pipes -Hagen Poiseuille equation -Velocity distribution for laminar and turbulent flows -Losses due to sudden expansion and sudden contraction -Losses in pipe fittings. **(9)**

FLUIDISED AND PACKED BEDS

Flow through packed beds - Ergun equation and Kozeny - Carman equation. Equation for one dimensional motion - Fluidisation Mechanism of fluidisation - Types of fluidisation-Pressure drop in fluidised beds - Minimum fluidisation velocity. **(9)**

HYDRAULIC PUMPS AND PIPE FITTING

Pipes, Fittings and valves - Pumps, Fans, Compressors and Blowers - Positive displacement pumps - Centrifugal pumps - NPSH and cavitation - Pump calculations - Constant and variable head flow meters. **(9)**

TOTAL : 45

TEXT BOOKS

1. *McCabe. W.L., Smith. J C., Harriot. P., Unit operations of Chemical Engineering, McGraw Hill, Seventh Edition, 2014*
2. *Douglas.J.F.,Gasiorek. J.M., Swaffielf. J.A., FLUID MECHANICS, Sixth Edition, 2011.*
3. *Noel de Nevers, Fluid Mechanics for Chemical engineers, Second Edition, 2013*

REFERENCES

1. *Hughes. F., John A Brighton and Nicholas Winowich, Schaum's Outline of Fluid Dynamics, Third Edition 1999.*
2. *Ranald.V.Giles, Cheng Liu and Jack Evett, Schaum's outline of Fluid Mechanics and Hydraulics, Fourth Edition 2010.*
3. *Sulzer Pumps Ltd, Centrifugal pump Handbook, Third edition, Winterthur, Switzerland, 2010.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

COs	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	3	1	1					2	3	2	1
CO2	3	2	2	3	2	3					2	3	2	2
CO3	3	2	3	3		3		1				3	2	3
CO4	3	2	1	3	2	2					1	3	2	1
CO5	3	2	1	3	1	2					1	3	2	1

(1: Slight, 2: Moderate 3: Substantial)

19CH33 - CHEMICAL ENGINEERING THERMODYNAMICS

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students will able to

CO1 : *Apply mass and energy balances to closed and open systems and predict the feasibility of process.*

CO2 : *Predict the thermodynamic properties of fluids.*

CO3 : *Formulate phase equilibria problem and explain the concepts of fugacity.*

CO4 : *Construct the phase diagrams for different systems.*

CO5 : *Examine the chemical reaction equilibria problem*

BASIC CONCEPTS AND LAWS OF THERMODYNAMICS:

Preliminary Concepts - The language of Thermodynamics - Measured Thermodynamic Properties - The first law of thermodynamics for closed and open systems -Reversible and Irreversible Process - Thermochemical Data for U and H -PVT behaviour of pure substances - Entropy and The second law of thermodynamics, The second law of thermodynamics for closed and open systems, Calculation of entropy for ideal gases **(9)**

EQUATION OF STATE AND THERMODYNAMICS PROPERTY RELATIONSHIP

Intermolecular forces-Principles of corresponding states - Equation state generalized compressibility charts Determination of parameters for mixtures - Thermodynamic property relations - calculation of change in entropy, internal energy and enthalpy - Departure functions - Joule - Thomson Expansion and Liquefaction **(9)**

PHASE EQUILIBRIA - PROBLEM FORMATION AND FUGACITY

Introduction - Pure Species Phase Equilibrium- - Thermodynamics of Mixtures -Multicomponent Phase Equilibria - The Fugacity - Fugacity in the Vapor Phase - Fugacity in the Liquid Phase - Fugacity in the Solid Phase. **(9)**

PHASE EQUILIBRIA - PHASE DIAGRAMS

Vapor Liquid Equilibrium- Ideal Gas and Ideal Solution- Non-ideal Solution - Azeotropes - Fitting Activity Coefficient Models with VLE data - Liquid-Liquid Equilibrium (LLE)-Vapor- Solid Liquid-Liquid Equilibrium (VLLE)- -Liquid and solid -solid Equilibrium (SLE & SSE)-Colligative Properties. **(9)**

CHEMICAL REACTION EQUILIBRIA

Introduction-Chemical Reaction and Gibbs Energy-Equilibrium for a single reaction-Calculation of K from Thermochemical data and Gibbs Energy of formation - Relationship between the Equilibrium and constant and the concentration of reacting species-Equilibrium constant in Electrochemical Systems-Multiple Reactions - Reaction Equilibria of point Defects in crystalline solids. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Koretsky, Milo D. Engineering and chemical thermodynamics. John Wiley & Sons, 2012.*
2. *J.M. Smith, H.C. Van Ness and M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, 7th edition, McGraw-Hill International Edition,2005.*
3. *Rao, Y. V. C. Chemical engineering thermodynamics. Universities Press, 1997.*
4. *Narayanan, K. V. "Chemical Engineering Thermodynamics." Prentice Hall India Learning Private Limited; 2nd Revised edition edition (2013).*

REFERENCES

1. *M J Moran, H N Shapiro, D D Boettner and M B Bailey, Principles of Engineering Thermodynamics, 8th Edition, Willey.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

COs	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	2	1					2	3	
CO2	3	1	1	2	3	2	1					2	3	
CO3	3	1	1	2	1	2	1					2	3	
CO4	3	3	3	3	3	3	1					3	3	
CO5	3	3	3	3	3	3	1					3	3	

(1: Slight, 2: Moderate 3: Substantial)

19CH34 - ENVIRONMENTAL SCIENCE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

The students completing the course will have

CO1 : *An insight in to the chemical reactions in water, air and soil environment.*

CO2 : *Ability to apply chemistry principles in analysing pollution of water, air and soil environment.*

CO3 : *An understanding on the fate of chemicals on the environment and suggest relevant interventions*

CO4 : *To understand the importance of green chemistry in the environment.*

CO5 : *An insight into the environmental protection act and the associated rules, knowledge on the institutional setup for environmental management and pollution control.*

NATURAL RESOURCES

Forest resources: Use and over-exploitation, deforestation, Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems - Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. **(9)**

RENEWABLE ENERGY RESOURCE AND ENVIRONMENTAL POLLUTION

Energy resources-growing energy needs, renewable and non-renewable energy sources uses of alternative energy sources-merits and limitation of solar energy-wind and tidal energy- OTEC-Geothermal energy-Hydel energy.

Sources, causes, effects and management of air pollution and water pollution, soil pollution, noise pollution, marine pollution and radioactive pollution. Solid waste Management. **(9)**

ECOSYSTEM AND BIODIVERSITY

Concept of an ecosystem- structure and functions- ecological succession, food chain, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystem (Ponds, lakes, ocean and rivers). Biodiversity-types, Importance and values of biodiversity, India as a mega diversity nation, Hot spots of biodiversity, Threats to biodiversity, conservation of biodiversity. **(9)**

ENVIRONMENTAL BIOTECHNOLOGY AND GREEN CHEMISTRY

Biotechnology and its applications in environment protection, Bioinformatics, Bioremediation, Bio de-odorization. Green chemistry for clean technology, significance of green chemistry-basic components of green chemistry. Industrial application of green chemistry-green fuels-e-green propellants and bio catalysts. **(9)**

GLOBAL ENVIRONMENTAL ISSUES AND MANAGEMENT

Water conservation, Rain water harvesting, Environmental Ethics, Climate change, Ozone depletion, Acid rain and Greenhouse effect and global warming, Environment (protection) Act, Air (prevention and control of pollution) Act, Water (prevention and control of pollution) Act, Wildlife protection Act and Forest (conservation) Act. Disaster management- Earthquakes, Floods, Landsides and cyclones. **(9)**

TOTAL: 45

TEXTBOOKS

1. *Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006.*
2. *Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.*
3. *Dara SS (2005) A Text Book of Environmental Chemistry and Pollution Control, S. Chand & Company, New Delhi.*

REFERENCES

1. *Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD,New Delhi, 2007.*
2. *ErachBharucha, "Textbook of Environmental Studies", Universities Press(I) PVT, LTD, Hydrabad, 2015.*
3. *G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014.*
4. *Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.*
5. *De AK (2003) Environmental Chemistry, 5th edition, New Age International (P) Ltd, New Delhi.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3					3							
CO2			3	2										
CO3						2	3							
CO4										1				
CO5		3	3										3	

(1: Slight, 2: Moderate 3: Substantial)

19CH35 - CHEMICAL PROCESS CALCULATIONS

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students will able to

CO1 : *Apply the principles of dimensional homogeneity to convert one form of unit to other equivalent forms in CGS, FPS. MKS and SI unit systems and apply fundamental gas laws to solve ideal gas problems.*

CO2 : *Calculate the composition of a mixture in terms of mole fractions from a given composition expressed in terms of mass fractions or vice versa.*

CO3 : *Compute the concentration, degree of saturation and dew point of vapour -gas mixture at the given temperature and pressure using humidity chart.*

CO4 : *Formulate steady state material balance for the unit operations such as distillation, evaporation, mixing, extraction, drying and crystallization processes with recycle, by-pass and purge.*

CO5 : *Practice the combined steady state material and Energy balance for simple processes like distillation, evaporation and combustion.*

MASS RELATIONS AND IDEAL GASES

Units and dimensions: Basic and derived units - Different ways of expressing units and quantities, Conversion of units. Properties of pure substances, calculations on solid, liquid and gas mixtures using Ideal gas laws. Mole fractions and partial pressures - Application of Dalton's and Amagat's law. **(9)**

HUMIDITY AND SATURATION

Calculations involving change in mass of gas mixture, Concept of Vapour pressure, Raoult's law and its applications, Calculation on Vapor-Liquid mixture, Concepts of gas-vapour mixture, Humidity and Saturation, relative and percentage saturation, Dew point - humid heat, adiabatic saturation curve Humidity Charts. **(9)**

MATERIAL BALANCE - SYSTEM WITHOUT CHEMICAL REACTIONS

Material balance in systems without chemical reactions, Material balance in systems- Distillation, Evaporation, Mixing, Extraction (LLE & Leaching), Absorption, Drying and Crystallization with concept of solubility. Material Balance - Recycle, Byepass and Purge. **(9)**

MATERIAL BALANCE - SYSTEMS INVOLVING CHEMICAL REACTIONS

Combustions Reaction, Concept of ToD, Excess air, Calculations on Orsat Analysis, Flue gas analysis, Calculations on conversion, yield. Concepts of tie elements, Material Balance system involving reactions with recycle, by-pass and purge. **(9)**

ENERGY BALANCE

Definition of Heat capacity and Specific heat, Heat capacity of gases as a function of temperature, Mean heat capacity, heat capacity of mixture of gases. Heat capacities of solids and liquids - Kopp's rule. Standard heat of reaction, formation and combustion, Hess's law of heat summation and its application to determine heat of reaction, heat of neutralization, integral heat of solution, heat of mixing. Effect of pressure and temperature on heat of reaction. Theoretical and actual flame temperature in combustion calculations. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Bhatt, B.I. and Vora, S.M., Stoichiometry, Fourth Edition, Tata-McGraw Hill, New Delhi, 2004.*
2. *Narayanan. K.V. and Lakshmikutty.B., Stoichiometry and Process Calculations, First Edition, Prentice-Hall of India, New Delhi, 2006.*
3. *Richard.M.Felder, Ronald.W.Rousseau, Elementary Principles of Chemical Processes, Third Edition, John Wiley and sons, 2005*
4. *Venkataramani.V, Anantharaman.N, Meera Sheriffa Begum.K.M, Process Calculations, Second Edition, PHI Learning Private Limited, 2011.*

REFERENCES

1. *David M. Himmelblau, Basic Principles and Calculations in Chemical Engineering, Eighth Edition, Prentice -Hall of India, New Delhi, 2012.*
2. *Hougen, O.A., Watson, R.M. and Ragatz, R.A., Chemical Process Principles - Part I, Second Edition, John Wiley (ISE), 1976.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		2						2		2	2	
CO2	3													
CO3	3	3	3	3		2							3	
CO4	3	3	3	2		1							2	
CO5	3	3	3	2		1							2	

(1: Slight, 2: Moderate 3: Substantial)

19HSS01 - SCIENCE OF CREATIVITY AND PROFESSIONAL ETHICS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of course, students will be able to

CO1 : *Understand the principles of karma yoga, duty consciousness and evolution of the universe.*

CO2 : *Analyze the benefits of yoga and meditation.*

CO3 : *Understand the benefits of harmony, introspection and examine human values for sustained growth in career and life*

LIFE FORCE, CONCIOUSNESS AND EVOLUTION OF UNIVERSE

Science of Creativity and Personality Development - Principles of Karma Yoga - Duty Consciousness - Law of Nature - Life Force -Potentiality of the Life Force - Consciousness - Pancha Thanmatras - Biomagnetism. Evolution of the Universe: Creation Theory - Evolution Theory - Evolution of Living Beings: Absolute Space and Force - Seven Constituent Layers in the Body. **(6)**

YOGA AND ITS BENEFITS

Simple and Safe yoga - Upa yoga Practices : Yoga for peace, health, joy, love, well-being and success. Physical exercise - Meditation - Seven centers of meditation - benefits - effect of good vibrations - cause and effect system. **(3)**

HARMONY IN LIFE, INTROSPECTION AND HUMAN VALUES

Harmony in Life : Self, family, society and nature - Introspection : Analysis of thought, Moralization of desire, Neutralization of anger, Eradication of worries and Self realization.

Morals, Values and Ethics - Integrity - Work ethics - Service learning - Virtues - Respect for others - Valuing time - Co-operation -Commitment - Empathy - Self confidence - Challenges in work place - impact of cyber space on individual. **(6)**

TOTAL: 15

TEXT BOOKS

1. *Yogiraj Vethathri Maharishi, "Karma Yoga - The Holistic Unity", Vethathri Publications 4th Edition, 2009.*
2. *R.S.Naagarazan, "A Textbook on Professional Ethics and Human Values", New Age International Publishers, New Delhi, 2011.*

REFERENCES

1. *Sadhguru, "Body the Greatest Gadget and Mind is your Business", Diamond Pocket Books Pvt. Ltd, Isha Foundations, 2013.*
2. *Swami Vivekananda and Swami Nikhilananda, "Karma Yoga and Bhakti Yoga", 2nd Edition, Ramakrishna Vivekananda Publications, 2008.*
3. *Mike W. Martin and Roland Schinzinger,"Ethics in Engineering", 4th Edition McGraw Hill, NewYork, 2005.*

19CHL36 - COMPUTERS LABORATROY
(PROGRAMMING FOR PROBLEM SOLVING)

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students will be able to

CO1 : *Describe the basics of C Programming and understand the problem-solving aspect*

CO2 : *To write algorithms and to draw flowcharts for solving problems*

CO3 : *Develop C programs with simple expressions for problem solving*

CO4 : *Use arrays, pointers, strings and structures to formulate algorithms and programs*

CO5 : *Design and develop solutions to real world problems using C.*

LIST OF EXPERIMENTS

Write a C-Program using

1. Operators and expressions
2. Decision Statements
3. Switch operations
4. Basic Loop operations
5. Advanced loops
6. Array
7. Functions
8. Structure

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3													
CO2		3												1
CO3	3													
CO4														
CO5		3			2									

(1: Slight, 2: Moderate 3: Substantial)

19CHL37 - ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Measure the electrical quantities accurately and analyse the performance of DC and AC machines.*

CO2 : *Implement the proper speed control techniques to DC and AC motors with proper selection of power rating and corresponding drive system using power electronic controller for carios industry process applications.*

CO3 : *Conduct experiments to solve complex engineering problems effectively as an individual or team work.*

CO4 : *Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.*

EXPERIMENTS

1. Calibration of Ammeter, Voltmeter and Wattmeter
2. Calibration of Single Phase Energy meter
3. Swinburne's Test
4. No load Speed Control of DC Shunt Motor
5. Open Circuit Characteristics of a separately excited DC generator
6. Critical speed of DC shunt generator
7. Load Test on DC shunt Motor
8. Load Test on DC shunt Generator
9. Open circuit and short circuit test on single phase Transformer
10. Predetermination of efficiency and regulation characteristics of single phase transformer
11. Load test on single phase transformer
12. Load test on three phase squirrel cage induction motor
13. Load test on slip ring induction motor
14. Load test on single phase capacitor start induction motor
15. Load test on single phase Alternator
16. Study of capacitive transducers
17. Study of inductive transducers
18. Speed torque characteristics of single phase Fan motor
19. Simple programs in ARM
20. Interfacing programs in ARM.

19HOC31 - COMMUNICATION SKILLS FOR ENGINEERS - I

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Students will be able to

CO1 : *Gain confidence, enhance Personality and develop positive attitude in their work and life.*

CO2 : *Effectively communicate and present opinions using appropriate functional expressions for a given situation.*

CO3 : *Compose Emails, Reports for a given business scenario using appropriate sentence construction and in the prescribed format.*

CO4 : *Generate ideas and speak on a given topic in a competitive scenario like Debate, Group Discussion, and Public Speaking.*

PERSONALITY DEVELOPMENT

Motivation and Self Confidence, SCOT Analysis - Personality Development - What is Personality, Developing Positive Attitude towards work and life, Building Relationship with others - Personality Development - Paradigms of Human Interaction, Fear Management. **(4)**

VERBAL COMMUNICATION

English Conversation - Asking and Giving Opinions - English Conversation -Thanking People, Asking and Giving Suggestions - English Conversation - Asking for Direction, Agreeing and Disagreeing - Role Play-Business. **(5)**

BUSINESS COMMUNICATION

Email Writing - Format, Etiquettes and Tips - Report Writing -Introduction, elements and tips - Drafting a report - Error Identification - Rules, Common Mistakes and Exercises - Sentence Completion Filler (fill in the blanks using apt words). **(5)**

PUBLIC SPEAKING

How to start and sustain a conversation - Debate - Extempore - Group Discussion - Importance and Process - Public Speaking - Introduction, Tips - Drafting a Public Speech - Interview - Types, Dos and Don'ts - Mock Press. **(6)**

REFERENCES

1. *https://nptel.ac.in/content/storage2/courses/109104030/references/references.pdf (online resource)*
2. *John Seelay, Oxford Guide to Effective Writing and Speaking, 2nd Edition, Kindle Edition by Oxford University Press, 2007.*
3. *Sabina Pillai, Agna Fernandez, Soft Skills and Employability Skills - Published by Cambridge University Press, 2017.*

19CH41 - BIOLOGY FOR CHEMICAL ENGINEERS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of course, students will be able to

CO1 : *Gain insight into the various levels of organization of life, their characteristics and basic needs in the ecosystems.*

CO2 : *Explain the major anabolic & catabolic pathways in carbohydrate, protein & lipid metabolism and understand the significance of high energy compounds.*

CO3 : *Understand the various types of genes, their functions and inheritance, analyze the mechanisms involved in protein synthesis and gene regulation.*

CO4 : *Gain knowledge on the structure and functions of basic cell types and their importance in cellular processes, relate the role of lipid bilayer membrane & proteins to transport of molecules and understand communication of cells through signalling pathways.*

CO5 : *Have knowledge on identification of microorganisms, their physiology, diversity, conservation, growth kinetics & culturing methods, understand microbial interactions and infections and strategies to manage them.*

BASICS

Diversity of life - Genetic diversity, Species diversity & Ecosystem diversity. Prokaryotic and Eukaryotic cells - Constituents and organelles present in prokaryotic and eukaryotic cells. Similarities and differences between prokaryotic and eukaryotic cells. Macromolecules present in cells. **(9)**

BIOCHEMISTRY METABOLISM

(Anabolism and Catabolism) Carbohydrate metabolism - Glycolysis and TCA cycle. Lipid metabolism - Beta oxidation of saturated fatty acids. Synthesis of saturated fatty acids. Protein metabolism - General breakdown of proteins - Deamination, Transamination & Urea cycle. Bioenergetics - Electron transport chain and Oxidative phosphorylation. **(9)**

GENETICS AND MOLECULAR BIOLOGY

Mendelian laws of inheritance. Structure and types of DNA and RNA. Basic features of prokaryotic and eukaryotic genome organization. DNA replication - Basic principles and mechanism of DNA replication - k model of DNA replication. Transcription - Synthesis of RNA and Post-transcriptional modifications. Translation - Genetic code - General features of the genetic code. Mechanism of protein synthesis and Post translational modifications. Regulation of gene expression - Operon concept with specific reference to lac operon. **(9)**

CELL BIOLOGY

Cytoskeleton -functions of microfilaments and microtubules. Membrane systems - Structure and organization of biological membranes. Fluid Mosaic Model. Membrane proteins. Transport of molecules across membranes -Transport of small molecules - Passive transport, Active transport (Sodium-Potassium pump) and Facilitated diffusion. Transport of large molecules - exocytosis and endocytosis. Cell division - Mitosis and Meiosis. Signal transduction - Intracellular and Intercellular signalling. Role of cyclic AMP. **(9)**

MICROBIOLOGY

Basics -Broad classification and Characteristics of microorganisms. Types of culture media. Identification of microbes - Simple staining and Differential staining. Growth kinetics and growth curve. Host-Microbe interaction - Major diseases caused by different microbes in plants, animals and humans. Microbial diversity - Conservation of biodiversity - in-situ and ex-situ conservation. Ecology - Types of Ecosystems. Ecological pyramids. Virology - Structure, mode of spread and clinical manifestations of Human Immunodeficiency virus. **(9)**

TOTAL: 45

REFERENCES

1. *Ananthanarayanan and Paniker's (2017). Textbook of Microbiology, 10th edition, Orient Longman Pvt. Ltd.,Hyderabad.*
2. *Verma, P.S. and Agarwal,V.K.(2008). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. 5thedition, New Age International Publishers, New Delhi.*
3. *Karp, G., Iwasa,J. & Marshall, W. (2015). Cell and Molecular Biology-Concepts and Experiments, 8th edition, John Wiley & Sons Inc., New York.*
4. *Murray,K.R., Bender,D.A., Botham,K.M., Kennelly, P.J., Rodwell.W.V. and Weil, P.A. (2018). Harper's Illustrated Biochemistry, 31st edition, The McGraw Hill Companies.*
5. *Nelson,D.L. and Cox, M.M. (2017). Lehninger Principles of Biochemistry, 17th edition, W.H. Freeman and Company, New York.*
6. *Bery, J.M.,Tymoezko,J.L. and Stryer,L. (2015). Biochemistry, 8th edition, W.H.Freeman and Company, NewYork.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2			1	1							3	
CO2	2	3	2		1	2							2	
CO3	3	1				1							1	
CO4	2	2	2		1	1							3	1
CO5	1	2	2		1	1							2	1

(1: Slight, 2: Moderate 3: Substantial)

19CH42 - MECHANICAL OPERATIONS

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students will be able to:

CO1 : *Select the appropriate size reduction equipment and analyze the particle size distribution in the feed and product.*

CO2 : *Identify suitable storage, transportation and recovery methods for various types of solids.*

CO3 : *Design the different type of agitators and mixers used in chemical industries and compare the same.*

CO4 : *Apply the basic principles of settling and sedimentation for the separation of different type of solid particles.*

CO5 : *Understand and analyse the working principles of industrial filters, centrifuges and membrane filters.*

PROPERTIES OF PARTICULATE SOLID AND SIZE REDUCTION

Forces employed for size reduction of solids. Types of crushers, grinders and disintegrators for coarse, intermediate, fine and ultrafine grinding. Cutting machines. Size reduction operation - Power requirements - Laws of comminution. Open and closed circuit grinding. Shape factor of particulate solids. Standard sieves and sieve scales. Differential and cumulative analysis - Specific surface determination - Calculation of particle size from sieve analysis data. Size distribution of fine particles. Industrial screening equipments. Screen effectiveness. **(12)**

STORAGE, TRANSPORTATION AND RECOVERY OF FINE PARTICLES

Storage of solids - Angle of repose and angle of internal friction. Pressures in bins - Janssen equation. Mechanical and pneumatic conveying equipments. Gas cleaning methods - Cyclone separators, Bag filters, Scrubbers and electrostatic precipitators. Magnetic separation. Dense Media Separation (DMS), Flotation process. **(9)**

MIXING AND AGITATION

Agitation equipment, classification and types of impellers- applications, power requirement in agitation. Scale up of agitator design. Types of Mixers and mixing equipments for liquids, pastes, rubber and plastic materials and for dry powders. Criteria for mixing of Solids - Mixing Index. **(7)**

SIZE SEPARATION BY SETTLING AND SEDIMENTATION METHODS

Drag on spherical and non-spherical particles, Terminal settling velocity under laminar and turbulent conditions (Stokes' law and Newton's law). Size separation by settling methods - Free settling and Hindered settling. Equipments - Settling chambers, classifiers, jigging and Tabling. Theory of Sedimentation. Types of Thickeners - Batch and Continuous. Applications of batch sedimentation tests for design of continuous thickeners. **(9)**

FILTRATION AND CENTRIFUGAL SEPARATION

Principles and Theory of filtration and washing. Filter media and Filter aids. Compressibility of filter cakes. Batch and continuous filtration equipments. Principles of centrifugal filtration- industrial centrifuges, Membrane filtration. **(8)**

TOTAL : 45

TEXT BOOKS

1. *McCabe. W. L., Smith. J. C., Harriot. P., Unit Operations of Chemical Engineering, Seventh Edition, McGraw-Hill, New York, 2005.*
2. *Badger. W.L., Banchero. J.T., Introduction to Chemical Engineering, McGraw Hill (ISE), 1997.*

REFERENCES

1. *Perry. R. H., Green. D. W., Perry's Chemical Engineer's Handbook, Eighth Edition, McGraw-Hill, New York, 2007.*
2. *Narayanan. C.M., Bhattacharyya. B.C., Mechanical Operation for Chemical Engineers (Incorporating Computer Aided Analysis), Khanna Publisher, Third Edition, 2005.*
3. *Rhodes, M. J., Introduction to Particle Technology, 2nd edition, John Wiley, Chichester ; New York, 2008.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2			1	1							3	
CO2	2	3	2		1	2							2	
CO3	3	1				1							1	
CO4	2	2	2		1	1							3	1
CO5	1	2	2		1	1							2	1

(1: Slight, 2: Moderate 3: Substantial)

19CH43 - CHEMICAL REACTION ENGINEERING - I

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of course, students will be able to

CO1 : *Formulate the rate equation from the stoichiometry and reaction mechanism for elementary and non-elementary reactions and determine the effect of temperature on the rate of reaction based on Arrhenius, Collision and Transition State Theories.*

CO2 : *Analyze kinetic data and determine the components of the rate equation (reaction order and specific reaction rate) for homogeneous single or multiple reactions using differential and integral method of analysis.*

CO3 : *Design batch, plug flow and continuous stirred tank reactors and choose the appropriate reactor or reactor combination based on qualitative and quantitative analysis for the specific reaction conditions.*

CO4 : *Predict the effect of pressure and temperature on adiabatic and non-adiabatic operation*

CO5 : *Compute precisely the moments of RTD using pulse tracer test data for the real reactors and estimate extent of non-ideality of real reactors based on the segregation, tank in series and dispersion models using pulse tracer test or conversion data.*

CHEMICAL KINETICS

Classification of reactions, Types of rate expressions, Elementary and Non elementary reactions, Types of intermediates and testing a mechanism in nonelementary reactions, Temperature dependency of the rate constant based on Arrhenius, collision and Transition State Theories. **(9)**

DATA ANALYSIS AND INTERPRETATION

Differential and integral Methods of analysis of rate data, Interpretation of rate data in constant and variable volume systems, Kinetics of irreversible, Parallel and Series reactions in constant volume batch reactor. **(9)**

DESIGN OF IDEAL REACTORS

Development of design expressions for Batch, Plug flow and Continuous Stirred Tank reactors. Comparison, advantages and limitations. Concept of space time and velocity. Size comparison of single reactors. Plug flow reactors in series and parallel, Mixed Flow Reactors of equal and different sizes in series. Reactors of different types in series. Recycle reactor. Qualitative and quantitative treatment of parallel, series reactions. **(9)**

TEMPERATURE AND PRESSURE EFFECTS

Single reactions - Heats of Reaction from Thermodynamics, Equilibrium Constants from Thermodynamics, General Graphical Design Procedure, Optimum Temperature Progression, Adiabatic and non-adiabatic operations, Multiple reactions - Product Distribution and Temperature. **(9)**

NON-IDEAL FLOW

Residence time distribution Function. Relationship among E, F and C curves. Moments of RTD. Models for non-ideal flow - Segregation, Tanks in series and Dispersion models. **(9)**

TEXT BOOKS

1. *Levenspiel O "Chemical Reaction Engineering"(Third Edition) Wiley Eastern, New Delhi,(2000)*
2. *Foggler H.S. " Essentials of Chemical reaction Engineering" PHI Ltd,2010*

REFERENCE

1. *Smith J.M.,"Chemical Engineering Kinetics"(Third Edition),McGraw Hill (ISE)(1981)*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	2	1					2	3	3
CO2	3	3	2	3	2	2	1					2	3	3
CO3	3	3	3	2	2	3	1					3	3	3
CO4	3	3	3	2	2	3	1					2	3	3
CO5	3	3	3	3	2	3	1					3	3	3

(1: Slight, 2: Moderate 3: Substantial)

19CH44 - HEAT TRANSFER

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students will be able to

CO1 : *Solve one-dimensional steady state heat conduction problems for the rectangular, cylindrical and spherical Co-ordinate systems.*

CO2 : *Analyze the convection heat-transfer problems for laminar and turbulent flows in internal and external configurations by understanding the basics of the boundary layer theory.*

CO3 : *Estimate heat exchanger design parameters like heat transfer area and overall heat transfer coefficient using LMTD and effectiveness - NTU method.*

CO4 : *Estimate the heat transfer co-efficient for phase change operations using empirical correlations.*

CO5 : *Apply fundamental laws of radiation to determine the heat transfer rate between surfaces and apply the principles of evaporation to precisely calculate the energy requirement for single and multiple effect evaporators.*

CONDUCTION

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer - Fourier's law of heat conduction - one dimensional steady state heat conduction equation for flat plate, hollow cylinder and sphere - Heat conduction through a series of resistances - effect of temperature on thermal conductivity; Combined Conduction- Convection Heat transfer, Critical radius of insulation, Heat transfer in extended surfaces, Unsteady state heat transfer. **(9)**

CONVECTION

Concepts of heat transfer by convection - Natural and forced convection, Dimensional analysis in heat transfer, Correlations for the calculation of heat transfer coefficients, heat transfer coefficient for flow through a pipe, flow through a non circular conduit, Concepts of thermal boundary layer, Von karmaan Integral & energy Equation for flow past flat plate, Heat transfer by natural convection. **(9)**

HEAT EXCHANGERS

Parallel and counter flow heat exchangers - Log mean temperature difference - Single pass and multipass heat exchangers; plate heat exchangers; use of correction factor charts; heat exchangers effectiveness; number of transfer unit - Chart for different configurations - Fouling factors - Design of various types of heat exchangers and condensers. **(9)**

CONDENSATION AND BOILING

Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, effect of non-condensable gases on rate of condensation. Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling. **(9)**

EVAPORATION AND RADIATION

Theory of evaporation - single effect and multiple effect evaporation -Types of Evaporators -Design calculation for single and multiple effect evaporation. Radiation heat transfer - Emissive power, Black body radiation, Emissivity, Stefen - Boltzman law, Planck's law, radiation between surfaces. **(9)**

TEXT BOOKS

1. *Binay K. Dutta., Heat Transfer: Principles and Applications, Fifth Printing, Prentice Hall of India Private Limited, 2006.*
2. *Holman, J. P., Heat Transfer, Tenth Edition, McGraw Hill, USA, 2010.*
3. *Ghajar A.J., Cengel Y.A., Heat and Mass Transfer: A Practical Approach, 5th edition., McGraw-Hill, USA, 2014.*

REFERENCES

1. *McCabe W.L., Smith J.C., Harriott. P., Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill International Student Edition, 2005.*
2. *Frank Kreith, Raj M Manglik, Principles of Heat Transfer, 8th edition., Cengage Learning, USA, 2016.*
3. *Kern, D.Q., Process Heat Transfer, McGraw-Hill, 1999.*
4. *Coulson, J.M. and Richardson, J.F., Chemical Engineering, Vol-1, Fourth Edition, Asian Books Private Limited, India, 1998.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2		3	3				1	2		3	
CO2	3	3	2	2	3	3				1	1		3	
CO3	3	3	3	1	3	3				1	2		3	
CO4	3	3	3	1	2	3				1	2		3	
CO5	3	3	3	1	2	3				1	2		3	

(1: Slight, 2: Moderate 3: Substantial)

19CH45 - MASS TRANSFER - I

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students will be able to:

CO1 : *Estimate the mass transfer flux for molecular diffusion in fluids and measurement of diffusivity.*

CO2 : *Analyze mass transfer theories to predict the mass transfer coefficients, develop the analogy between momentum, heat and mass transfer.*

CO3 : *Compute the height of packing or number of plates required for the given separation by graphical and analytical method for absorption.*

CO4 : *Analyze flash, differential and steam distillation methods and calculate the vapour-liquid equilibria.*

CO5 : *Determine the number of ideal plates using Ponchon-savarit and Mccabe-thiele method and categorize azeotropic and extractive distillation.*

DIFFUSION IN FLUIDS

Molecular diffusion and eddy diffusion. Steady state molecular diffusion in fluids at rest and in laminar flow. Molecular diffusion in gases, Steady state diffusion of gas A through non-diffusing gas B, steady state equimolal counter diffusion. Steady state diffusion in multicomponent mixtures - Effective diffusivity, Molecular diffusion in liquids. Diffusivity prediction in gases and liquids. **(9)**

INTERPHASE MASS TRANSFER

Mass transfer coefficients, F and K type mass transfer coefficients, Relation between mass transfer coefficients, Film theory, Penetration theory, Danckwerts surface renewal theory. Two film theory. Wetted wall towers. Equilibrium stage modelling: equilibrium curve and operating line. Analogy between momentum, heat and mass transfer. **(9)**

ABSORPTION

Equipment for gas-liquid operations: Packed towers and plate columns. Equilibrium solubility of gases in liquids. Choice of solvents for absorption. Single component absorption. Operating and equilibrium lines for absorber and stripper. Minimum liquid - gas ratio for absorption. Counter current multistage operation, absorption of one component in packed tower, overall coefficients, Concept of HETP, NTU and HTU - graphical and analytical methods. **(9)**

DISTILLATION

Vapour - Liquid - Equilibrium (VLE). Ideal solutions and Raoult's law, non ideal solutions and Henry's law, relative volatility, azeotropes - minimum and maximum boiling. Flash distillation, differential distillation - Rayleigh's equation, steam distillation. **(9)**

CONTINUOUS FRACTIONATION

Determination of number of theoretical plates using McCabe - Thiele and Ponchon - Savarit methods. Location of feed plate. Reflux ratio - minimum reflux, optimum reflux, total reflux. Plate efficiency - overall and Murphree efficiencies. Azeotropic and extractive distillations. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Treybal R.E., Mass Transfer Operations, Third Edition, McGraw Hill Education (India) Private Limited., 2012.*
2. *Binay K Dutta, Principles of Mass Transfer and Separation Processes, PHI learning Private Limited, New Delhi, 2013.*
3. *McCabe W.L., Smith J.C., Harriott P., Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill Education (India) Private Limited., 2014.*
4. *N.Anantharaman, K.M.Meera Sheriffa Begum, Mass Transfer :Theory and Practice, Prentice Hall India Pvt Ltd, 2017.*

REFERENCES

1. *Geankoplis C. J., Transport Processes and Unit Operations, Third Edition, Prentice Hall of India Private Limited, New Delhi, 2003.*
2. *E.L. Cussler, Mass transfer in fluid systems, 2nd edition, Cambridge university press, 1984.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3			1	1							1	
CO2	3	1			1	1							2	1
CO3	3	3	1		2	2							3	2
CO4	1	2	1		1	1							1	1
CO5	3	3	1	1	2	1							3	1

(1: Slight, 2: Moderate 3: Substantial)

19CH46 - INSTRUMENTAL METHODS OF ANALYSIS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Understand the basic principles of spectroscopy and identify the structure of the organic compound from the spectroscopic studies.*

CO2 : *Predict the functional groups and mass of the organic & inorganic compounds from IR & mass spectroscopy.*

CO3 : *Determine the thermal stability from TGA, exothermic & endothermic reactions of the sample from DTA and surface analysis using various advanced techniques.*

CO4 : *Determine the concentration of the solutes in a mixture using solvent extraction and chromatographic methods.*

CO5 : *Understand about the types of precipitants, their advantages and disadvantages; theories of precipitation; general rules for precipitation and role of crucibles.*

UV-VISIBLE SPECTROSCOPY AND NMR SPECTROSCOPY

UV-VISIBLE SPECTROSCOPY

Electromagnetic radiation - Characteristics - Wave length, wave number, frequency, energy. Lambert's and Beer-Lambert's laws - Theory of electronic spectroscopy - Chromophores - Auxochrome - Types of absorption bands - Absorption and intensity shifts -Instrumentation -Applications. **(5)**

NMR SPECTROSCOPY

Theory - Chemical shift - Factors influencing chemical shift - Spin-Spin coupling -Instrumentation. **(4)**

IR SPECTROSCOPY AND MASS SPECTROSCOPY

IR SPECTROSCOPY

Theory of IR spectroscopy, Various molecular vibrations - stretching, bendingand its types -various ranges of IR (Near, Mid, Finger print and Far). Fundamental Vibrational frequency & overtones - Number of vibrational modes for diatomic and triatomic molecules (both linear and nonlinear) - Instrumentation of IR spectroscopy - Applications. **(5)**

MASS SPECTROSCOPY

Basic principles - Theory - Nitrogen rule - Advantages and disadvantages of mass spectra - McLafferty rearrangement - Applications. **(4)**

THERMAL METHODS AND SURFACE CHARACTERIZATIONS

Principles of thermogravimetric analysis (TGA) - Instrumentation - Factors influencing the thermogram - Applications of TGA. Differential thermal analysis (DTA) - Theory - Instrumentation - Thermal analysis of calcium oxalate monohydrate and calcium acetate monohydrate - Applications of DTA. **(6)**

Surface area determination by BET method - Particle size determination by light scattering method- Scanning Electron Microscopy (principles & theory only) and EDAX analysis. **(3)**

SEPARATION METHODS

Principles of solvent extraction - Extraction techniques (Soxhlet extractor) - Analytical applications. **(3)**

Chromatography - Theory - Classification - Principle, Instrumentation and Applications of thin layer, column, paper, gas and high-performance liquid chromatography. **(6)**

PRINCIPLES OF GRAVIMETRIC ANALYSIS

Methods of obtaining the precipitate - Conditions for precipitation - Choice of precipitants - Advantages of using organic precipitants - Disadvantages - Types of organic precipitants - Specific and selective precipitants - Sequestering agents.Theories of precipitation - Co-precipitation - Post-precipitation. Effects of digestion - General rules for precipitation - Precipitation from homogeneous medium - Washing of precipitates - Drying of precipitates - Types, care and use of crucibles. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Sharma B.K., Instrumental methods of chemical analysis, Eighteenth Edition, GOEL publishing House. 2002.*
2. *Ewing G.W., Instrumental methods of Chemical Analysis, Fifth Edition, McGraw Hill, New York, 1992.*
3. *Chatwal, Anand, Instrumental Methods of Chemical Analysis, Seventh Edition, Himalaya Publishing House. 2005.*
4. *Vogel's textbook of Quantitative Chemical Analysis, Fifth Edition. ELBS Publications, 2007.*

REFERENCES

1. *Skoog D.A. - Pinciples of Instrumental Analysis, Sixth Edition, Saunders College Publication, 2007.*
2. *Williard H.H., Meritt L.C and Dean J.H., - Instrumental Methods of Analysis, Sixth Edition, 1990.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2		2	2					1			2	1
CO2		2		2	2					1			2	1
CO3		2		2	2					1			2	1
CO4		2		2	2					1			2	1
CO5	3	2		2	2					1			2	1

(1: Slight, 2: Moderate 3: Substantial)

19CHL47 - FLUID MECHANICS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students will be able to

CO1 : *Apply the concepts of fluid mechanics in fluid flow meters to estimate its performance characteristics.*

CO2 : *Calculate the friction losses and loss coefficient of pipe fittings in pipe network.*

CO3 : *Operate fluid transportation equipment and compare the results of analytical models to the actual behaviour of real fluid flows and draw performance curves.*

CO4 : *Conduct experiments to solve complex engineering problems effectively as an individual or team work.*

CO5 : *Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.*

LIST OF EXPERIMENTS

1. Determination of discharge / loss coefficient in venturi and orifice Meter
2. Pressure drop studies on helical coil and spiral coil
3. Determination of friction factor and expansion loss coefficient in a pipe
4. Performance studies on reciprocating pump
5. Determination of discharge coefficient for globe Valve and loss coefficient for 90°bend in a pipe
6. Performance studies on centrifugal pump
7. Determination of discharge coefficient for various notch apparatus
8. Pressure drop studies on fluidized bed
9. Pressure drop studies on packed bed
10. Determination of relationship between friction loss and Reynolds number in an annular pipes
11. Verification of Bernoulli's Theorem
12. Study on Reynolds apparatus

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	3					2	1	3	
CO2	2	3	1	1	1	1					2	1	3	
CO3	1	1	1	2	3	2				2	1	2	3	
CO4	3	2	2	2	1	2	1	1	3		2	3	2	3
CO5			2				2	3	3		1	2	1	2

(1: Slight, 2: Moderate 3: Substantial)

19CHL48 - TECHNICAL ANALYSIS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, the students will be able to

CO1 : *Analyse the samples by both quantitative and qualitative methods.*

CO2 : *Attain skills in analysing various samples and handling of instruments.*

CO3 : *Assess practical knowledge to carry out meaningful interpretation of data from analytical chemical measurements.*

CO4 : *Conduct experiments to solve complex engineering problems effectively as an individual or team work.*

CO5 : *Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.*

LIST OF EXPERIMENTS

1. Analysis of cement
2. Estimation of available chlorine in bleaching powder
3. Estimation of nitrogen in inorganic fertilizer
4. Determination of total fatty matter in soap
5. Determination of acid value of an oil
6. Determination of saponification value of an oil
7. Evaluation of purity in calcium carbonate
8. Estimation of calcium oxide in quick lime
9. Estimation of magnesium silicate in talcum powder
10. Estimation of Glucose
11. Estimation of manganese dioxide in Pyrolusite
12. Estimation of loss on ignition, silica, iron and aluminum oxides in Bauxite
13. Estimation of tin, lead, copper and zinc in Brass
14. Determination of biochemical oxygen demand (BOD)
15. Determination of acidity or alkalinity of a solution using pH meter
16. Determination of concentration of unknown solution by UV-Vis Spectrophotometer
17. Determination of concentration of unknown solution by Nephelometer
18. Determination of sodium / potassium using Flame Photometer

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1		1		1							1	
CO2	2	2		1		1								
CO3	2		1	1									1	
CO4								1	3	3	2			1
CO5				1				1	2	1	2			1

(1: Slight, 2: Moderate 3: Substantial)

19HOC41 - COMMUNICATION SKILLS FOR ENGINEERS - II

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Students will be able to

CO1 : *Solve objective questions on analogy, Statement and Argument, Statement and Conclusion, Data Sufficiency and Sentence improvement within a given time.*

CO2 : *Construct grammatically correct sentences.*

CO3 : *Speak confidently to describe a process, present information on the specified topic and disseminate information in a professional manner.*

SELF EVALUATION

Self believe and self Esteem - Activities based on Current Events. **(2)**

VERBAL AND LOGICAL RESONING

Analogy - Introduction, Types and Exercises - Statement and Argument - Statement and Conclusion - Data Sufficiency - Sentence Improvement - Critical Reasoning / Theme Detection **(5)**

GRAMMAR

Basic Grammar- Subject Verb Agreement - One word substitute - Preposition- Cause and Effect - Basic level questions and Moderate level questions. **(4)**

PRESENTATION TECHNIQUES

Describing a Process - Presentation Skills - Introduction, Planning and Preparation - Presentation on a Topic - Group Discussion - Dos and Don'ts - Functional Expressions used in Group Discussion - Interview Skills - Ideal Grooming for an interview, Preparing for the Interview **(9)**

REFERENCES

1. *Sanjay Kumar, Pushp Lata, Communication Skills SECOND EDITION, published by Oxford University Press, New Delhi, India, 2015.*
2. *Anthony Manning, Chris Sowton and Craig Thaine, Cambridge Academic English, published by Cambridge University Press, U P, India, 2012.*

19CH51 - NUMERICAL METHODS IN CHEMICAL ENGINEERING

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of course, students will be able

CO1 : *To solve systems of algebraic equation using various numerical schemes and to develop programming code using MATLAB and EXCEL.*

CO2 : *To Solve nonlinear algebraic equation using open and bracketing type numerical methods*

CO3 : *To practice numerical integration using trapezoidal, Simpsons techniques for chemical problems*

CO4 : *To solve single ODE and Simultaneous ODEs using various numerical schemes.*

CO5 : *To formulate and solve PDEs for real time chemical Engineering Problems.*

NUMERICAL METHODS FOR SINGLE ALGEBRAIC EQUATIONS

Introduction, Root finding methods for solution on non-linear algebraic equations: Bisection, Newton-Raphson and Secant methods, System of Non-linear Equations. Chemical Engineering problems involving solution of non-linear equations **(9)**

NUMERICAL METHODS FOR SIMULTANEOUS ALGEBRAIC EQUATIONS

Methods like Gauss elimination, LU decomposition and matrix inversion, Gauss-Seidel method, Chemical Engineering problems involving solution of linear algebraic equations. **(9)**

INTERPOLATION AND NUMERICAL INTEGRATION

Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression, Numerical integration: Trapezoidal rule, Simpson's rule, integration with unequal segments, Chemical engineering problems involving numerical differentiation and integration **(9)**

NUMERICAL METHODS FOR ODES

Ordinary Differential Equations: Euler method, Runge-Kutta method, Adaptive Runge-Kutta method, Initial and boundary value problems, Chemical engineering problems involving single, and a system of ODEs. **(9)**

NUMERICAL METHODS FOR PDES

Introduction to Partial Differential Equations: Characterization of PDEs, Laplace equation, Heat conduction/ diffusion equations, explicit, implicit, Crank-Nicholson method, Introduction to Finite element method. **(9)**

TEXT BOOKS

1. *Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012.*
2. *Pradeep Ahuja, “Intrduction to Numerical Methods in Chemical Engineering”, 2nd Edition, PHI Learning Private Limited, 2019.*

REFERENCES

1. *S.C. Chapra & R.P. Canale, "Numerical Methods for Engineers with Personal Computer Applications", McGraw Hill Book Company, 1985.*
2. *R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.*
3. *Atkinson, K. E., "An Introduction to Numerical Analysis", John Wiley & Sons, 1978.*
4. *Press, W. H. et al., "Numerical Recipes in C: The Art of Scientific Computing, 3rd Edition, Cambridge University Press, 2007.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3			1	1							1	
CO2	3	1			1	1							2	1
CO3	3	3	1		2	2							3	2
CO4	1	2	1		1	1							1	1
CO5	3	3	1	1	2	1							3	1

(1: Slight, 2: Moderate 3: Substantial)

19CH52 - CHEMICAL REACTION ENGINEERING - II

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of course, students will be able to

CO1 : *Develop rate kinetic for catalytic reaction and catalyst deactivation.*

CO2 : *Analyze external diffusion Effects on heterogeneous reactions.*

CO3 : *Solve the problem based on diffusion and reaction in porous catalysts*

CO4 : *Develop the reaction kinetics for a non-catalytic reaction with chemical reaction and mass transfer controlling regime and design non-catalytic reaction system*

CO5 : *To explain the underlying principles in multiphase reactors kinetics.*

CATALYSIS AND CATALYTIC REACTORS

Catalysts - Steps in a Catalytic Reaction - Synthesizing a Rate Law, Mechanism, and Rate-Limiting Step - Design of Reactors for Gas-Solid Reactions - Heterogeneous Data Analysis for Reactor Design - Chemical Vapor Deposition- Catalyst Deactivation. **(9)**

EXTERNAL DIFFUSION EFFECTS ON HETEROGENEOUS REACTIONS

Mass Transfer Fundamentals - Binary Diffusion - External Resistance to Mass Transfer - Mass Transfer to a Single Particle- Mass Transfer-Limited Reactions in Packed Beds - Mass Transfer-Limited Reaction on Metallic Surfaces - The Shrinking Core Model. **(9)**

DIFFUSION AND REACTION IN POROUS CATALYSTS

Diffusion and Reaction in Spherical Catalyst Pellets - Internal Effectiveness Factor - Falsified Kinetics - Overall Effectiveness Factor - Overall Effectiveness Factor - Estimation of Diffusion- and Reaction-Limited Regimes - Mass Transfer and Reaction in a Packed Bed. **(12)**

HETEROGENEOUS NON-CATALYTIC FLUID-SOLID SYSTEMS

Kinetic models for non-catalytic fluid-solid systems - Progressive conversion and Unreacted core Models. Development of rate expressions for various controlling regimes- Application to design. **(9)**

FLUID-FLUID REACTIONS: KINETICS AND DESIGN

The rate equation- The rate equation for straight mass transfer (absorption) of a - the rate equation for mass transfer and reaction - straight mass transfer - mass transfer plus not very slow reaction - Multiphase Reactors - Slurry Reactors and Trickle bed reactors. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Foggler H. S, Elements of Chemical Reaction Engineering, (Third Edition) Prentice Hall, 2001*
2. *Levenspiel .O, Chemical Reaction Engineering (Third Edition) Wiley Eastern, New Delhi, (2000)*

REFERENCES

1. *Carberry, J. J., Dover, Chemical and Catalytic Reaction Engineering, Mc GrawHill-USA,2001.*
2. *Gilbert F. Froment, Kenneth.B.Bischoff, Juray De Wilde, Chemical Reactor Analysis and Design, John Wiley & Sons, Incorporated, 2010.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	2	1					3	3	
CO2	3	2	3	2	2	3	1					3	3	
CO3	3	3	3	2	2	3	1					3	3	
CO4	3	3	3	2	2	3	1					3	3	
CO5	3	2	3	2	2	3	1					3	3	

(1: Slight, 2: Moderate 3: Substantial)

19CH53 - MASS TRANSFER - II

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of course, students will be able to

CO1 : *Determine the number of stages and recovery efficiency for solid-liquid and liquid-liquid extraction processes.*

CO2 : *Calculate the quantity of adsorbent required for stage-wise operations and illustrate the types of adsorption, adsorption isotherms and ion-exchange process.*

CO3 : *Determine the properties of air-water system using psychrometric chart and review the operational features of cooling towers.*

CO4 : *Analyse the applications of dryers and calculate the time of drying from rate of drying curve.*

CO5 : *Compute the yield of crystals and select the crystallizer by revising the working features.*

EXTRACTION

Application of liquid-liquid extraction, Liquid-liquid equilibria, general features of triangular co-ordinate systems, Choice of solvent for extraction, Number of stages, Minimum solvent rate, Solid-liquid extraction, Typical industrial applications, Factors affecting leaching - agitation, particle size, temperature and solvent properties, Leaching by percolation moving bed leaching and shank's system, Operation of stage wise and differential contact extractors. **(9)**

ADSORPTION AND ION EXCHANGE

Types of adsorption, factors influencing adsorption, nature of adsorbents, Industrial adsorbents, Adsorption isotherms, Adsorption operation - single stage and multistage crosscurrent and countercurrent operations, Determination of number of stages. Recovery of solvent vapors, Principles of ion exchange - techniques and applications - equilibria, rate of ion exchange **(9)**

HUMIDIFICATION

Humidification operation, Properties of air-water vapour system, Psychometric chart, Methods of humidification and dehumidification, Lewis relation, Theory and principles of cooling towers, Types of cooling towers. Design of cooling tower. **(9)**

DRYING

Theory and mechanism of drying. Batch drying test, drying rate curve, time of drying. Mechanism of moisture movement, drying rate during constant rate period, unsaturated surface drying, drying with internal diffusion. Methods of drying- Classification of dryers, Continuous drying operations and equipment. Application of dryers in process industries. **(9)**

CRYSTALLIZATION

Theory of crystallization, methods of supersaturation, nucleation and crystal growth, Batch and continuous crystallizers. Performance and applications of industrial crystallizers. **(9)**

TOTAL : 45

TEXT BOOKS

1. *McCabe W. L., Smith J.C., and Harriott P., Unit Operations of chemical Engineering, seventh Edition, McGraw Hill Education (India) Private Limited, 2014.*
2. *Treybal R.E., Mass Transfer Operations, Third Edition, McGraw Education (India) Private Limited, 1980.*
3. *Binay.K.Dutta., Principles of Mass Transfer and Separation Process, PHI Learning Pvt.Ltd, 2013.*
4. *N.Anantharaman, K.M.Meera Sheriffa Begum, Mass Transfer :Theory and Practice, Prentice Hall India Pvt Ltd, 2017.*

REFERENCES

1. *Coulson J.M., Richardson J.F., Backhurst J.R Harker J.M., Coulson and Richardson's., Chemical Engineering, Vol II, 6th Edition,Butter Worth Heinemann, Oxford, 2002.*
2. *Alan S. Foust, Leonard A Wenzel, CurlisW.Clump, Louis Maus, L.Bryce Andersen., Principles of Unit operations, second ed, John Wiley and Sons, 2008.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		2	1							3	1
CO2	3	3	2			1	1						1	
CO3	2	1	1			2							2	
CO4	1	2	1			1							3	3
CO5	1	2	2			1							1	1

(1: Slight, 2: Moderate 3: Substantial)

19CHL56 - ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Upon successful completion of course, students will be able to

CO1 : *To differentiate between wage employment, self-employment and entrepreneurship*

CO2 : *To appreciate and develop positive thinking and self-confidence for embarking on self-employment / entrepreneurship.*

CO3 : *To appreciate the importance of systematic planning in setting up and managing a business enterprise.*

PART I

MOTIVATION AND CONFIDENCE BUILDING

Positive thinking, shedding negative feelings, Experience Sharing by successful entrepreneurs, Motivational video clips, Scope for Self-employment. **(7)**

PART II

SELF EMPLOYMENT

Advantages over wage employment, Entrepreneurship Development, Need and importance of embarking on self-employment Advantages of self-employment, Assessing self to know entrepreneurial tendencies, Process of Entrepreneurship Development Importance of behavioural changes for entrepreneurship, Difference between Income Generating Activity, Self-Employment and Entrepreneurship, Characteristics of an entrepreneur - Dynamics of Entrepreneurship, Attitude and its impact on Entrepreneurship. **(8)**

TOTAL : 15

TEXT BOOKS

1. *Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Entrepreneurship, Tata McGraw Hill, 10 th Edition.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								2	1					
CO2									2					
CO3								3	2					

(1: Slight, 2: Moderate 3: Substantial)

19CHL57 - MECHANICAL OPERATIONS LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students will be able to

CO1 : *Apply the concepts of mechanical operations in physical separation processes.*

CO2 : *Perform the sieve analysis using various size reduction equipment's.*

CO3 : *Operate and estimate the performance characteristic parameters for solid fluid and solid-solid separation equipment's.*

CO4 : *Conduct experiments to solve complex engineering problems effectively as an individual or team work.*

CO5 : *Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.*

LIST OF EXPERIMENTS

1. Determination of Critical Speed and Reduction Ratio of Ball Mill
2. Performance Studies on Jaw Crusher
3. Estimation of Separation Efficiency of Froth Floatation Cell
4. Determination of Specific Cake and Filter Medium Resistance of slurry using Plate and Frame Filter Press
5. Performance Studies on Roll Crusher
6. Estimation of area of Thickener for a Batch Sedimentation Unit
7. Determination of Effectiveness of Screen
8. Determination of Specific Cake Resistance of Slurry and Compressibility Factor of Leaf Filter under Constant Pressure Filtration
9. Estimation of Separation Efficiency of Cyclone Separator
10. Performance Studies on Hammer Mill
11. Determination of Specific Cake Resistance of Slurries Using a Continuous Rotary Vacuum drum filter press
12. Estimation of separation efficiency of Air Classifier
13. Study the Wall Effect on the Terminal Settling Velocity of a Sphere
14. Performance studies on mixing apparatus
15. Performance studies on solid transportation equipment

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	3					2	1	3	
CO2	2	3	1	2	1	2					2	1	3	
CO3	3	2	2	2	2	2	1		2	2	1	2	3	
CO4	3	2	2	2	1	2	1	1	3		2	3	2	3
CO5			2				2	3	3		1	2	1	2

(1: Slight, 2: Moderate 3: Substantial)

19CHL58 - HEAT TRANSFER LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students will be able to

CO1 : *To collect quality raw data from any heat transfer operation and to compare observed with predicted performance.*

CO2 : *To apply the concepts of heat transfer, fluid dynamics and thermodynamics to the design and operation of heat transfer experiments.*

CO3 : *To determine the heat transfer co-efficient and effectiveness of heat exchangers from experimentally observed data.*

CO4 : *Conduct experiments to solve complex engineering problems effectively as an individual or team work.*

CO5 : *Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.*

EXPERIMENTS

1. Determination of heat transfer coefficients by Natural Convection
2. Heat transfer in agitated vessel(steady state)
3. Heat transfer studies in fluidized bed dryer
4. Heat transfer studies in packed bed
5. Studies in Cross flow plate fin Heat Exchanger
6. Studies in Plate type Heat Exchanger
7. Studies in on Nucleate Boiling
8. Studies in Shell and Tube Heat exchanger
9. Studies in Stefan Boltzmann apparatus
10. Studies in Film wise and Drop wise Condensation

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	3					2	1	3	
CO2	2	3	1	2	1	2					2	1	3	
CO3	3	2	2	2	2	2	1		2	2	1	2	3	
CO4	3	2	2	2	1	2	1	1	3		2	3	2	3
CO5			2				2	3	3		1	2	1	2

(1: Slight, 2: Moderate 3: Substantial)

19INT51 - INTERNSHIP-I

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, the students are able to

CO1 : *Analyze the basic principles and knowledge of chemical engineering which has been applied in the production of various products in industries.*

CO2 : *Conduct lab scale experiments through the experience gained from the large scale industries.*

CO3 : *Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.*

- Students are instructed to complete six to eight weeks of internship in any Chemical Process Industry or Nationalized Academic Institution.
- A written report and an oral presentation should be given after successful completion of internship.

19HOC51 - EMPLOYABILITY AND PERSONALITY DEVELOPMENT SKILLS - I

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Students will be able to

CO1 : *Solve objective questions on Syllogisms, Data Interpretation, Critical Reasoning, Theme Detection, Sentence Completion and Business Vocabulary*

CO2 : *Develop appropriate responses for business phone calls and negotiate effectively.*

CO3 : *Speak with appropriate body language for a technical speaking task.*

CO4 : *Project the appropriate grooming and the right etiquettes, for interview and group discussion task.*

VERBAL APTITUDE

Syllogisms-Paragraph Comprehension -Data Interpretation -Critical Reasoning/Theme Detection - Grammar -Sentence Completion Filler - Business Vocabulary- Foreign phrases used in English **(3)**

PROFESSIONAL COMMUNICATION

Telephonic Conversation Skills - Telephonic Interview -Etiquettes - Professional, Dining & Telephone - Employability skills - Importance and Employability level of present Y and Z Generation - Interpersonal Skills - Negotiation Skills - Types, Expressions used in formal and informal negotiations, Stages of Negotiation - Time Management - Pareto principle, Prioritizing tasks, Barriers to time management. **(7)**

THE ART OF SPEAKING

Types of Speaking - Barriers to Speaking - Presentation on a Technical Topic - Speaking on Current Trends in the Industry. **(5)**

NON-VERBAL COMMUNICATION

Interview Skills - Non-Verbal Communication - Smiling, Posture, Handshake, Tone of Voice and Eye Contact - GD tips & techniques and Mock GD- Body Language - Grooming. **(5)**

REFERENCES

1. *Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.*
2. *Petes S. J., Francis. Soft Skills and Professional Communication. New Delhi: Tata McGraw-Hill Education, 2011.*
3. *John Hayes. Interpersonal Skills at Work. Second Edition. Routledge publication. 2005*

19CH61 - PROCESS DYNAMICS AND CONTROL

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students will be able to

CO1 : *Apply conservation principles in order to model the dynamics of simple process systems to develop first, second and multi capacity transfer functions.*

CO2 : *Analyse closed loop stability systems by applying transient responses and also to test the stability of the control system by Root Locus, Routh and Bode methods.*

CO3 : *Discuss P, PI, PD, PID controller actions and its transfer functions. Practice block diagram development for closed loop systems by applying transient responses to find the process error.*

CO4 : *Devise control strategies for the control of mass and heat transfer equipment using advanced controllers.*

CO5 : *Discuss digital process controllers and the hardware components of its direct digital controllers and its applications.*

OPEN LOOP SYSTEMS

Laplace Transforms - Standard functions and solution of ODE, Open loop systems, first order systems and their transient response for standard input functions, first order systems in series, Transportation Lag and Dead time, second order systems and their dynamics. **(12)**

CLOSED LOOP SYSTEMS

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, stability analysis using Routh-Huritz and root-locus and its diagrams. **(12)**

FREQUENCY RESPONSE

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, Principle of Nyquist diagram, stability criterion, Controller tuning, Zeigler Nicholas, Cohen-Coon and other methods. **(8)**

ADVANCED CONTROL SYSTEMS

Introduction to advanced control systems, cascade control, feed forward control, feed back controller Model predictive control, Smith Predictor, Ratio controller, IMC and its application. **(8)**

DIGITAL CONTROLLERS

Introduction to Computer control loops, Digital computer, computer process Interface, digital to analog and analog to digital converters, sampling continuous signal, Hardware components of a DDC loop, supervisory controller, DCS and PLC. **(5)**

TOTAL : 45

TEXT BOOKS

1. *Coughanowr D., Steven Leblanc, Process Systems Analysis and Control, Third Edition, McGraw Hill, New York, 2009.*
2. *Vyas R. P, Process Control and Instrumentation, Eighth Edition, Denett & Co, Nagpur, India, 2016.*
3. *Stephanopoulos G., Chemical Process Control: An Introduction to Theory and Practice, Sixth Edition, Prentice Hall of India Pvt.Ltd, New Delhi, 1998.*
4. *Coleman Brosilow, Babu Joseph, Techniques of Model-Based Control, Prentice,Hall International,2002.*
5. *Surekha Bhanot, Process Control: Principles and Applications, Oxford University Press,2007.*

REFERENCES

1. *Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, Francis J. Doyle, III, Process Dynamics and Control, Fourth Edition, John Wiley and sons, New York, 2016.*
2. *Carlos A Smith, Armando B Corripio, Principles and Practice of Automation process control, Third Edition, John Wiley, New York, 2005.*
3. *Harriot P., Process Control, Tata McGraw Hill, New Delhi, 1997.*
4. *Jose.A. Romagnoli, Ahmet Palazoglu, Introduction to Process Control, CRC Press, 2016.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	2	2	-
CO2	2	2	-	-	2	-	-	-	-	-	-	2	2	-
CO3	2	2	-	-	2	-	-	-	-	-	-	2	2	-
CO4	2	3	2	-	2	2	1	-	-	-	-	2	3	-
CO5	2	3	2	-	2	2	1	-	-	-	-	2	3	-

(1: Slight, 2: Moderate 3: Substantial)

19CH62 - CHEMICAL PROCESS INDUSTRIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students will able to

CO1 : *Identify the contemporary technologies in water treatment and label the process economics in sal and sulphur based industries.*

CO2 : *Design the production methodology of oil industries and analyse the efficiency of the products.*

CO3 : *Analyze and formulate the chemical processes and economics involved in the carbohydrate industries.*

CO4 : *Describe the flow sheets of manufacture process of pulp based, leather industries and engineering problems faced in the industries.*

CO5 : *Evaluate the surface coating & cement industry processes to justify their appropriate production techniques and their handling processes.*

NITROGEN, PHOSPHOROUS AND SULPHUR BASED INDUSTRIES

Nitrogen, Ammonium nitrate, Ammonium sulphate and Urea. Phosphorus, Phosphoric acid, Ammonium phosphates, Sodium phosphates, Nitrophosphate& Phosphate esters. Mixed fertilizers (NPK Mixtures). Manufacture of Sulphur and Sulphuric acid. Materials for handling, storage and transportation. **(11)**

OIL AND ALLIED INDUSTRIES

Vegetable oil extraction methods.Refining of vegetable oils.Hydrogenation of Oils.Soaps and Candle.Detergents and Glycerine.Materials for handling, storage and transportation. **(7)**

CARBOHYDRATES AND FERMENTATION INDUSTRIES

Manufacture of Starch, Dextrin, Glucose and sucrose and manufacture of Ethyl alcohol, Acetic acid, Citric acid, Oxalic acid and Antibiotics (Penicillin). Materials for handling, storage and transportation. **(9)**

PULP AND LEATHER INDUSTRIES

Production of Pulp.Conversion to paper.Production of Viscose, Cuprammoniumrayons and Cellulose acetate.Production of Dimethyl sulphite and Dimethyl sulphoxide from wood liquor. Manufacture of leather from hides and skins. Manufacture of Glue and Gelatin.Materials for handling, storage and transportation. **(9)**

SURFACE COATING, CEMENT AND GLASS INDUSTRIES

Constituents of paints & varnishes and their functions. Paint mixing process. Manufacture of pigments such as White lead, Zinc oxide and Titanium dioxide. Cements: Introduction, types of cements, properties and applications. Manufacture of Portland cement. Beneficiation & Production of Hydrated lime. Raw materials for Glass Industries.Production of glass by tank furnace - shaping and forming of articles from glass. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Gopala Rao, M. & Marshall Sittig.: Dryden's Outlines of Chemical Technology, (3rd Ed.), Affiliated East-West Press, New Delhi, (2004).*
2. *Austin, G.T.: Shreve's Chemical Process Industries, (5th Ed.), McGraw Hill (ISE), (1984).*
3. *Shukla, S.D. Pandey, G.N.: A Text Book of Chemical Technology, Vol. I, Vikas, New Delhi, (1994)*

REFERENCES

1. *Venkateswaralu, D., Upadrashta, K.R. & Chandrasekaran, K.D. (Editors): CHEMTECH - I, S. Chand & Co., New Delhi, (1975).*
2. *CHEMTECH - II, Chemical Engineering Education Development Centre, I.I.T., Madras, (1977).*
3. *Kent, A.J. : Riegel's Handbook of Industrial Chemistry, Van Nostrand - Reinhold, New York, ninth Edition (1974).*
4. *Stephenson, R.M. : Introduction to Chemical Process Industries, Van Nostrand, New Jersy, (1966).*
5. *Furnas, C.C. (Editor): Roger's Manual of Industrial Chemistry, Vol. I, (6th Ed.), Van Nostrand, New Jersy, (1942).*
6. *Lowenheim, F.A. & Moran, M.K. : Faith, Keyes and Clark's INDUSTRIAL CHEMICALS, (4th Ed.), John Wiley, New York, (1975).*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3			1	1							1	
CO2	3	1			1	1							2	1
CO3	3	3	1		2	2							3	2
CO4	1	2	1		1	1							1	1
CO5	3	3	1	1	2	1							3	1

(1: Slight, 2: Moderate 3: Substantial)

19CH63 - CHEMICAL PROCESS SAFETY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students would be able to

CO1 : *judge the importance of safety in chemical process plants*

CO2 : *evaluate the degree of toxicity*

CO3 : *select the extinguishing methods for fire and explosion hazards*

CO4 : *assess temperature hazards and reaction safety.*

CO5 : *analyze risk using qualitative and semi-quantitative methods.*

OVERVIEW OF PROCESS SAFETY

Introduction to safety: Concept and importance of industrial safety-Bhopal disaster. Safety in site selection and lay out, Flares and rupture discs, work permit system, confined space safety practices, Hazards classification - GHS system, accident and loss statistics. **(9)**

TOXICOLOGICAL STUDIES

Toxicology, Dose-response relationship, Hodge-sterner table, Source models-basic, pool boiling, Threshold Limit Value - classification and significance, NFPA diamond, Industrial hygiene. **(9)**

FIRE AND EXPLOSION

Fire hazards, Fire pyramid, Types of fires, Types of fire extinguishers, Sprinklers, Explosion-classification, Fire fighting techniques, Inerting. **(9)**

TEMPERATURE AND REACTION HAZARDS

Extreme temperature hazards - hot and cold, Thermal burns, Reactive chemical hazards- characterisation using calorimeters, Thermal runaway - causes, adiabatic temperature rise, onset temperature, phi factor. **(9)**

RISK ANALYSIS

Hazard identification- Process hazard checklists, Hazard survey, HAZOP, safety review; fault tree analysis, FMEA (failure mode and effect analysis), Layer of Protection Analysis, Bow-tie analysis, domino effect. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Tweeddale, Mark, Managing risk and reliability of process plants, Gulf Professional Publishing, 2003*
2. *Kletz, Trevor, Still going wrong, Case histories of process plant disasters and how they could have been avoided, Gulf Professional Publishing, 2003*
3. *Crowl, Daniel A. and Louvar, Joseph F., Chemical process safety, Fundamentals with applications, 2nd Ed, Prentice Hall, 2002*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

COs	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2		2			2	3						
CO2	1	1	1										3	
CO3		2				2			2					
CO4			2								2			
CO5	1								2				1	

(1: Slight, 2: Moderate 3: Substantial)

19CHL66 - CHEMICAL REACTION ENGINEERING LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students will be able to

CO1 : *Collect and analyse experimental data for steady state and unsteady state reactors using statistical principles, and compare results to theoretical principles.*

CO2 : *Collect and analyse kinetic data to determine order, activation energy, frequency factor and rate constant in rate equation.*

CO3 : *Collect RTD data from steady state reactors and analyse the deviation of real reactor from ideal reactors*

CO4 : *Conduct experiments to solve complex engineering problems effectively as an individual or team work.*

CO5 : *Perform as a leader with good ethical principles to meet societal needs in the field of Chemical Engineering.*

LIST OF EXPERIMENTS

1. Kinetic Studies in Batch Reactor-I
2. Kinetic Studies in Batch Reactor-II
3. Performance Characteristics of Semi-Batch Reactor-I
4. Performance Characteristics of Semi-Batch Reactor-II
5. Performance Characteristics of Mixed Flow Reactor
6. Performance Characteristics of Plug Flow Reactor
7. Adiabatic Reactor
8. Residence Time Distribution Studies in Plug Flow Reactor
9. Residence Time Distribution Studies in Mixed Flow Reactor
10. Performance Characteristics of Tubular Reactor
11. Performance Studies of Mixed Flow Reactor in Series
12. Determination of Activation Energy

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1	0	0	0	0	0	0	**0**	**0**	**0**
CO2	3	3	3	2	0	0	0	1	0	0	0	0	0	0
CO3	3	3	3	2	0	2	0	0	1	0	0	0	0	0
CO4	3	3	3	2	0	0	0	0	0	0	0	0	0	0
CO5	3	3	3	2	0	0	0	0	0	0	0	0	0	0

(1: Slight, 2: Moderate 3: Substantial)

19CHL67 - MASS TRANSFER LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, the students will be able to

CO1 : *Design experiments to obtain mass transfer coefficients like diffusion coefficient in liquids and gases.*

CO2 : *Apply the concepts of mass transfer and thermodynamics to the design and operation of mass transfer experiments*

CO3 : *Calculate drying rates of wet solids and to determine the critical moisture & equilibrium moisture content in the different regimes of drying.*

CO4 : *Conduct experiments to solve complex engineering problems effectively as an individual or team work.*

CO5 : *Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.*

LIST OF EXPERIMENTS

1. Determination of HETP for random packing
2. Diffusivity Measurement
3. Drying Characteristics of Solid Materials By Air Blower
4. Generation of Ternary Liquid Equilibrium Data
5. Generation of Vapour Liquid Equilibrium Data
6. Studies in Counter Current Leaching
7. Studies in Cross Current Leaching
8. Studies in Distillation of Immiscible Liquids
9. Verification of Rayleigh's Equation using Simple Distillation

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2		2							3	3
CO2	3	3	3	2		2							3	3
CO3	3	3	3	2		2							3	3
CO4	3	2	2	2		2							3	3
CO5	3	2	2	2		2							3	3

(1: Slight, 2: Moderate 3: Substantial)

19CH68 - MINI PROJECT

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students will be able to

CO1 : *Understand how a project has to be started, their pre-requirements, flowchart preparation, and economic calculation and solution.*

CO2 : *Conduct experiments to solve complex engineering problems effectively as an individual or team work.*

CO3 : *Perform as a leader with good ethical principles to meet societal needs in the field of chemical and allied engineering.*

The students are expected to carry out mini project connected with process development studies which will be assigned by the faculty in charge. Progress of the work will be assessed periodically in which the student will give an oral presentation on the work done. The student should maintain a record of the work done regularly and submit them for assessment periodically. At the end of the semester, the students should submit a report of the work done in standard format which will be evaluated by the faculty and subject experts.

19INT61 - INTERNSHIP-II

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, the students will be able to

CO1 : *Analyze the basic principles and knowledge of chemical engineering which has been applied in the production of various products in industries.*

CO2 : *Conduct lab scale experiments through the experience gained from the large scale industries.*

CO3 : *Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.*

- Students are instructed to complete six to eight weeks of internship in any Chemical Process Industry or Nationalized Academic Institution.
- A written report and an oral presentation should be given after successful completion of internship.

19HOC61 - EMPLOYABILITY AND PERSONALITY DEVELOPMENT SKILLS - II

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

Students will be able to

CO1 : *Exhibit Corporate Etiquettes with assertiveness and personal effectiveness.*

CO2 : *Build teams and solve problems at workplace.*

CO3 : *Manage conflicts in a professional manner*

CO4 : *Simulate an actual Job Interview scenario to prepare a candidate for a real Interview*

CORPORATE ETIQUETTE

Corporate Etiquette: Dos and Don'ts, - Conversational dos and don'ts - Creating elusive first impression- Assertiveness-Personal Effectiveness **(4)**

LEADERSHIP AND TEAM MANAGEMENT

Leadership Skills - Understanding Traits and Styles - Team Building: Bonding, Development and Delegation - Adaptability and Work Ethics - Handling Team Dynamics- Giving and Receiving Feedback- Problem Solving Skills. **(5)**

STRESS AND CONFLICT MANAGEMENT

Emotional Intelligence: Recognition, Understanding and Managing - Stress Management: Techniques and Benefits - Conflict Management: Introduction - Handling Conflicts - Conflicts settlement **(6)**

GROUP DISCUSSION AND INTERVIEW SKILLS

Mock GD - Interview Skills - Answering challenging questions - Common Interview Questions **(5)**

REFERENCES

1. *Barun K Mitra., Personality Development and Soft Skills. Second Edition. Oxford University Press. 2016*
2. *N.Krishnaswamy & Lalitha Krishnaswamy - Mastering Communication Skills and Soft Skills. New Delhi. Bloomsburry. 2015*
3. *Stein, Steven J. & Howard E. Book. The EQ Edge: Emotional Intelligence and Your Success. Canada: Wiley & Sons, 2006.*

19CH71 - TRANSPORT PHENOMENA

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Determine the interrelationship between the molecular, microscopic and macroscopic descriptions of transport processes and compare the various coordinate systems to formulate Continuity, Navier-Stokes and Euler equations.*

CO2 : *Apply shell balance technique to formulate the differential equation of change for steady and unsteady-state flows*

CO3 : *Analyse the problems involving steady state and unsteady state heat conduction in simple geometries and obtain numerical solutions for the problems.*

CO4 : *Develop microscopic and macroscopic energy balances for steady and unsteady energy transport processes*

CO5 : *Apply the individual and overall mass transfer coefficient in multi-phase systems for design applications.*

BASIC CONCEPT AND CONSERVATION THEOREM IN MOMENTUM TRANSPORT

Derivation of the basic momentum transport equation - derivation using elementary volume concept and conservation theorems. Equation of continuity and motion - Navier-Stokes and Euler equations of motion in rectangular, cylindrical and spherical co- ordinate systems. Dimensional analysis of equations of change. Analysis of momentum transport using shell balance technique and basic transport equations - types of boundary conditions. **(12)**

APPLICATIONS OF EQUATIONS OF CHANGE IN MOMENTUM TRANSPORT

Flow of fluids in thin films, parallel plates, circular tubes and annulus, adjacent flow of two immiscible fluids, Couetteflow, rotating surface flow and radial flow. Flow near a wall suddenly set in motion. **(12)**

BASIC CONCEPTS AND CONSERVATION THEOREMS IN ENERGY TRANSPORT

Basic energy transport equations - derivations using elementary volume concept and conservation theorems in different co- ordinate systems. Dimensional analysis of equations of change. Analysis of energy transport using shell balance technique and basic transport equations - types of boundary conditions. **(12)**

APPLICATIONS OF EQUATIONS OF CHANGE IN ENERGY TRANSPORT

Conduction with energy sources in fixed bed catalytic reactors and in cooling fins. Forced convection in circular tubes - Natural convection from a heated plate. Unsteady state conduction of finite slab. **(12)**

MASS TRANSPORT

Continuity equation for a binary mixture and its derivation. Dimensional analysis of equations of change. Analysis of mass transport using shell balance technique and types of boundary conditions. Steady and unsteady state one dimensional diffusion, diffusion in porous catalyst with and without chemical reaction and diffusion in falling liquid film. **(12)**

TOTAL = 60

TEXT BOOKS

1. *Byron Bird.R, Warren E Stewart, Edwin N.Lightfoot, Transport Phenomena, Revised Second Edition., John Wiley(ISE), India, 2007.*
2. *Robert S. Brodkey, Harry C.Hershey, Transport Phenomena-A unified approach, McGraw Hill (ISE), 2003.*

REFERENCES

1. *James Welty, Charles E. Wicks, Gregory L. Rorer, Robert E. Wilson, Fundamentals of Momentum, Heat and Mass Transfer, Sixth Edition, John Wiley, (ISE), 2013.*
2. *Carroll O.Bennet, John Earle Meyers, Momentum, Heat and Mass Transfer, Third Edition, Tata-McGraw Hill, New Delhi,1983.*
3. *Christie J. Geankoplis, Transport Processes and Separation Process principles, Fourth Edition, Prentice Hall Professional Technical Reference, 2003.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	3		3			2				3	
CO2	3	2	1	3		3			2				3	
CO3	3	2	1	3		3			2				3	
CO4	3	2	1	3		3			2				3	
CO5	3	2	1	3		3			2				3	

(1: Slight, 2: Moderate 3: Substantial)

19CH72 - PROCESS ECONOMICS AND TECHNOLOGY MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students will be able to

CO1 : *Practice various depreciation methods and its uses in industries for the recovery of plant cost*

CO2 : *Assess the various financial ratios by taking the real time data's of the industries and comment the stability of the financial statements*

CO3 : *Practice various Process technology cost calculations and its feasibility analysis.*

CO4 : *Outline the various management principles and organization types practiced in the organizations*

CO5 : *Discuss the production planning control methods in industries and also role of control charts in production for the quality control.*

INTEREST AND PLANT COST

Time value of money-concept of interest, equivalence, Depreciation, Depletion, Capital requirement for complete plant, cost indices, various components of Cost Productions and their Estimation and Project Cost preparations. **(10)**

PROJECT PROFITABILITY AND FINANCIAL RATIOS

Estimation of project profitability, Project Financing, income statement and financial ratios, balance sheet preparation - case studies and problems. **(10)**

PROCESS TECHNOLOGY COST CALCULATION

Description, Raw material and energy sources and Consumption, operating condition, basic block diagram and Simplified Process flow diagram for some of the industrially relevant chemicals like Ammonia, fertilizer, chloro-alkali and Petro chemicals. **(10)**

PRINCIPLES OF MANAGEMENT

Principles of management, planning, organizing, staffing, coordinating, directing, controlling and communicating. Types of organizations, Management information systems (MIS). **(8)**

PRODUCTION PLANNING CONTROL

Work measurement techniques, motion study, principles of time study, elements of production control, forecasting, planning, routing, scheduling, dispatching, inventory methods, role of control charts in production and quality control. **(7)**

TOTAL : 45

TEXT BOOKS

1. *Max Peters, Klaus Timmerhaus, Ronald West, Plant design and economics for chemical Engineers, Fifth Edition, McGraw Hill (ISE), 2013.*
2. *Ahuja K.K, Industrial management, khanna publishsers, New Delhi, 2004.*

3. *H.E. Schwyer, Process Engineering Economics, McGraw Hill Book, New York, 1970.*
4. *Gopala Rao, M. & Marshall Sittig.: Dryden's Outlines of Chemical Technology, (3rd Ed.), Affiliated East-West Press, New Delhi, (2004).*

REFERENCES

1. *FC Jelen, JH Black, Cost and Optimization Engineering, Second Edition, McGraw-Hill., New York, 1990.*
2. *Robin Smith, Chemical Process Design and Integration, Second edition, John Wiley & Sons, United States, 2016.*
3. *Jacob.A.Moulijn, Michiel Makkee, Annelies Van Diepen, Chemical Process Technology, Third Edition, Wiley, 2022.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	1	1	-	-	-	-	3	2	2	2
CO2	2	2	-	1	2	1	-	-	1	-	3	2	2	1
CO3	2	3	2	-	2	2	1	1	1	-	2	2	3	1
CO4	-	1	1	-	1	-	1	2	3	1	3	2	2	2
CO5	2	3	1	-	1	-	-	1	1	-	3	2	2	2

(1: Slight, 2: Moderate 3: Substantial)

19CH73 - PROCESS MODELING AND SIMULATION

L	T	P	C
2	1	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students will be able to

CO1 : *Apply first principles and constitutive laws to develop ordinary or partial differential equations by incorporating valid assumptions for both macroscopic and microscopic systems.*

CO2 : *Derive phenomenological models for simple and variable flow hydraulic tanks, enclosed mixing vessel with reaction, steam jacketed mixing vessel and Continuous flow boiling systems.*

CO3 : *Develop the mathematical model for simple flow systems and Homogeneous and Heterogeneous reaction kinetics.*

CO4 : *Formulate distributed parameter model for various stage operations like binary distillation, multi stage counter current extraction and distributed systems like heat exchanger, tubular reactors and membrane separation unit.*

CO5 : *Apply numerical methods to solve modeled equations using simulation tool Matlab/simulink.*

INTRODUCTION AND FIRST PRINCIPLES

Definition, Uses of Mathematical Models - Principles of formulation, Classification of Process Models, Fundamental laws: Total Continuity equation- Macroscopic and Microscopic Examples, Component Continuity Equation - Macroscopic and Microscopic Examples, Energy equation, Equations of motion, Transport equations, Equations of State, Equilibrium and Chemical Kinetics. Simple Examples. **(10)**

BASIC MODELING

Simple Hydraulic Tank, Variable flow hydraulic tank, Enclosed tank, Adiabatic compression in gas space, Mixing vessel, Mixing with reaction, Reversible reaction, Steam jacketed vessel, Continuous - Flow boiling system. **(9)**

STAGED OPERATIONS AND DISTRIBUTED SYSTEMS

Staged Operations: Counter current extraction, Distillation columns - Binary distillation. Distributed systems: Counter current Heat Exchanger, Membrane Separation Process, tubular Reactor and Evaporators. **(9)**

FITTING DATA TO MODEL

Fitting Data to Linear Model, Multi-Linear Models, Matrix representation of Multi Linear Model, Fitting Data to Quadratic Model, Cubic Model and Polynomial model using Regression, Power Law models. Performance Criteria to check quality model, Co-efficient of Determination (R^2). **(9)**

SIMULATION OF BASIC MODELS

MATLAB/Simulink - Introduction, Basic components, Operational Blocks, Examples - Three CSTR's in series, Gravity flow tank, Numerical Solution of Model using RK4, Euler's explicit and implicit techniques, Introduction ODE 45 Solver, Dynamic Simulation of Simple Tank, Variable Flow Tank, Enclosed Tank with isothermal Compression, Mixing Vessel, Mixing Vessel with Reaction using ODE 45 Solver. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Luyben, W.L.: Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill, International Student Edition, Second Edition, 1996.*
2. *Franks, R.G.E.: Modeling and Simulation in Chemical Engineering, Wiley-Interscience, New York, 1972.*
3. *Amiya.K.Jana, Chemical Process Modeling and Computer Simulation, Prentice Hall India Pvt. Ltd, Second Edition,2011.*

REFERENCES

1. *Himmelblau, D.M. and Bischoff, K.B,: Process Analysis and Simulation, Wiley, 1968.*
2. *Ramirez,W.F.: Computational methods for Process Simulation, Butterworths, NewYork, 2nd Edition, 1998*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		3						3		2	3	
CO2	3													
CO3	3	2	3	2		1							2	
CO4	3	2	2	2		1							2	
CO5	3	3	1	2		1							2	

(1: Slight, 2: Moderate 3: Substantial)

19CH74 - ELECTROCHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students would be able to

CO1 : *Determine interfacial tension, charge density and cell potential*

CO2 : *Estimate electrode over potentials and limiting currents*

CO3 : *Design electrochemical reactors using various electrodes*

CO4 : *Explain the principles and working conditions of primary and secondary batteries*

CO5 : *Demonstrate electrode reactions*

REVIEW OF BASICS IN ELECTROCHEMISTRY

Electrolytes - strong and weak, dilution law, Debye-Huckel theory, faraday's laws, origin of potential, single electrode potential, theories on electrical double layer. Thermodynamics of ideally polarizable and non-polarizable interfaces- Lipman equation- determination of interfacial tension, charge density, surface excess and double layer capacitance by electro capillary & bridge methods- Helmholtz, Gouy-Chapman and stern models of double layer with discussion of potential and charge distribution inside the double layer-contact adsorption and its determination.Electrochemical series, electrochemical cells, Nernst equation and its application, reference electrodes- SHE, Ag/AgCl, Calomel. **(9)**

MASS TRANSFER IN ELECTROCHEMICAL SYSTEMS

Concepts of equilibrium potential, Nernst equation, overpotential and its different types, equilibrium exchange current density-derivation of Butler-Volmer equation -high field and low field approximations - charge transfer resistance and polarizability of the interface - concepts of rate determining step, Stoichiometric number, reaction order - Determination of kinetics parameters by Tafel and linear polarization methods.Current-voltage relationships & estimation of mass transfer co-efficient, plug flow & cstr systems model, thermal behavior of reactors, convective diffusion equation & current distribution, dispersion models & optimization of electrochemical reactor. **(9)**

ELECTRODES AND SEPARATORS

Metals- graphite- lead dioxide- titanium substrate insoluble electrodes, iron oxide- semiconducting type, etc. Metal finishing- cell design, types of electrochemical reactors, batch cell, fluidized bed electrochemical reactor, filter press cell, swiss roll cell, plug flow cell, design equation, figures of merit of different types of electrochemical reactors. **(9)**

ELECTROCHEMICAL PROCESSES

Electrodeposition, electrorefining, electroforming, electropolishing, anodizing, selective solar coatings, types of batteries- primary and secondary batteries, fuel cells.Corrosion studies- Introduction to corrosion, corrosion theories, derivation of potential-current relations of activities controlled and diffusion controlled corrosion process. Potential- pH diagram, forms of corrosion- definition, factors and control method of various forms of corrosion- corrosion control measures, industrial boiler water corrosion control, protective coatings, vapor phase inhibitors, cathodic protection, sacrificial anodes, paint removers. **(9)**

ELECTROANALYTICAL TECHNIQUES

Study of electrode reactions: Cyclic voltammetry - reversible, irreversible and quasi reversible processes - study of reaction mechanism, adsorption, quantitative applications - spectroelectrochemistry - scanning electrochemical microscopy. Controlled potential and current techniques: Chronoamperometry -pulse voltammetry - square wave and staircase voltammetry - AC voltammetry - stripping voltammetry - bulk electrolysis - chronopotentiometry - Tafel polarisation - electrogravimetry - flow analysis. Electrochemical impedance spectroscopy: Faradaic impedance - equivalent circuits - AC impedance- Bode and Nyquist plots - applications. Electrochemical instrumentation: Operational amplifiers - current and voltage feedback - potentiostat and galvanostat - troubleshooting in electrochemical systems. **(9)**

TEXT BOOKS

1. *Joseph Wang. Analytical Electrochemistry. Germany, Wiley, 2004.*
2. *Allen Bard and Larry Faulkner. Electrochemical methods: fundamentals and applications. India, Wiley India Limited, 2004.*

REFERENCES

1. *Evgenij Barsoukov and Ross Macdonald.Impedance Spectroscopy: Theory, Experiment and Applications". Wiley, 2005.*
2. *Bagotsky. Fundamentals of Electrochemistry. Wiley, 2006.*

Mapping of Course Outcomes (COs) with Program Outcomes (POs)

COs	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1			1										
CO2		1											1	
CO3			2											
CO4			1		1									
CO5				1						1				1

(1: Slight, 2: Moderate 3: Substantial)

19CHL76 - PROCESS EQUIPMENT DESIGN AND DRAWING

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Design storage and agitator vessel for the specified requirement as per standard codes.*

CO2 : *Design shell and tube heat exchangers and evaporators for the industrial demand by considering standard codes.*

CO3 : *Compute the design parameters of distillation columns, absorption towers and rotary drier for the given duty according to standards codes.*

CO4 : *Conduct experiments to solve complex engineering problems effectively as an individual or team work.*

CO5 : *Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.*

LIST OF EXERCISE

1. Detailed design and drawing of Agitator vessel
2. Detailed design and drawing of Storage vessel
3. Process and mechanical design of Shell and Tube Heat Exchanger (Cooler, Condenser & Reboiler)
4. Process and mechanical design of evaporator
5. Process and mechanical design of Distillation column
6. Process and mechanical design of Absorption column
7. Process and mechanical design of Rotary Drier

TOTAL : 60

TEXT BOOKS

1. *Don W. Green, Robert H. Perry, Perry's Chemical Engineers' Handbook, Eighth Edition, McGraw Hill, 2007.*
2. *Indian Standard Codes:*
   - *(a) IS: 2825 - 1969: Code for Unfired Pressure Vessels.*
   - *(b) IS: 4049 - 1979: Specifications for formed ends for Tanks and Pressure vessels.*
   - *(c) IS: 4179 - 1967: Sizes of Process Vessels and their Leading Dimensions.*
   - *(d) IS: 4864 to 4870 - 1968: Specifications for Shell Flanges for Vessels and Equipment.*
   - *(f) IS: 803 - 1962: Code of practice for Design, Fabrication and Erection of Mild Steel Cylindrical Welded Oil Storage Tanks. (Published by Bureau of Indian Standards, New Delhi).*
   - *(g) ASME Section 8 and 9*
3. *Joshi M.V., Process Equipment Design, Third Edition, MacMillan, India, 2004.*
4. *Bhattacharya.B.C., Introduction to Chemical Equipment Design, CBS Publishers and Distributors,New Delhi, 1985.*

5. *Coulson J.M., Richardson J.F., Sinnott R.K., Chemical Engineering, Vol. VI, Maxwell-Macmillan, New York, 1989.*
6. *Kern, D.Q.: Procss Heat Transfer, McGraw Hill (ISE), (1999).*
7. *Dawande,S.D.: Process Design of Equipments, Central Techno Publications, Nagpur, 1999*

REFERENCES

1. *Brownell, L.E, & Young, E.H.: Process Equipment Design, Wiley Eastern, New Delhi, (1977).*
2. *Smith, B.D.: Design of Equilibrium Stage Processes, McGraw Hill, New York, (1963).*
3. *Ludwig, E.E.: Applied Process Design for Chemical & Petrochemical Plants, Vols. I, II & III, (2nd Ed.), Gulf Publishing Company, Texas, (1977, 1979, 1983).*
4. *Strigle, R.F.: Random Packings & Packed Towers (Design & Application), Gulf Publishing Company, Texas, (1987).*
5. *Fraas, A.P. & Ozisik, M.N.: Heat Exchanger Design, (2nd Ed.), John Wiley, New York, (1989).*
6. *Bednar, H.H.: Pressure Vessel Design Handbook, (2nd Ed.), CBS Publishers & Distributors, New Delhi, (1989).*
7. *Backhurst, J.R. & Harker, J.H.: Process Plant Design, Heinemann Books, London, (1973).*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		3						3		2	3	
CO2	3													
CO3	3	2	3	2		1							2	
CO4	3	2	2	2		1							2	
CO5	3	3	1	2		1							2	

(1: Slight, 2: Moderate 3: Substantial)

19CHL77 - PROCESS CONTROL AND SIMULATION LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Evaluate the dynamics of first order system and analyze the behaviour of second order system for step and impulse inputs.*

CO2 : *Estimate the control valve flow coefficient, flow characteristics and examine the response of ON-OFF, P, PI and PID controllers.*

CO3 : *Simulate the unit operations equipment's using Software Packages Such As MATLAB, Fluent Ansys.*

CO4 : *Conduct experiments to solve complex engineering problems effectively as an individual or team work.*

CO5 : *Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.*

EXPERIMENTS

- Determination of Control Valve Co-Efficient
- Calibration of Pressure Gauge
- Flow Characteristics of Control Valve
- Dynamic Response of First Order System
- Dynamic Response of Second Order System
- Response of A Non-Interacting System
- Transient Response of Proportional Control
- Transient Response of PI Control
- Transient Response of PD Control
- Transient Response of PID Control
- Simulation of Chemical Process Models using Software Packages Such As MATLAB, FLUENT, Excel and Python

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	0	2	2	0	0	1	0	2	0	0
CO2	3	2	2	1	0	2	2	0	0	2	0	2	0	0
CO3	3	3	3	1	0	3	1	0	0	0	0	2	0	0
CO4	3	3	3	3	0	2	2	0	0	0	0	3	0	0
CO5	2	2	1	0	0	3	2	0	0	0	0	2	0	0

- (1: Slight, 2: Moderate 3: Substantial)

19CH78 - PROJECT WORK PHASE-I

L	T	P	C
0	0	6	3

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, the students are able to

CO1 : *Prepare a detailed report on the project work carried out by the students.*

CO2 : *Conduct experiments to solve complex engineering problems effectively as an individual or team work.*

CO3 : *Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.*

The students should carry out the project work allotted to them in the stipulated time duration. They should submit a detailed report prior to the final semester examinations. The dates for allocation of the questions and for the submission of the final report will be notified by the department. The following Instructions should be followed by the students regarding the project.

INSTRUCTIONS

1. The answers should be made on preferably 22 x 28.5 cm. size (A-4 Size) papers and the number of pages should be around fifty.
2. The written part should be type written.
3. Drawings must be as blue/ammonia prints or in Indian ink on good quality drawing paper.
4. Detailed flow sheets for the Process, Material and Energy should be given.
5. All symbols used in the flow diagrams should follow the norms prescribed as per IS. Code 3233-1965 (Recommendations on Graphical Symbols for Process Flow Diagrams).
6. All calculations should be made by application of fundamental principles and from available published data.
7. All Physical and Thermodynamic properties required for calculations should be obtained from standard Text books, Handbooks or International Critical Tables. In the absence of such data these properties must be calculated using other known techniques (like group contribution, etc.,). No data should be assumed.
8. Design of equipments should be from first principles as per Indian Standard Codes and other standard text and REFERENCES.
9. A complete drawing of the designed equipment should be furnished.
10. All dimensions, mechanical details and materials of construction should be furnished as per norms prescribed in IS-696: 1972 (Code of Practice for Engineering Drawings). Wherever possible detailed or working drawings should be given.
11. Complete layout diagrams including conveying equipment must be furnished and the floor area should be evaluated for calculating building costs.
12. Cost estimation must be done as per methods followed by text and REFERENCES in Cost Engineering. Current market prices should be obtained from Trade literature or periodicals.
13. References must be given in detail to all sources of published information made use of by the students. The names of the journals/periodicals should be abbreviated as in the Chemical Abstracts (Published by the American Chemical Society).
14. All calculations should be done in SI. Units only.

19CH84 - PROJECT WORK PHASE - II

L	T	P	C
0	0	10	5

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, the students are able to

CO1 : *Prepare a detailed report on the project work carried out by the students.*

CO2 : *Conduct experiments to solve complex engineering problems effectively as an individual or team work.*

CO3 : *Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.*

The students should carry out the project work allotted to them in the stipulated time duration. They should submit a detailed report prior to the final semester examinations. The dates for allocation of the questions and for the submission of the final report will be notified by the department. The following Instructions should be followed by the students regarding the project.

INSTRUCTIONS

1. The answers should be made on preferably 22 x 28.5 cm. size (A-4 Size) papers and the number of pages should be around fifty.
2. The written part should be type written.
3. Drawings must be as blue/ammonia prints or in Indian ink on good quality drawing paper.
4. Detailed flow sheets for the Process, Material and Energy should be given.
5. All symbols used in the flow diagrams should follow the norms prescribed as per IS. Code 3233-1965 (Recommendations on Graphical Symbols for Process Flow Diagrams).
6. All calculations should be made by application of fundamental principles and from available published data.
7. All Physical and Thermodynamic properties required for calculations should be obtained from standard Text books, Handbooks or International Critical Tables. In the absence of such data these properties must be calculated using other known techniques (like group contribution, etc.,). No data should be assumed.
8. Design of equipments should be from first principles as per Indian Standard Codes and other standard text and REFERENCES.
9. A complete drawing of the designed equipment should be furnished.
10. All dimensions, mechanical details and materials of construction should be furnished as per norms prescribed in IS-696: 1972 (Code of Practice for Engineering Drawings). Wherever possible detailed or working drawings should be given.
11. Complete layout diagrams including conveying equipment must be furnished and the floor area should be evaluated for calculating building costs.
12. Cost estimation must be done as per methods followed by text and REFERENCES in Cost Engineering. Current market prices should be obtained from Trade literature or periodicals.
13. References must be given in detail to all sources of published information made use of by the students. The names of the journals/periodicals should be abbreviated as in the Chemical Abstracts (Published by the American Chemical Society).
14. All calculations should be done in SI. Units only.

19CHE01- WATER CONSERVATION AND MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After the completion of the course students would be able to

CO1 : *Understand the concepts of Water conservation and management.*

CO2 : *Manage and Conserve quality water for sustainable development*

CO3 : *Gain knowledge on sources of water pollution and environmental standards.*

CO4 : *Knowledge on water conservation and recycling.*

CO5 : *Provide solutions for Water management in industries.*

INTRODUCTION

Concepts of Water Management, Water Cycle, Water Storage, Water Quality, Need for Water conservation - homes, work place and industries. **(9)**

WATER MANAGEMENT

Water Quality- use and controlled use of quality water, water flow measurements, test for salinity, water sanitation, water audits. **(9)**

MANAGEMENT OF WATER QUALITY

Water Pollution, types and sources of pollution, environmental guidelines for water quality. **(10)**

WATER CONSERVATION AND RECYCLING

Perspective on recycle and reuse, Waste water reclamation, Types of Water Conservation - Rain Water harvesting, roof catchment systems. **(9)**

CASE STUDIES

Water conservation and Management in agriculture, process industry, service industry, construction industry. **(8)**

TEXT BOOKS

1. *Rao M N. & Datta, A.K, Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd., 3rd Edition, 2008.*
2. *Glenn O. Schwab, Soil and Water Conservation Engineering, Wiley India Pvt.Ltd., 4th Edition, 2009*

REFERENCES

1. *F.F. Sturm, Goen Ho,Kuruvilla Mathew, Water Auditing and Water Conservation,IWA Publishing*
2. *Mukund Narayan, Satyendra Kumar, Nilesh Biwalkar, Reference Manual Of Soil & Water Conservation Engineering, BioTech Books Publishing.*

Mapping of Course Outcomes with Program Outcomes

COs	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1						3	2						
CO2							3							
CO3	1	1				2	3							
CO4		1												
CO5			1						2				1	

19CHE02 - SUSTAINABILITY ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After the completion of the course the students would be able to

CO1 : *Understand the importance of Sustainable Environment.*

CO2 : *Know about the types of water conservation and its importance*

CO3 : *Acquire knowledge on the Environmental Acts*

CO4 : *Develop an assessment technique for Sustainable development*

CO5 : *Assess and report a real time problem and solutions for the Sustainable development*

SUSTAINABILITY AND ITS RELEVANCE

Introduction to the idea of sustainability and its relevance, Social issues and the environment from unsustainable to sustainable development. **(8)**

WATER CONSERVATION FOR SUSTAINABLE ENVIRONMENT

Water conservation, rainwater harvesting, watershed management, resettlement and rehabilitation of people, its problems and concerns. **(8)**

ENVIRONMENTAL ACTS

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. **(11)**

SUSTAINABILITY - A CHAIN APPROACH

Tools used to ensure sustainability in engineering activities (environmental management systems and environmental impact assessment); green buildings; green chemistry; sustainable cities; sustainable transportation; sustainable sources of energy; economic and social factors affecting sustainability. **(10)**

CASE STUDIES

Case studies, environmental ethics, issues and possible solutions- climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. Wasteland reclamation, consumerism and waste products. **(8)**

TEXT BOOKS

1. *Bhavik.R. Bhakshi, Sustainable Engineering- Priniciple and practice ,Cambridge University Press.*
2. *Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD,New Delhi, 2007.*

REFERENCES

1. *Dara SS (2005) A Text Book of Environmental Chemistry and Pollution Control, S. Chand & Company, New Delhi.*
2. *Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I) PVT, LTD, Hydrabad, 2015.*

Mapping of Course Outcome with Program Outcomes

COs	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	1						3	2						
CO2							3							
CO3	1	1				2	3							
CO4		1												
CO5			1						2				1	

19CHE03 - NANOSCIENCE AND NANOTECHNOLOGY FOR CHEMICAL SCIENCE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Demonstrate a systematic knowledge of the range and breadth of application of nanomaterials*

CO2 : *Review critically the potential impact in all classes of materials of the control of nanostructure*

CO3 : *Describe the methods for the chemical and nano structural characterization of such materials and select appropriate techniques for a range of situations*

CO4 : *Outline the nanotechnology production routes currently available*

CO5 : *Identify possible opportunities for nanomaterials in product development and enhancement*

BULK SYNTHESIS

Synthesis of bulk nano-structured materials -sol gel processing -Mechanical alloying and mechanical milling- Inert gas condensation technique - Nanopolymers - Bulk and nano composite materials. **(9)**

CHEMICAL APPROACHES

Self-assembly, self-assembled monolayers (SAMs). Langmuir-Blodgett (LB) films, clusters, colloids, zeolites, organic block copolymers, emulsion polymerization, templated synthesis, and confined nucleation and/or growth. Biomimetic Approaches: polymer matrix isolation, and surface-templated nucleation and/or crystallization. Electrochemical Approaches: anodic oxidation of alumina films, porous silicon, and pulsed electrochemical deposition. **(9)**

PHYSICAL APPROACHES

Vapor deposition and different types of epitaxial growth techniques- pulsed laser deposition, Magnetron sputtering - Micro lithography (photolithography, soft lithography, micromachining, e-beam writing, and scanning probe patterning). **(9)**

NANOPOROUS MATERIALS

Nanoporous Materials - Silicon - Zeolites, mesoporous materials - nanomembranes and carbon nanotubes - AgX photography, smart sunglasses, and transparent conducting oxides -molecular sieves - nano sponges. **(9)**

APPLICATION OF NANOMATERIALS

Molecular Electronics and Nanoelectronics - Nanobots- Biological Applications - Quantum Devices - Nanomechanics - Carbon Nanotube - Photonics- Nano structures as single electron transistor -principle and design. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Cao G. Nanostructures, Nanomaterials, Synthesis, Properties and Applications, Imperial College Press, 2004.*
2. *Gaddand,W., Brenner,D., Lysherski,S. and Infrate, G.F., Handbook of NanoScience, Engineering and Technology, CRC Press, 2002.*

REFERENCES

1. *Gaponenko,S.P. Optical Properties of semiconductor nanocrystals, Cambridge University Press, 1980.*
2. *Barriham,K., Wedensky,D.D. Low dimensional semiconductor structures, fundamental and device applications, Cambridge University Press, 2001.*
3. *George,J. Preparation of Thin Films, Marcel Dekker, Inc., New York. 2005.*

Mapping of Course Outcome with Program Outcomes

COs	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2	2	3		3					2	3	1	
CO2		2	3	3		3					2	3	1	
CO3		2	3	3		3		1				3	1	
CO4		2	3	3		3		1			2	3	1	
CO5		2	3	3		3		1			2	3	1	

1- Slight; 2- Moderate; 3-Substantial

19CHE04 - POLYMER SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After the completion of course, students are able to

CO1 : *Understand the basic concepts of polymer science and identify the polymerization techniques and its kinetics.*

CO2 : *Assess the molecular weight distribution techniques, glass transition, and solution properties like thermodynamics, phase separations.*

CO3 : *Explain the morphology, rheology, mechanical and thermal properties of bulk polymers.*

CO4 : *Compare and analyze the manufacture and properties of commercial polymers.*

CO5 : *Apply the knowledge in assessing the polymeric, fiber and elastomer processing techniques.*

INTRODUCTION TO POLYMERS AND POLYMERIZATIONS

Polymers - Basic concepts - Classification - Natural and synthetic polymers, thermoplasts and thermosets. Polymerization - Addition, condensation, ring opening, copolymerization, ionic and coordination polymerization - Kinetics of polymerization. **(9)**

POLYMER ANALYSIS AND SOLUTION PROPERTIES

Molecular weight and distribution- Number average, weight average, viscosity average and Z-average molecular weight - Determination by light scattering, solution viscosity and gel permeation chromatography. Degree of polymerization.Glass transition temperature - Theory and measurements. Polymer solutions- Solubility and swelling, Thermodynamics of polymer solutions, Phase separation in polymer solutions. **(9)**

STRUCTURE AND PROPERTIES OF BULK POLYMERS

Morphology and order in crystalline polymers -crystal structure of polymers, morphology of polymer single crystals. Rheology and the mechanical properties of polymers - Viscous flow, kinetic theory of rubber elasticity and viscoelasticity, stress-strain behavior, compression vs tensile tests, deformation of solid polymers. Thermal analysis of polymers using TGA and DSC. **(9)**

MANUFACTURE AND PROPERTIES OF COMMERCIAL POLYMERS

Hydrocarbon plastics and elastomers - low density (branched) polyethylene, high density (linear) polyethylene, polypropylene, natural rubber, rubbers derived from butadiene. Other carbon chain polymers - polystyrene, acrylic polymers, poly(vinyl esters) and derived polymers. Heterochain thermoplastics - Polyamides. Thermosetting resins - Phenolic resins and amino resins. **(9)**

POLYMER PROCESSING TECHNIQUES

Plastic molding techniques - Injection, blow, extrusion and compression. Processing agents - Fillers, plasticizers, and other additives. Fiber Technology - Textile and fabric properties, spinning - wet and dry methods - fiber treatments. Elastomer technology - Compounding and elastomer properties, vulcanization and reinforcement. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Billmeyer F.W., Textbook of Polymer Science, Third Edition, Wiley Interscience, 1984.*
2. *Charles E., Carraher Jr., Seymour/carraher's polymer chemistry, Seventh Edition, CRC Press, 2012.*

REFERENCES

1. *Fried J.R., Polymer Science and Technology, Second Edition, Prentice Hall of India Pvt Ltd., 2003.*
2. *Bhatnagar M.S., A Textbook of Polymers, Vol. 2, S.Chand and Company Ltd., 2012.*

CO & PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2												1	
CO2		2		2	2					1				1
CO3		2		2	2					1				1
CO4		2		2						1				1
CO5		2		2	2									1

19CHE05 - RENEWABLE ENERGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Understand the Need, importance and scope of non conventional and alternate energy resources.*

CO2 : *Understand significant role of solar energy.*

CO3 : *Know the importance of Wind Energy.*

CO4 : *Analyse the utilization of Biogas plants and geothermal energy*

CO5 : *Understand the concept of energy Conservation.*

INTRODUCTION

Introduction (world energy status, current energy scenario in India, environmental aspects of energy utilization, energy and sustainable development **(9)**

SOLAR ENERGY

Solar Radiation, Measurements of Solar Radiation, Flat Plate And Concentrating Collectors, Solar Direct Thermal Applications, Solar Thermal Power Generation, Fundamentals of Solar Photo Voltaic Conversion, Solar Cells, Solar PV Power Generation, Solar PV Applications. **(9)**

WIND ENERGY

Wind Energy Estimation, Types of Wind Energy Systems, Performance, Site Selection, Details of Wind Turbine Generator. **(9)**

BIO-MASS AND GEOTHERMAL ENERGY

Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking Geothermal Energy- Resources, types of wells, methods of harnessing the energy, scope in India. **(9)**

ENERGY CONSERVATION TECHNIQUES

Principles of energy conservation, the different energy conservation appliances, cooking stoves, Benefits of improved cooking stoves over the traditional cooking stoves **(9)**

TOTAL : 45

TEXT BOOKS

1. *Ristinen RA. Kraushaar JJ. Energy and the Environment, 2nd edition, John Willey & Sons, 2006*
2. *Kishore VVN. Renewable Energy Engineering and Technologies, TERI, 2009*

REFERENCES

1. *Banerjee BP. Handbook of Energy and Environment in India, Oxford University Press, 2005, India.*
2. *J W Twidell & A D Weir, Renewable Energy Resources, ELBS, 2006*
3. *Tiwari GN. Ghoshal MK. Fundamental of Renewable Energy Sources, Narosa, 2007.*

CO & PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3			2	3			2				3
CO2	3		3			2	3			2				3
CO3	3		2			2	3			2				3
CO4	3		2			2	3			2				3
CO5	3		3			2	3			2				3

19CHE06 - ADVANCED SEPARATION PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to:

CO1 : *Identify and label the recent developments in separation techniques and its properties through the process concepts.*

CO2 : *Recognize the types and choice of membrane reactors and its several separation techniques.*

CO3 : *Apply and analyze the functioning of separation processes and its economics in the industries.*

CO4 : *Conclude the controlling factors; classify the equipment and its applications used in various ionic separations.*

CO5 : *Compare the existing separating techniques with the other techniques like pervaporation to achieve the better processing methods can be used in modern separations of solids, liquids and gases.*

INTRODUCTION

Review of conventional processes, recent advances in separation techniques based on size and surface properties. Process concept - theory and equipment used in cross flow filtration. Surface based solid - liquid separations involving a second liquid. **(9)**

MEMBRANE SEPARATIONS

Types, choice of membrane, plate and frame, tubular, spiral wound and hollow fiber membrane reactors - relative merits. Commercial, pilot plant and laboratory membrane permeators involving dialysis. microfiltration, ultrafiltration, nanofiltration & reverse osmosis - Economics of membrane operations. **(9)**

SEPARATIONS BY ADSORPTION TECHNIQUES

Mechanism, types and choice of adsorbents, foam separation - surface adsorption, nature of foams. Normal adsorption techniques, types of equipment and commercial process, recent advances and process economics. **(9)**

IONIC SEPARATIONS

Controlling factors, applications, types of equipment employed for electrophoresis, dielectrophoresis, electrodialysis and commercial processes. **(9)**

OTHER TECHNIQUES

Pervaporation - basic principles, mass transfer in pervaporation, factors affecting pervaporation and permeation techniques for solids, liquids and gases. Industrial viability and examples, zone melting-equilibrium diagrams, adductive crystallization - fundamental and process techniques. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Kaushik Nath, Membrane separation processes, First Edition, Prentice Hall publishers, 2008.*

REFERENCES

1. *Herbert M.Schoen, New Chemical Engineering Separation Techniques, Interscience publishers, 1962.*
2. *Svarovsky L., Solid-Liquid separation, Fourth Edition, Butterworth and co publishers, 2001.*

CO & PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1			1	1						3	1
CO2	1	2	2	1	1	1	2						1	
CO3	1	3	1			2	2						3	2
CO4	1	2	1			1	1						2	
CO5	1	2				1	1						1	

19CHE07 - ENVIRONMENTAL POLLUTION AND CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After the completion of the course the students would be able to

CO1 : *Understand the importance on conservation of environment and its rules and regulations.*

CO2 : *Ascertain the standards of Air Pollutants and its effects.*

CO3 : *Analyse the physical and Chemical parameters of water and able to assess the water quality*

CO4 : *Distinguish between different types of Solid waste and disposal techniques.*

CO5 : *Assess the ways to control pollution in industries.*

ENVIRONMENTAL ACTS

Introduction and importance of Environmental Pollution, Types of environments and their pollutants. Classification of pollutants. Legislative aspects including Water act. 1974, Air Act 1981 and Effluent standards. EPA. **(8)**

AIR POLLUTION

Sources and effects of different air pollutants, Sampling and analysis of air pollutants, Air pollution control methods and equipment, Cyclone Separator, Baghouse, ESP, Venturi Scrubber **(8)**

WATER POLLUTION

Sources, sampling and classification of water pollutants, determination of basic parameters and computations associated with: BOD, COD, TS, TDS, SS; Waste water treatment: primary, secondary, tertiary and advanced; aerobic treatment with special reference to activated sludge and trickling filter. **(9)**

SOLID WASTE MANAGEMENT

Sources and classification, public health aspects, Methods of collection and disposal methods: open dumping, landfill, incineration, composting, vermiculture; Solid waste management using bioremediation for specific pollutants like chromium. Mercury, ammonia / urea, phenolic sludges. Management and handling of Bio-medical waste; E-waste - classification and re-use and disposal; Hazardous waste management - Electro-chemical and photo-chemical oxidation - dye waste, chrome slag. **(10)**

POLLUTION CONTROL IN PROCESS INDUSTRIES

Fertilizer industries, Petroleum refineries and petrochemical units, pulp and paper industries, Tanning industries, Sugar industries, Dairy, Alcohol industries, Electroplating and metal finishing industries, Radioactive wastes, ranking of wastewater treatment alternatives- Case Studies. **(10)**

TEXT BOOKS

1. *C S Rao ,Environmental Pollution Control Engineering Third edition , New age International Publishers.*
2. *S.P.Mahajon, Pollution Control in Process Industries, Tata McGraw Hill Education.*

REFERENCES

1. *Wastewater Engg. - Metcalf & Eddy, Tata McGraw Hill Education.*
2. *S.J.Arceivala, Wastewater treatment for pollution control and reuse, Tata McGraw Hill Education.*
3. *Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media*

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES

COs	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1						3	2						
CO2							3							
CO3	1	1				2	3							
CO4		1												
CO5			1						2				1	

19CHE08 - COLLOID AND INTERFACIAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students will be able to:

CO1 : *Understand the development of the concept of interfacial phenomena in chemical engineering.*

CO2 : *Analyse the different forces involved in interfacial phenomena.*

CO3 : *Understand the concepts of mesoscale thermodynamics and mesoscale phenomena.*

CO4 : *Recognize the stability of nanoparticle dispersions.*

CO5 : *Understand the importance of nanofluidics and advanced and functional Interfaces.*

SURFACE TENSION, ADHESION AND CAPILLARITY

General introduction of colloids, interfaces, surfactants, and micellization. Effects of confinement and finite size; Concepts of surface and interfacial energies and tensions; Apolar (van der Waals) and polar (acid-base) components of interfacial tensions. Young-Laplace equation of capillarity; examples of equilibrium surfaces. **(9)**

INTERMOLECULAR, NANOSCALE AND INTERFACIAL FORCES

Intermolecular, nanoscale and interfacial forces in organic, polymeric, biological and aqueous systems. Van der waals, electrostatic double layer, acid-base interactios including hydrophobic attraction and hydration pressure. **(9)**

MESOSCALE THERMODYNAMICS AND MESOSCALE PHENOMENA

Mesoscale thermodynamics and Mesoscale phenomena in soft matter & applications Gibb's treatment of interfaces, concept of excess concentration, variation of interfacial tension with surface concentration, Adhesion, wetting, nucleation, flotation, patterning of soft material by self organization and other techniques. **(9)**

STABILITY OF NANOPARTICLE DISPERSIONS

Stability of nanoparticle dispersions: DLVO and DLVO like theories and kinetics of coagulation plus general principles of diffusion in a potential field/Brownian movement. **(9)**

NANOFLUIDICS

Nanofluidics and advanced & functional Interfaces: Stability of thin (< 100 nm) film, self-organization in confined systems, mesoscale patterning. Superhydrophobicity, functional coatings, structural colours, nano-adhesives, nanocomposites. **(9)**

TOTAL : 45

TEXT BOOKS

1. *P. C. Hiemenz, and R. Rajagopalan, Principle of colloid and surface chemistry, MercelDekher, 3rd edition,1997.*
2. *Berg, J.C. "An Introduction to Interfaces and Colloids: The Bridge to Nanoscience", World Scientific (2010).*

REFERENCES

1. *Physical Chemistry of Surfaces, Arthur W. Adamson, 5th edition, Wiley, 1990.*
2. *Foundations of Colloid Science, Robert J. Hunter, Clarendons, Oxford, Volume 1, 1989.*

CO & PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1				1							3	
CO2	1	1				1							2	
CO3	1													
CO4	1	1												
CO5	3	1				1							2	1

19CHE09 - ENERGY MANAGEMENT IN CHEMICAL INDUSTRIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Plan to optimize energy using systems and procedures to meet energy demand*

CO2 : *Describe the Relationship between Energy & Environment.*

CO3 : *Examine the relationship between energy systems and society*

CO4 : *Use optimization techniques for conservation of energy in chemical industries*

CO5 : *Evaluate the production rate and analyze the cost from economic balance for energy consumption.*

PLANNING FOR ENERGY NEEDS

Forecasting techniques; energy demand; magnitude and pattern; input and output analysis; energy modelling and optimal mix of energy sources. **(9)**

ENERGY AND ENVIRONMENT

Energy; various forms; energy storage; structural properties of environment; bio-geo-chemical cycles; society, environment population and technology. **(9)**

ENERGY AND SOCIETY

Energy and evolution; growth and change; patterns of consumption in developing and advanced countries; commercial generation of power requirements and benefit. **(9)**

MANAGEMENT OF ENERGY CONSERVATION IN CHEMICAL INDUSTRIES

Chemical industries; classification; conservation in unit operations such as separation; cooling tower; drying; conservation applied to refineries, petrochemical, fertilisers, cement, pulp and paper, food and chlor-alkali industries; conservation using optimization techniques. **(9)**

ECONOMIC BALANCE IN ENERGY CONSUMPTION

Cost analysis; capacity; production rate; system rate; system cost analysis; corporate models; production analysis and production using fuel inventories; input-output analysis; economics; tariffs **(9)**

TOTAL : 45

TEXT BOOKS

1. *Jerrold H Kertz, Energy Conservation and Utilization, Allyn and Bacur Inc, 1976.*
2. *Gemand M Gramlay, Energy, Macmillion publishing Co, Newyork, 1975.*

REFERENCES

1. *Krentz J. H., Energy Conservation and Utilization, Allyn and Bacur Inc., 1976.*
2. *Gramlay G. M., Energy, Macmillan Publishing Co., New York, 1975.*
3. *Rused C. K., Elements of Energy Conservation, McGraw-Hill Book Co., 1985.*

CO & PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3			2	3			2				3
CO2	3		3			2	3			2				3
CO3	3		2			2	3			2				3
CO4	3		2			2	3			2				3
CO5	3		3			2	3			2				3

19CHE10 - BIOCHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Distinguish the chemical and biochemical process and explain the basic terminologies of biochemical engineering.*

CO2 : *Demonstrate the basic concept of enzyme engineering and develop kinetic equation for enzyme catalyzed reactions.*

CO3 : *Analyze the factors affecting the cell growth and develop models for cell growth.*

CO4 : *Apply concepts of mechanical operations, mass transfer and heat transfer in biochemical processes and microbiological systems.*

CO5 : *Design bioreactors for Downstream Processes and Effluent Treatment.*

INTRODUCTION

An overview of industrial biochemical processes with typical examples, comparison of chemical and biochemical processes, development and scope of biochemical engineering as a discipline. Industrially important microbial strains and their classification; structure; cellular genetics; typical examples of microbial synthesis of biologicals. **(9)**

ENZYMES AND ENZYME KINETICS

Enzymes fundamental concepts, classification of enzymes; industrial applications of enzymes; industrially important enzymes; mechanism of enzymatic reactions; Michaelis-Menten and Briggs Haldane equation; Models for complex enzyme kinetics; enzymes inhibition; factors affecting the reaction rates; industrial production, purification and immobilization; enzyme reactors with typical examples. **(9)**

MICROBIAL KINETICS

Typical growth characteristics of microbial cells; factors affecting growth; Monod`s equation; modeling of batch and continuous cell growth; immobilized whole cells and their characteristics. **(9)**

TRANSPORT IN MICROBIAL SYSTEMS

Newtonian and Non-Newtonian behavior of broths; agitation and mixing; power consumption; gas-liquid transport in cells; transfer resistances; mass transfer coefficients and their role in scale-up of equipments; enhancement of O2 transfer; heat transfer correlation; sterilization cycles and typical examples of heat addition during biological production. **(9)**

BIOREACTORS

Batch and continuous types; immobilized whole cell and enzyme reactors; high performance bioreactors; sterile and non-sterile operations; reactors in series with and without recycle; design of reactors and scale-up with typical examples. Downstream Processes and Effluent Treatment Recovery and purification of products; Different unit operations in down streaming with special reference to membrane separations; extractive fermentation; anaerobic treatment of effluents; typical industrial examples for downstream processing and effluent disposal. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Shuler M.L., Kargi F., Bioprocess Engineering Basic Concepts, Second Edition, Prentice Hall of India, 2002.*
2. *Bailey J.E., Ollis D.F., Biochemical Engineering Fundamentals, McGraw-Hill, International Edition, Second Edition, Reprint, New York, 2010.*

REFERENCES

1. *Lee J.M., Biochemical Engineering, First Edition, Prentice Hall, 1992 (Second Edition e-book 2001).*
2. *Blanch H.W., Clark D.S., Biochemical Engineering, Marcel Dekker, 1997.*
3. *Rao D.G., Introduction to Biochemical Engineering, Second Edition, McGraw Hill, 2010.*
4. *Doran P.M., Bioprocess Engineering Principles, Second Edition, Academic press, 1995.*

Mapping of Course Outcome with Program Outcomes

COs	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2	2	3		3					2	3	2	
CO2		2	2	3		3					2	3	2	
CO3	2	2	3	3	2	3		1				3	2	
CO4	3	2	2	3		3					2	3	2	
CO5	2	2	2	3	2	3					2	3	2	

Slight; 2- Moderate; 3-Substantial

19CHE11 - PROCESS ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of course, students will be able

CO1 : *Know about the basic concept of equipment in oil and gas industry.*

CO2 : *Know about the project execution, different phases in a project.*

CO3 : *Understand the software used for simulation and flow studies.*

CO4 : *Understand the PFD, P&ID for various processes.*

CO5 : *Understand the works in an EPC company.*

INTRODUCTION TO OIL AND GAS FACILITIES

Introduction to Oil and Gas Industry-Process description- Piping elements- Instruments: field instruments, control valves- Process equipment- Role of Process Engineer. **(9)**

INTRODUCTION TO PROJECT ENGINEERING

Elements in Project Execution, Different Phases of a Project-(Basic Engineering package-BEP, Front End Engineering Design-FEED, Proposal Engineering, EPC-EPCM Contract, LSTK), Elements of Engineering, Process Engineering Deliverables.

Introduction to Piping design engineering, Instrument Design Engineering. **(9)**

PROCESS SIMULATION AND DESIGN

Introduction and purpose- Software used for Simulation, Simulation inputs- Steady state simulation- Typical operation in simulation schemes- Heat and material balance generation, Dynamic Simulation Study and its uses. Introduction to Relief and Blow down Studies, Pipeline Flow assurance Study-Steady State and Transient, software used in Flow assurance Studies, Introduction to AIV/FIV studies, CFD analysis. **(9)**

ENGINEERING DIAGRAMS

Block flow diagram-Process/Utility flow diagram-Symbols for P&ID development: piping elements, control system-Operation & control philosophy-Cause and Effect chart- typical PID development for Glycol Dehydration unit, Process Safety Flow diagrams, SAFE Chart. Introduction to Plot plan, General arrangement drawings. **(9)**

FACILITIES ENGINEERING

Process Design Basis and Design Criteria, Overview of various process equipment and its design principles: Separators, Pumps, Compressors, Heat exchangers, Absorber column, Heaters, Air coolers, Storage Tanks, Line hydraulics (Gas, Liquid and Multiphase lines)- Pump Hydraulics- Control valve hydraulics, software used in Equipment design (Column, Heat Exchanger etc.). Introduction to various Codes and Standards followed in a PROJECT (API, TEMA, ISA etc. **(9)**

TOTAL : 45

REFERENCES

1. *Perry's Chemical Engineers' Handbook, Robert H. Perry, October 2007.*
2. *GPSA Engineering Data Book, Gas Processors Suppliers Association, 13th Edition 2012.*
3. *American Petroleum Institute (API) Standards.*
4. *ISA Standards*
5. *TEMA standards, Tubular Exchanger Manufacturers Association, Inc.*

Mapping of Course Outcomes with Program Outcomes

COs	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			3		3	3	3					3	
CO2	3		2	2		3	3	3						2
CO3	3		3	2	2		2	3						
CO4	3		2		2		3	3			1			
CO5	3	2		2			2	2						

(1: Slight, 2: Moderate 3: Substantial)

19CHE12 - PETROLEUM REFINERY ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students would be able to

CO1 : *Assess the quality of refinery products -Liquified Petroleum Gas (LPG), Gasoline, Jet fuel, Diesel, Kerosene and Lube oils using analytical procedures*

CO2 : *Ascertain distillation characteristics of crude and analyze the physical and chemical properties of refinery products*

CO3 : *Illustrate the processes of atmospheric distillation, vacuum distillation, gasoline treatment, kerosene treatment, lube treatment, wax removal from petroleum fractions and sulphur recovery*

CO4 : *Develop flowcharts for thermal and catalytic processes*

CO5 : *Design distillation column, tubestill heaters and evaluate the economics*

FUNDAMENTALS OF PETROLEUM REFINING

Origin, formation, exploration and composition of petroleum, Petroleum reserves in India, Classification of crude, Refinery products and Test methods - Liquefied Petroleum Gas (LPG), Gasoline, Jet fuel, Diesel, Kerosene and Lube oils. **(9)**

PETROLEUM PROCESSING DATA

API gravity, Characterization factor, Correlation Index, Viscosity index, Octane number, Cetane number, Smoke point, Flash and fire points, Pour point, Cloud point, Aniline point, Chemical Analysis Data - Elemental Analysis, Carbon Residue, Detailed Hydrocarbon Analysis, Hydrocarbon Family Analysis, Aromatic Carbon Content, SARA (Saturate Aromatics Resins and Asphaltenes) Analysis, Distillation characteristics - ASTM and TBP (True Boiling Point) interconversion by Riazi- Daubert and Daubert's method **(9)**

PETROLEUM FRACTIONATION AND TREATMENT TECHNIQUES

Crude desalting, Atmospheric and Vacuum distillation, Gasoline treatment - Lead doctoring, Merox Sweetening, Sulphuric acid treatment, Kerosene treatment - Liquid sulphur dioxide extraction, Lube treatment - Clay treatment, Phenol extraction, Furfural extraction, Duo-sol process, Wax and Purification - Dewaxing (without solvent), Ketone dewaxing, Sulphur Recovery by Claus process **(9)**

THERMAL AND CATALYTIC PROCESSES

Visbreaking, Delayed coking, Flexi Coking, Fluid Catalytic Cracking, Catalytic Reforming, Alkylation, Polymerisation, Isomerisation. **(9)**

EQUIPMENT AND DESIGN CALCULATIONS

Design concepts of crude oil distillation column, Tube still heaters - Design, Lobo-Evans method, Refinery Economics - Refining costs, Refining margins, Refinery complexity **(9)**

TOTAL : 45

TEXT BOOKS

1. *Baskara Rao B.K., Modern Petroleum Refining Processes, Fifth Edition, Oxford-IBH, New Delhi, 2008.*
2. *Mohammed A.Fahim, Taher A. Aleahhaf, Amal Sayed Elkilani "Fundamentals of Petroleum Refining".*

REFERENCES

1. *Nelson W.L., Petroleum Refinery Engineering, Fourth Edition, McGraw Hill, Auckland, 1985.*
2. *Bland, W.F., Davidson, R.L., Petroleum Processing Handbook, McGraw Hill, New York, 1973.*
3. *J.H. Gary and G.E. Handwerk "Petroleum Refinery Technologies and Economics"*

19CHE13 - DRUGS AND PHARMACEUTICALS TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students would be able to

CO1 : *Develop nomenclature for upcoming drugs and gain knowledge of therapeutic agents to be used for treatment.*

CO2 : *Estimate the pharmacokinetic parameters and analyze the transformation of drugs in the body.*

CO3 : *Employ standards of hygiene in the manufacturing processes of drugs and pharmaceuticals.*

CO4 : *Examine the constituents present in pharmaceutical and microbiological products.*

CO5 : *Formulate drug delivery systems to transport pharmaceutical agents in the body to achieve therapeutic effect.*

INTRODUCTION

Development, sources, and characteristics of drugs; Important terms used in chemistry of drugs- Medicinal Chemistry, Pharmacology, Pharmacophore, Gram positive and negative bacteria, virus, fungi ; Classification and nomenclature of drugs; **(6)**

PHARMACOKINETICS AND PHARMACODYNAMICS

Physico - chemical principles; Pharmacokinetics - Absorption Distribution, Metabolism and Excretion of Drugs; Bioavailability measurement - Plasma level-time and Urinary excretion studies; Basic Pharmacodynamics. **(9)**

MANUFACTURING PRINCIPLES

Compressed tablets and coating, Wet granulation, Dry granulation or Slugging, Capsules, Parenteral solutions, Oral liquids, Ointments, Good Manufacturing Practice as per Drugs and Cosmetics Act. **(9)**

PHARMACEUTICALS, MICROBIOLOGICAL PRODUCTS

Laxatives, Radiopharmaceuticals, Cardiovascular agents, Central Nervous System stimulants, External Antiseptics, Analgesics, Antacids, Antibiotics, Antineoplastic drugs, Antidiabetic drugs, Hormones, Vitamins. **(12)**

DRUG DELIVERY

Transdermal drug delivery, Polymers in drug delivery, Liposomal drug delivery, Nano drug delivery, Opthalmic drug delivery, Design of Controlled Drug Delivery Systems. **(8)**

TOTAL : 45

TEXT BOOKS

1. *Chatwal G.R., Synthetic Drugs, Himalaya Publishing House, Delhi, 2009.*
2. *Brahmankar D.M. and Jaiswal S.B. Biopharmaceutics and Pharmacokinetics - A Treatise, Vallabh Prakashan, New Delhi, 2015.*
3. *Felton, Linda A., Remington : Essentials of Pharmaceutics, College of Pharmacy, Philadelphia, 2013.*

REFERENCES

1. *Juergen Siepmann, Ronald A. Siegel, Michael J. Rathbone, Fundamentals and Applications of Controlled Release Drug Delivery, Springer, 2011.*
2. *Tyagi O.D., Yadav M. A., Text Book of Synthetic Drugs, Anmol Publications, New Delhi, 2011.*
3. *Lachman L. Lieberman H.A. and Kanig J.L., The Theory and Practice of Industrial Pharmacy, Indian Edition, Varghese Publishing House, Mumbai, 2013.*

19CHE14 - FOOD TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students would able to

CO1 : *Understand the principles of Food Science and aware of the effects of Food Additives*

CO2 : *Apply the Preservation techniques in the practical and real world situations and problems.*

CO3 : *Gain Knowledge on various Food Packaging Technology.*

CO4 : *Incorporate the principles of food processing indifferent food sectors.*

CO5 : *Identify the government regulations for the Hygienic manufacture of foods.*

GENERAL ASPECTS OF FOOD INDUSTRY

Introduction, World food demand and Indian scenario, Control of food quality by regulatory mechanism in India, Constituents of food, Quality and nutritive aspects, Food additives, Standards, Deteriorative factors and their control, preliminary processing methods, conversion and preservation operation. **(8)**

FOOD PRESERVATION TECHNIQUES

Processing systems, Microbial survivor curves, Influence of external agents, Thermal death time, Spoilage probability. General methods of preservation by heat and cold dehydration, concentration, frying, irradiation, microwave heating, sterilization and pasteurization, fermentation and pickling, packing methods. **(10)**

PACKAGING TECHNOLOGY

Packaging - Introduction, Food protection, Product containment, Product communication, Product convenience, Innovations in food packaging, Food packaging and product shelf-life, Food canning technology. Heat sterilization of canned food, containers - metal, glass and flexible packaging. Canning procedures for Fruits, Vegetables, Meats, Poultry Marine products. **(10)**

PRODUCTION AND UTILIZATION OF FOOD PRODUCTS

Bakery, confectionery and chocolate products; Soft and alcoholic beverages; Dairy products; Meat; poultry and fish products, treatment and disposal of food processing wastes. **(8)**

FOOD PLANT SANITATION

Sanitation, Sanitation Laws , Regulations and guidelines, Establishment of Sanitary practices, Waste product handling, Role of HACCP in Sanitation, Good Manufacturing practices, Standard operating procedures. **(9)**

TOTAL : 45

TEXT BOOKS

1. *R. Paul Singh, Dennis R. Heldman., "Introduction to Food Engineering", Academic Press, 2014*
2. *Potter N.N., "Food Science", The AVI publishing Co., Fourth Edition, USA, 2013*
3. *Michael.M. Cramer, "Food Plant Sanitation : Design, Maintanance and Good Manufacturing Practices", CRC Press 2013.*

REFERENCES

1. *Ernest R.V., Elementary Food Science, Fourth Edition, Springer, 2001*
2. *Considine D.M., Considine G.D., Considine P.E., Foods and Food production Encyclopedia, Vol. 8, Van Nostrand - Reinhold, 1982*
3. *Heldman D.R., "Food Process Engineering", The AVI publishing Co., USA, 1975.*

COs	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	3				2						1			
CO2		1						2						
CO3				2						2				
CO4		2			1			2						2
CO5			2			2							1	

19CHE15 - PIPING AND INSTRUMENTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Determine the process flow sheets to identify the various process alternatives and to develop the piping and instrumentation diagrams.*

CO2 : *Design and formulate piping drawings for the various manufacturing chemical equipment pressure vessels, Process vessels and absorber.*

CO3 : *Generate the process flow sheet and control strategies for the heat and mass transfer equipment Heat exchanger, reactors, dryers, Distillation column and Evaporators.*

CO4 : *Outline and design the safety systems to the processes for control variables temperature, pressure and flow by employing DCS and SIS.*

CO5 : *Identify the P&I diagrams design and HAZOPS and Risk analysis for the application of process industries.*

INTRODUCTION

Types of flow sheets, flow sheet presentation, flow sheet symbols, process flow diagram - Synthesis of steady state flow sheet - Flow sheeting software. **(9)**

BASICS OF PIPING DRAWINGS

P&ID objectives, guide rules, symbols, line numbering, line schedule, P&ID development, typical stages of P&ID, P&ID for rotating equipment and static pressure vessels, process vessels, absorber. **(9)**

CHEMICAL EQUIPMENTS DESIGN AND CONTROL

Control System for heater, heat exchangers, reactors, dryers, distillation column and evaporators. **(9)**

INSTRUMENTATION DESIGN

Distributed Control Systems (DCS), Safety Instrument System (SIS), instrument symbols, instrument signal lines, temperature instruments, flow instruments. **(9)**

APPLICATIONS

Applications of P and ID in design stage - Construction stage - Commissioning stage - Operating stage - Revamping stage - Applications of P and ID in HAZOPS and risk analysis. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Ernest E. Ludwig, Applied Process Design for Chemical and Petrochemical Plants, Vol.1, Gulf Publishing Company, Houston, 1989.*
2. *Max. S. Peters, Timmerhaus K.D., Plant Design and Economics for Chemical Engineers, McGraw Hill, Inc., New York, 1991.*

REFERENCES

1. *Anil Kumar, Chemical Process Synthesis and Engineering Design, Tata McGraw Hill Publishing Company Limited, New Delhi 1981.*
2. *Westerberg A.N., Process Flow sheeting, Cambridge University Press, 1979*

Mapping of COs with Pos

Mapping of COs with Pos														
COs	Program Outcomes Pos													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3		3						3		2	3	
CO2	3													
CO3	3	2	3	2		1							2	
CO4	3	2	2	2		1							2	
CO5	3	3	1	2		1							2	

19CHE16 - PROCESS AUTOMATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

PREREQUESTIE : Process Dynamics and Control

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Demonstrate the concepts of instrumentation for the measurement, control and classification of systems by utilizing the analog / digital control devices.*

CO2 : *Develop the skills required for automation, control and monitoring of industrial processes in high level with automation and control systems.*

CO3 : *Employ high-level PLC control systems in the computer integration of manufacturing processes.*

CO4 : *Integrate the industrial processes, control of sequences for automation and monitoring through distributed control systems.*

CO5 : *Practice the manufacturing and inventory management systems currently used in the process industries.*

INTRODUCTION

Principles of measurement and classification of process control instruments, temperature, pressure fluid flow, liquid level, velocity, fluid density, viscosity etc., instrument scaling, sensors, transmitters and control valves, instrumentation symbols and labels. **(9)**

PROCESS AUTOMATION

Structure &components of Industrial Automation systems. Architectural levels of Industrial controls, Single loop and Multi loop controllers and their tuning. **(9)**

PROGRAMMABLE LOGIC CONTROLLER

Introduction, architecture, definition of PLC, PLC vs PC, PLC vs DCS, Relay diagram, Ladder diagram examples, timers/counters, PLC design **(9)**

DISTRIBUTED CONTROL SYSTEM

Introduction, functions, advantages, and limitations DCS as automation tool for resource planning and support enterprise, DCS architecture of different makes, specification, Configuration and programming **(9)**

PROCESS OPERATION MANAGEMENT SYSTEMS

Overview of process operation management systems, order, inventory management, process scheduling, quality management. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Nakara B.C., Choudary K.K., Instrumentation and Analysis, Second Edition, Tata McGraw Hill, New Delhi, Seventh Reprint, 2006.*
2. *Stephanopoulos G., Chemical Process Control, Tata McGraw Hill, New Delhi, 1993.*

REFERENCES

1. *Karl J.Astrom, Bjorn Willermans., Computer Controlled Systems, Prentice Hall of India Pvt. Ltd., 1994.*
2. *Chemical Engineering Refresher Series on Process Automation, McGraw-Hill Publications, New York, 1991.*

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	3							2	2
CO2	3	3	3	2	3	3							2	2
CO3	3	3	3	2	3	3							2	2
CO4	3	3	3	2	3	3							2	2
CO5	2	2	3	2	3	3							2	2

19CHE17 - PROCESS INSTRUMENTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After comletion of the course, students are able to,

CO1 : *Explain the basic principles of various measuring instruments and its static, dynamic response. Errors in the measurements.*

CO2 : *Demonstrate the various instruments utilized to measure the temperature and calculate the temperture using thermometer, thermistor, radiation pyrometer.*

CO3 : *Calculate the pressure using manometer and demonstrate the basic fundamentals of pressure measuring devices.*

CO4 : *Demonstrate the fundamentals of variable head meter, area flow meter, direct, inertial type level meter and density measurement devices.*

CO5 : *Select suitable measuring device for gas mixture analysis, thermal, electrical conductivity, viscosity and construct piping and instrumentation diagram.*

PRINCIPES OF MEASUREMENT

Analysis: Measurement of Force, Strain and Torque- Use of strain gauges. Transducers - Resistive, capacitive, Inductive and piezoelectric pickups.Static and Dynamic response of Instruments. Errors in measurements. **(9)**

TEMPERATURE MEASUREMENT

Liquid filled, Gas filled and Vapour pressure Thermometers. Bimetallic and Resistance thermometers.Thermocouples and Thermistors. Optical and Radiation pyrometers. **(9)**

PRESSURE MEASUREMENT

Manometers, Bourdon gauge and Bellow gauge. Measurement of pressure and Vacuum.Use of Transducers. **(9)**

FLOW, DENSITY AND LEVEL MEASUREMENTS

Variable head flow meters. Area flow meters. Positive displacement meters. Pressure Probes.Level measurements - Direct and Inertial types.Measurement of density and specific gravity. Instruments for weighing and feeding. **(9)**

MISCELLANEOUS MEASUREMENTS

Analysis of gas mixtures.Thermal conductivity, Viscosity and Electrical conductivity.Supporting instrumentation - Standard cells, Balancing circuits and Terminating devices.Principles of Telemetering. P and I diagrams. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Eckman, D.P, Automatic Process Control, Wiley Eastern, New Delhi, 2006.*
2. *Jain, R.K, Mechanical and Industrial Measurements, Twelfth Edition Khanna Publishers, New Delhi 2015.*

REFERENCES

1. *Perry, R.H., Green, D.W., Perry's Chemical Engineer's Handbook, Eighth Edition, McGraw Hill (ISE), 2007.*
2. *Considine, D.N., Process Instruments and Controls Handbook, Fifth Edition, McGraw Hill. New York, 1999.*
3. *Benedict, R.P, Fundamentals of temperature, Pressure and Flow measurements, Third Edition, John Wiley, New York. 1984.*
4. *Notlingk. B.E., Jones' Instrument Technology, Vol. I and II, Fourth Edition, ELBS, 1987.*
5. *Patranabis. D., Principles of Instrumentation, Second Edition, Tata-McGraw Hill, New Delhi, 2007.*

Mapping of Course Outcomes with Programme Outcomes

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2		1			1			1		1		
CO2	3	3	2	2			2			1		1		
CO3	3	3	2	2			2			1		2		
CO4	3	3	3	2			2			1		2		
CO5	3	3	2	2		2	2			1		2		

19CHE18 - TOTAL QUALITY MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students will be able to

CO1 : *Describe the basic concepts of Total Quality Management.*

CO2 : *Identify the Principles of Total Quality Management.*

CO3 : *Apply and acquire knowledge on quality tools & Techniques.*

CO4 : *Formulate the Quality Management System for use in any process industries.*

CO5 : *Justify and Gain confidence in implementing Quality system Management in process industries.*

INTRODUCTION

Definition of TQM, basic approach, gurus of TQM,TQM frame work, defining quality, obstacles, benefits of TQM, leadership - Concepts, The deming philosophy, The role of TQM leaders, implementation, quality council, quality statements, strategic planning. **(9)**

TQM PRINICIPLES

Customer satisfaction - Customer perception of quality, using customer complaints, service quality, customer retention; employee involvement - Motivation, empowerment, teams, recognition and reward, performance appraisal, benefits; Continuous process improvement - The juran trilogy, The PDSA cycle, kaizen, six sigma; supplier partnership - Partnering, sourcing, supplier selection, supplier rating, relationship development; performance measures - Basic concepts, strategy, presentation, quality costs analysis techniques. **(9)**

STATISTICAL PROCESS CONTROL

The seven tools of quality, statistical fundamentals, process capability, control charts for variable and attributes, new seven management tools. **(9)**

TQM TOOLS

Benchmarking - Reasons to benchmark, process, pitfalls and criticisms; Quality function deployment - Benefits, house of quality, QFD process; Taguchi's quality loss function; Total Productive Maintenance (TPM) - Concept, improvement needs; FMEA - Stages of FMEA. **(9)**

QUALITY SYSTEMS

Benefits of ISO registration, ISO 9000 series of standards, sector-specific standards, ISO requirements, implementation, documentation, internal audits, registration; environmental management system-ISO 14000 series standards, concepts of ISO 14001, requirements of ISO 14001, benefits of EMS. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Besterfield, Dale H., Carol Besterfield-Michna, Glen Besterfield and Mary Besterfield-Sacre,:Total Quality Management, Third Edition, Second Impression, Pearson Education Inc, Delhi, 2007.*
2. *Subburaj Ramasamy, : Total Quality Management, Second reprint, Tata McGraw Hill publishing Company Ltd, New Delhi, 2006.*

REFERENCES

1. *Kumar S, Total Quality Management, 1st Ed., Reprint, Laxmi Publications (P) Ltd., Delhi, 2007.*
2. *Naagarazan R.S and Arivalagar A.A, :Total Quality Management, First Edition, Reprint, New Age International (P) Ltd., New Delhi, 2005.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								3	3		3			3
CO2								3	3		3			3
CO3								3	3		3			3
CO4								3	3		3			3
CO5								3	3		3			3

(1: Slight, 2: Moderate 3: Substantial)

19CHE19 - OPTIMIZATION METHODS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Formulate a chemical engineering real world problem as a mathematical programming model by developing objective functions and the relevant environmental-economic constraints.*

CO2 : *Solve linear programming problems using the simplex method, Big-M method, two-phase method and duality theory.*

CO3 : *Estimate the optimum conditions for single and multivariable, unconstrained and constrained non-linear optimization problems using quadratic, geometric and dynamic programming techniques.*

CO4 : *Solve unconstrained and constrained non-linear optimization problems using numerical techniques such as Newton's, quasi Newton, secant methods; region elimination methods, polynomial approximation; quadratic and cubic interpolation techniques*

CO5 : *Apply the concepts of both linear and nonlinear optimization techniques to determine optimum number of effects, optimum reflux ratio and optimum pipe diameter in multiple effect evaporation, binary distillation and fluid flow problems.*

PROBLEM FORMULATION & CLASSIFCATION

Introduction; formulation of objective functions; fitting models to data; classification of functions; necessary and sufficient conditions for optimum; unimodal, multimodal functions; analytical methods. **(9)**

LINEAR PROGRAMMING

Review on basic concepts of LP formulations; Simplex methods; Big-M method, two phase method and Duality in linear programming. **(9)**

NON-LINEAR PROGRAMMING

The Lagrange multiplier method,Integer,quadratic,geometric and dynamic programming. **(9)**

NUMERICAL METHODS

Unimodal functions; Newton's quasi Newton, secant methods; region elimination methods, polynomial approximation; quadratic and cubic interpolation techniques for optimum. Multimodal functions; direct methods; Powell's technique; indirect methods; gradient and conjugate gradient methods; secant methods. **(9)**

APPLICATIONS

Heat transfer and energy conservation; separation processes; fluid flow systems; reactor design and operation; large scale systems. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Edgar T.F., Himmelblau D.M., Lasdon,L.S., Optimization of Chemical Processes, Second Edition, McGraw-Hill Book Co., New York, 2001.*
2. *Reklaitis G.V., Ravindran A., Ragsdell, K.M., Engineering Optimization, John Wiley, New York, 1980.*

REFERENCES

1. *Biles W.E., Swain J.J., Optimization and Industrial Experimentation, Inter Science, New York, 1980.*
2. *Seinfeld J.H., Lapidus L., Process Modeling, Estimation and Identification, Prentice Hall, Englewood Cliffs, New Jersey, 1974.*

19CHE20 - INTEGRATED DESIGN OF CHEMICAL PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Compute the design calculations for the various reactor configurations of reactors used for homogenous and heterogeneous reactions.*

CO2 : *Solve the design problems related to Settling and Sedimentation, Centrifugal filtration and drying unit.*

CO3 : *Solve the design problems for distillation, absorption, stripping, and Liquid-Liquid Extraction and Evaporation units.*

CO4 : *Formulate steady state material balance for the unit operations such as distillation, evaporation, mixing, extraction, drying and crystallization processes with recycle by-pass and purge.*

CO5 : *Apply the combined material and energy integration to select the optimal process conditions for the design equipments used for separation and transport processes.*

REACTOR CONDITIONS AND CONFIGURATION

Hierarchy and approaches of Chemical process Design and Integration. Role of process economics, optimization Reactor Performance - Idealized reactor models and their choice. Reactor conditions - Reactor temperature, pressure and concentration. Reactor Configuration - temperature control, reactors for homogeneous and hetero reactions **(9)**

HOMOGENEOUS SEPARATORS

Separators for Heterogeneous mixtures.Settling and Sedimentation, Inertial and Centrifugal separation, Filtration, Scrubbing, Flotation and Drying. **(9)**

HETEROGENEOUS SEPARATORS

Separator for Homogeneous fluid mixtures, Distillation, Absorption, stripping and Liquid-Liquid extraction, Adsorption, Membranes, Crystallization, Evaporation, Sequencing. **(9)**

NETWORKING

Reaction, separation and Recycle systems for continuous processes and for batch processes. Heat exchanger networks - Heat transfer equipments, Energy capital and total cost targets, network Design. **(9)**

PROCESS INTEGRATION

Heat Integration of reactions, Distillation columns, Evaporators, Dryers. Steam systems and Cogeneration, Cooling water networking design. **(9)**

TOTAL : 45

TEXT BOOK

1. *Robin Smith, Chemical Process Design and Integration, Second Edition, Willey India Pvt Ltd, New Delhi, 2009.*

REFERENCES

1. *Alexandre C. Dimian, CostinSorinBildea, Chemical Process Design: Computer-Aided Case Studies, WIELY-VCH VerlagGmbh and Co KGaA, Weinheim, 2008.*
2. *Anil Kumar, Chemical Process Synthesis and Engineering Design, McGraw Hill, 1982.*

19CHE21 - COMPUTER AIDED PROCESS EQUIPMENT DESIGN

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Apply the phase equilibrium concepts to estimate vapour or liquid phase composition, bubble point or dew point of ideal and non-ideal mixtures with the aid of ASPEN PLUS/ MATLAB /C Programming.*

CO2 : *Analyse a complete chemical process plant and assess alternative process flow sheets by decomposing the process flow sheets with the help of tearing- precedence ordering techniques.*

CO3 : *Develop MATLAB/C Programming codes to calculate performance indices like batch time, equilibrium conversion of ideal batch and continuous flow reactors.*

CO4 : *Generate MATLAB or C Programming codes to compute the design parameters for tubular exchanger, surface condenser, evaporator, crystallizer and storage tank.*

CO5 : *Apply the process simulation software like ASPEN PLUS/ MATLAB /C Programming in the design of single and multiple effect evaporators.*

PHYSICAL PROPERTIES EVALUATION

Review on Programming languages, Physical properties evaluation, Thermodynamic properties of gases, binary mixtures, methods of calculating vapor liquid equilibrium, data for ideal and non-ideal mixture. Bubble point and dew point. Flash and distillation calculation. **(12)**

FLOWSHEETING

Conceptual design- hierarchical approach- General Structure of computer aided design programme - hierarchical design procedure for chemical processes- Importance of Flow sheeting of Flow sheet - Flow sheet structure. **(12)**

DEVELOPMENT OF SOFTWARES

Development of Software for rectors- batch, stirred tank and tubular flow reactor, design of reactors for multiple reactions. **(12)**

SIMULATION SOFTWARE

Introduction to simulation software Design II, Design of process equipment using Design II - tubular exchanger, surface condenser, evaporator, crystallizer, storage tank. **(12)**

APPLICATIONS OF DESIGN SOFTWARES

Linear Programming, Dynamic Programming in Chemical Engineering, Formulation and solution through PC based programs. Introduction to simulation software Aspen Plus, Simulation of chemical processes using Aspen Plus. Introduction to EVAP software. Design of multiple effect evaporator using EVAP. **(12)**

TOTAL : 60

TEXT BOOKS

1. *Douglas J.M., Conceptual Design of Chemical Processes, McGraw Hill, New York, 1988*
2. *Sinnott R.K., Coulson and Richardson's Chemical Engineering Vol.6, Fourth Edition, Chemical Engineering Design, Butterworth-Heinemann, 2005.*
3. *Hanna O.T., Scandell, O.C., Computational Methods in Chemical Engineering, Prentice Hall, 1995.*
4. *Leasley M.E., Computer Aided Process Plant Design, Gulf Publishing, 1982.*

REFERENCES

1. *Jerry O.P., Breneman G.L., Spreadsheet Chemistry, Prentice Hall, Englewood Cliffs, 1991.*
2. *Myers A.L., Seider W.D., Introduction to Chemical engineering and Computer Calculations, Prentice-Hall,1976*

19CHE22 - SUGAR TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Determine the raw materials required for the manufacture of sugar and the analytical methods to be followed for high grade product.*

CO2 : *To produce a clear juice that is light in color and free of suspended matter*

CO3 : *Employ evaporation process to improve the concentration of syrup from clear juice.*

CO4 : *Determine the optimum temperature to control the size of sugar crystals and study the kinetics on growth rate*

CO5 : *Separate the sugar crystals based on the size and colour and utilise spent molasses to extract sucrose.*

INTRODUCTION

Sugar industry in India. Chemical and Physical properties of Sucrose and reducing sugars. Source for Sucrose. Formation of sucrose plants. Non sugar compounds of sugar cane. Inorganic constituents of sugar cane juices and sugars. Analytical methods used in Sugar Industry. **(9)**

PURIFICATION

Chemical technology of the purification processes. Fundamental reactions and physical chemistry aspects of clarification. Liming, sulphitation and carbonation processes. Filtration of sugar juice. **(9)**

EVAPORATION

Evaporation of sugar juice. Heat transfer in evaporators. Evaporation equipment and its auxiliaries. Methods of obtaining steam and quality of steam. Steam economy. Chemistry of the evaporation process. Scale formation and cleaning of evaporators. **(9)**

CRYSTALLIZATION

Solubility of sucrose. Solubility of sucrose - nucleation in super saturated solutions - kinetics and growth of crystallization. Chemistry of crystallization. Control methods and equipment used in sugar crystallization; Technology of sugar crystallization. Evaporation and circulation in vacuum pans. **(9)**

CENTRIFUGATION

Theory of the centrifugal processes. Centrifugal operation. Engineering principles of sugar centrifugals and the centrifugal process. Centrifugal equipment and its auxiliaries. Production of final molasses and its utilizations. Grading of sugar. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Honig P., Principles of Sugar Technology, Vol.1,2 and 3, Elsevier Publishing Company, 1953.*
2. *Van der Poel P.W., Schwartz T.K., Schiweck H.M., Sugar Technology [Beet and Cane Sugar Manufacture], Beet Sugar Development Foundation (Fort Collins, Colo.), Fourth Edition, Verlag Dr Albert Bartens KG, 1998.*

REFERENCES

1. *Payne J.H., Sugarcane factory Analytical control, Fifth Edition, Elsevier Publisher, London, 1968.*
2. *Jenkins G.H., Introduction to Sugarcane technology, Elsevier Publisher, London, 1966*
3. *Hoing P., Principle of Sugar Cane Technology, Elsevier Publisher, London.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	0	0	3	2	2	0	0	0	2	0	0
CO2	2	3	3	0	0	2	1	0	0	0	0	2	0	0
CO3	2	3	3	0	0	3	1	0	0	0	0	2	0	0
CO4	3	3	3	0	0	3	2	0	0	0	0	2	0	0
CO5	2	3	3	0	0	2	1	0	0	0	0	2	0	0

(1: Slight, 2: Moderate 3: Substantial)

19CHE23 - ENERGY TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *To understand the formation of coal and its classification, ranking, analysis, testing, carbonization, gasification, liquefication and manufacture of coke.*

CO2 : *To create the knowledge about occurrence of crude oil, its composition, classification and production of petroleum products, properties and testing, handling and storage of petroleum, refining and other conversion processes.*

CO3 : *To state the occurrence, properties, production and storage of gaseous fuels, combustion, furnaces for different gaseous fuels and waste heat recovery.*

CO4 : *To understand the concept of nuclear reactions and to infer the fuel materials, moderators and structural materials for construction of various types of nuclear reactors for contribution to the energy needs.*

CO5 : *To analyze the utilization of solar energy for room and water heating, to derive energy from biomass using different biogas plants and to study application of other energy resources such as wind energy, tidal and ocean energy.*

SOLID FUELS

Principal solid fuels, coal - preparation, storage, carbonization, biofuels, briquetting. **(9)**

LIQUID FUELS

Liquid fuels from crude oil, synthetic and other liquid fuels. Storage and handling of liquid fuels. **(9)**

GASEOUS FUELS

Natural gas, manufacture of gaseous fuels. Gas purification. Combustion. Furnaces. Waste heat recovery. **(9)**

NUCLEAR ENERGY SOURCES

Nuclear energy - Nuclear reactions. Fuel materials, moderators and structural materials. Nuclear reactors. Reprocessing of spent nuclear fuel. **(9)**

RENEWABLE ENERGY SOURCES

Solar energy - utilization for room and water heating. Silicon cells in storage of solar energy. Energy from biomasses - biogas plant. Wind energy, tidal and ocean thermal sources. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Gupta O.P., Elements of Fuels, Furnaces and Refractories, Khanna Publishers, New Delhi,1990.*
2. *Rao S, Parulekar B. B Energy Technology, Non Convectional, Renewable and Convectional Khanna publication, New Delhi 1997.*
3. *Himus G.W., The Elements of Fuel Technology, second Edition, Leonard Hill, London,1958.*

REFERENCE

1. *Considine D.M., Energy Technology Handbook, McGraw Hill, New York,1977.*

CO & PO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2	3				3		1				2	
CO2		2	3				3		1					
CO3			3				3		1				2	
CO4		2	3				3		1					
CO5		2	3				3		1				2	
		2	**3**				**3**		**1**				**2**	

19CHE24 - PETROCHEMICALS TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Identify the feed stock selection for the distillation of crude oil in to petrochemicals.*

CO2 : *Classify the production & purification techniques involved in separation of polymeric compounds.*

CO3 : *Discover the possible aromatic polymers from the crude oil separations.*

CO4 : *Distinguish the modern methods available for the production and separation of petrochemicals.*

CO5 : *Plan the production techniques for the production of synthesis gas, paraffines and aromatics.*

PETROCHEMICAL INDUSTRY-FEEDSTOCKS

Feed stock selection for Petrochemicals. Production and purification of raw materials like gaseous hydrocarbons, liquid hydrocarbons, Separation of impurities and precise fractionation, etc. **(9)**

OLEFINIC POLYMERS

Production of mono-olefines from gaseous and liquid petroleum fractions. Purification and polymerization for products like polyethylene, polypropylene, polyisobutylene and copolymers of olefins **(9)**

AROMATIC POLYMERS

Production and purification of aromatics, Synthetic rubbers, Synthetic fibres and Synthetic detergents. **(9)**

ALKYLATION, ISOMERIZATION

Alkylation, Isomerization, Oxosynthesis, Udex process and Fischer-Tropsch reactions. Modern methods of production of acetylene and its compounds. **(9)**

SYNTHESIS GAS AND CHEMICALS

Hydrogen and Synthesis gas production. Petroleum carbon and petroleum coke. Oxidation products of paraffines and aromatics **(9)**

TOTAL : 45

TEXT BOOKS

1. *Bhaskara Rao B.K., Textbook on Petrochemicals, Fourth Edition, Khanna Publishers Delhi, 2007.*
2. *Waddams A.L., Chemicals from Petroleum, Fourth Edition, John Murray Publishers Ltd., ELBS, 1980.*
3. *Belov P.S., Fundamentals of Petroleum Chemicals Technology, Mir Publishers, Moscow, 1970.*

REFERENCES

1. *Kobe K.A., McKetta J.J.(Jr.), Advances in Petroleum Chemistry and Refining, Vol. 2,3 and 4, Interscience, New York, 1958 - 1962.*
2. *Hengstebeck R.J., Petroleum Processing, McGraw Hill, New York, 1959.*
3. *Chauvel A., Lefebvre G., Petrochemical Processes, Vol.1 and 2, Second Edition, Paris, 1989.*
4. *Tonohue D., Lang K., A First Course in Petroleum Technology, Prentice Hall, New Jersy, 1989.*
5. *Wiseman P., Petrochemicals, Ellis Horwood, 1986.*

19CHE25 - FERTILIZER TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Illustrate chemical, organic fertilizers and nutrients*

CO2 : *Develop the flow chart for manufacture of nitrogenous fertilizers*

CO3 : *Analyze the various processes and develop the flow chart for the manufacture of phosphatic fertilizers.*

CO4 : *Develop the flow chart for the manufacture of potassic fertilizer and analyze the unit operations involved in the process.*

CO5 : *Illustrate the quality and pollution standards permissible in fertilizer industry.*

INTRODUCTION

Chemical Fertilizers and Organic Manures - Types of chemical Fertilizers. Secondary nutrients, micro nutrients. **(9)**

NITROGEN FERTILIZERS

Nitrogenous Fertilizers - Methods of production of Ammonia and Urea. Nitric acid, Ammonium sulphate, Ammonium Nitrate, Calcium Ammonium Nitrate, Ammonium Chloride - Their methods of production, characteristics, storage and handling specifications. **(9)**

PHOSPHATIC FERTILIZERS

Raw materials, phosphate rock, Sulphur pyrites -Process for the production of Sulphuric and Phosphoric acids. Ground phosphate rock, bone meal. Single Super Phosphate, Triple Super phosphate -Methods of production, characteristics and specifications. **(9)**

POTASSIC FERTILIZERS

Potassium chloride, Potassium sulphate, Potassium schoenite - Methods of production, specification, characteristics. Complex Fertilizers, NPK Fertilizers, Mono ammonium phosphate, Diammonium phosphate, Nitro phosphate Methods of production. **(9)**

FERTILIZERS IMPACTS AND STANDARDS

Fluid fertilizers. Controlled Release of fertilizers. Solid, Liquid and Gaseous pollution from ammonia urea and NPK fertilizer industries and standards laid down for them. Fertilizer production in India. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Gopala Rao M., Marshall Sittig, Dryden's Outlines of Chemical Technology, Third Edition, WEP East-West Press, New Delhi, 2010.*
2. *George T. Austin., Shreve's Chemical Process Industries, Fifth Edition, McGraw Hill Professional, 2012*
3. *Vincent Sauchelli., The Chemistry and Technology of Fertilizers, Reinhold Pub. Corp., 1960*

REFERENCES

1. *Editorial Committee - FAI Seminar on Fertilizer in India in the Seventies (Proceedings), The Fertilizer Association of India, New Delhi, 1973.*
2. *Editorial Committee - Seminar on Recent Advances in Fertilizer Technology, The Fertilizer Association of India, New Delhi, 1972.*
3. *Sauchelli V., Manual on Fertilizer Manufacture, Industry Publication Inc, New Jersy, 1963.*
4. *CHEMTECH - II - (Chapter on Fertilizers by Chari, K.S.), Chemical Engineering Education Development Centre, I.I.T., Madras, 1977.*
5. *Menon M.G., Fertilizer Industry - Introductory Survey, Higginbothams, Madras, 1973.*

CO & PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2	3				3		1				2	
CO2		2	3				3		1					
CO3			3				3		1				2	
CO4		2	3				3		1					
CO5		2	3				3		1				2	
		2	**3**				**3**		**1**				**2**	

19CHE26 - MINERAL PROCESSING TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Recall the size reduction and size separation equipment's used in the mechanical operations processes.*

CO2 : *Understand the specific gravity separation of minerals would be exposed to the practices of beneficiation ores which is important for value upgradation for main product and for byproduct recovery.*

CO3 : *Understand the various commonly used methods to beneficiate (separate) minerals from less valuable gangue material, including density, electrostatic and magnetic, based approaches.*

CO4 : *Design the flotation circuits and identify the chemicals used for concentrating minerals in flotation process.*

CO5 : *Identify the suitable disposal and treatments methods for mineral wastes and flowsheet for various mineral processes.*

COMMUNITION

Testing sieve analysis. Principles of size reduction, size separation. Different types of crushers, grinding mills, screens and classifiers. Closed and open circuit operations in size reduction. **(9)**

CONCENTRATING OPERATIONS

Principles of specific gravity separation. Launders, vibrating tables, spiral concentrators, cone concentrators, vanners, cordouries, pans and other types of specific gravity separators. **(9)**

SEPARATION PROCESSES

Electrical separation and magnetic separation of minerals. Different types of electrical and magnetic separators. **(9)**

FROTH FLOTATION

Interfacial phenomenon for mineral particles in water. Collection, frothing, activation, depression, regulation and conditioning. Froth flotation machines. Design of froth flotation circuits. **(9)**

WASTE DISPOSAL

Dewatering and drying operations. Disposal and treatment of mineral sludges. Mineral processing flow sheets for copper, lead, zinc and gold only. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Gaudin A.M., Principles of Mineral Dressing, First Edition, Tata McGraw Hill, New Delhi, 2002.*
2. *Wills B.A., Mineral Processing Technology, Seventh Edition, Maxwell Macmillan, 2006.*
3. *Pryor E.J., Mineral Processing, Third Edition, Elsevier, New York, 1965*

REFERENCES

1. *Richards R.H., Locke C.E., Text Book of Ore Dressing, Third Edition, McGraw Hill, New York, 1940.*
2. *Taggart A.F., Hand Book of Mineral Dressing, John Wiley, New York, 1954.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	0	2	2	1	0	0	3	0	0	1	1	2	0	0
CO2	0	3	3	2	0	0	2	0	0	2	1	2	0	0
CO3	0	3	3	2	0	0	3	0	0	2	1	2	0	0
CO4	0	3	3	2	0	0	3	0	0	1	1	2	0	0
CO5	0	3	3	2	0	0	3	0	0	2	1	2	0	0

(1: Slight, 2: Moderate 3: Substantial)

19CHE27 - FLUIDIZATION ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Analyze the various fluidization behavior, operating conditions and its industrial application*

CO2 : *Develop the various flow models and test their empirical correlations*

CO3 : *Develop a heat and mass transfer fluidization correlations for the industrial chemical equipment*

CO4 : *Evaluate the two and three phase inverse fluidized bed correlation and their application*

CO5 : *Solve the solid- liquid mixing problems for the fluidization operations by applying various temperature and other conditions*

INTRODUCTION

Fluidized state - nature of Hydrodynamic Suspension, Regimization of the fluidized state, Operating models for fluidization systems and its industrial applications. **(9)**

HYDRODYNAMICS OF FLUIDIZATION SYSTEM

General bed behavior, pressure drop, empirical correlations for solid holdup, flow Models **(9)**

SOLIDS MIXING AND SEGREGATION

Degree of segregation, Operation shifts, reversal points, mixing - segregation Equilibrium generalized fluidization of poly systems, Liquid phase mixing and gas phase mixing. **(9)**

HEAT AND MASS TRANSFER IN FLUIDIZATION SYSTEMS

Mass Transfer - Gas- Liquid Mass Transfer, Liquid-Solid mass Transfer and wall to bed Mass Transfer. Heat Transfer - Column wall to bed Heat transfer. **(9)**

MISCELLANEOUS SYSTEM

Moving bed, slurry bubble column, two phase and three phase inverse fluidized bed, typical applications. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Kunii D., Levenspiel O., Fluidization Engineering, Second Edition, Butterworth-Heinemann, 2013.*
2. *Leva M, Fluidization, McGraw Hill, New York, 1959.*
3. *J.F. Davidson, R. Clift and D. Harrison, Fluidization. Second Edition, 1985, Academic Press, New York.*

REFERENCES

1. *Zenz F.A., Othmer D.F., Fluidization and Fluid Particle Systems, Sixth Edition, Reinhold, New York, 1960.*
2. *Geldart D., Gas Fluidization Technology, John Wiley, New York, 1986.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

COs	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	3		2					2		2	
CO2	2	2	2	3		2					2		2	
CO3	2	2	2	3		2		1					2	
CO4	2	2	2	3		2					2		2	
CO5	2	2	2	3		2					2		2	

(1: Slight, 2: Moderate 3: Substantial)

19CHE28 - PULP AND PAPER TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Identify the available sources and preparation of pulp.*

CO2 : *Explain the steps involved in mechanical and chemical pulping process and determine the kappa number and H- factor for bleached pulp*

CO3 : *Analyze the significance of recycling of chemicals in paper manufacturing process*

CO4 : *Analyze the importance of additives in paper machine operation and control measures involved in paper and pulp industry*

CO5 : *Illustrate the quality parameters of paper and usage of alternate raw material for the scope of paper industry*

INTRODUCTION TO SOURCE OF PULP AND PROPERTIES

Source of Pulp wood. Structure and properties of pulp wood. Preparation of pulp wood:Debarking, chipping, depithing. Softwoods. Hardwoods. Comparison of different raw materials. **(9)**

PULPING PROCESS AND TREATMENT

Manufacture of pulp - Mechanical, Sulphite, Kraft and alkaline process. Treatment of pulp :Washing, screening, cleaning and Bleaching of pulp. H-factor.control parameters: Effect of raw material on pulp quality; kappa number. **(9)**

CHEMICAL RECOVERY

Kraft and soda recovery cycles.black liquor characterization, oxidation and causticization.lime mud reburning. **(9)**

PAPER MAKING EQUIPMENT AND PROCESSES

Manufacture of paper and boards.Additive preparation.Special papers.Auxiliary paper mill equipment.Pollution control and effluent treatment in paper and pulp industries. **(9)**

PAPER TESTING AND SCOPE OF PAPER INDUSTRY

Specification for paper and boards.Testing of paper and paper products. Future and scope of paper industry in India. Use of alternate raw materials. **(9)**

TOTAL : 45

TEXT BOOKS

1. *John B. Calkin, Modern Pulp and paper Making, Third Edition, Reinhold Pub.Corp, 1960.*
2. *Stephenson N., Pulp and Paper manufacture, Vol.1, 2, 3 and , McGraw Hill, New York, 1950.*
3. *Halpern M.G, Pulp Mill Processes, Park Ridge, N.J: Noyce Data Corporation, 1975.*

REFERENCES

1. *Britt.K.W., Handbook of Pulp and Paper Technology, Second Edition, CBS Publishers Delhi,1984.*
2. *Smook, G.A., Handbook for pulp and paper technologist, Third Edition, Angus Wilde Publications, Inc., 2003.*
3. *Casey J.P., Pulp and Paper: Chemistry and Chemical technology, Third Edition, Vol. 4, Wiley Interscience, 1983.*
4. *The complete Technology Book on Pulp and Paper Industries, NIIR Board of Consultants & Engineers, 2003.*
5. *Pratima Bojpai., Biermann's Handbook of Pulp & paper, Raw Material and Pulp maing, Third Edition, Vol. 1.*
6. *Pratima Bajpai. Pulp and Paper Industry : Chemical Recovery Elsevior science, 2016.*
7. *Christopher J. Biermann, Handbook of Pulping and Paper making, Second Edition, Elgevier Science, 1996.*

Mapping of Course Outcomes (Cos) with Program Outcomes (Pos)

Cos	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	3		2					2		2	-
CO2	2	2	2	3		2					2		2	-
CO3	2	2	3	3		2		1					2	-
CO4	2	2	2	3		2					2		2	-
CO5	2	2	2	3		2					2		2	-

(1: Slight, 2: Moderate 3: Substantial)

19CHE29 - SURFACE COATING TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Analyze and improve the surface properties of materials for protection in demanding contact conditions or aggressive environments.*

CO2 : *Calculate the composition and properties of various resins and manufacturing procedures.*

CO3 : *Evaluate the amount of solvents and additives required for surface coating with its appropriate properties to meet out the quality standards.*

CO4 : *Design and develop the modern technologies involved in the synthetic pigments and choose the suitable pigments for better surface coatings.*

CO5 : *Differentiate the interior and exterior decorative coatings to be appropriately used for commercial purposes.*

FILM FORMATION AND DRYING OILS

Film formation - Film forming compositions - Properties - Types of polymerization in film forming compounds. Drying oils - Composition - Manufacturing procedure. **(9)**

RESINS

Resins - Types - Natural resins and its extraction - Alkyl resin - Manufacturing procedure - Compositions - Properties - Various synthetic resins - Chemical constitution - Manufacturing procedure. **(9)**

SOLVENTS AND ADDITIVES

Diluents - Thinners - Plasticizers - Driers - Additives - Anti settling agents in sur face coating. **(9)**

PIGMENTS

Pigments - Properties - Types - White pigments - Properties - Red pigments - Green pigments - Blue pigments - Black pigments - Properties and manufacturing procedure. **(9)**

COATINGS TYPES

Formulation of exterior coating - Interior - Decorative - Industrial - Special purpose - Marine - Bituminous - Powder coatings. Manufacture of Various paints. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Payne H., Organic Coating Technology, Vol. I, John Wiley and Sons Inc., New York, 1954.*
2. *Payne, H., Organic coating technology, Pigments and Pigmented Coatings, Vol.2, John Wiley and Sons Inc., New York, 1961.*

REFERENCES

1. *Oil and Colour chemists Association, Australia: Surface coatings, Vol. 1, Raw materials and their usage, Third Edition, Tafe educational books, Chapman and Hall, London, 1993.*
2. *Oil and Colour chemists Association, Australia: Surface coatings, Vol.2, Paints and their applications, Second Edition, Tafe educational books, Chapman and Hall, London, 1984.*
3. *Oil and Colour chemists Association, Australia: NON- convertible coatings, Part 1, Eleventh Edition, Tafe educational books, Chapman and Hall, London, 1987. (H.W. Keenan, chairman, Technical education committee.)*
4. *Parkar P.K., Technology of Resins.*
5. *Noel Heaton, Introduction to Paint Technology, Second Edition, Charles Griffin and Co. Ltd., London, 1940.*
6. *Noel Heaton, Outlines to Paint Technology, Third Edition, Charles Griffin and Co. Ltd., London, 1947.*
7. *Keenan H.W., Convertible Coatings, Vol. 1 and 2, Oil and Colour chemists Association, Australia, Chapman and Hall, London, 1961.*
8. *Wood H.R, Morrel R.S, The Chemistry and Technology of Drying Oils, Ernest Benn ltd., Seventh Edition, 1984.*

Mapping of Course Outcomes with Program Outcomes

COs	Program Outcomes/Program Specific Outcomes (Pos/PSOs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2		1		1					1		2	
CO2	1	1			1		1							
CO3			1					1				1		
CO4			1		2				2					
CO5	2					1		1						

19CHE30 - HEAT POWER ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Understand the principle and applications of refrigeration and air-conditioning processes.*

CO2 : *Understand the working principle of IC engines and to analyze port-timing and valve timing diagram for four stroke engines.*

CO3 : *Analyze various process cycles and to solve problems for various cycles.*

CO4 : *Understand the working principles of steam Boilers steam and gas Turbines.*

INTERNAL COMBUSTION (IC) ENGINE

Classification - working of four stroke and two stroke engines - Petrol and Diesel engines - Ignition systems - working of simple carburetor - cooling and lubrication systems - Testing of IC Engines - various efficiencies - Heat balance test. **(12)**

AIR POWER CYCLES AND JET PROPULSION

Otto cycles, Diesel cycle, Dual cycle, comparison. Mean Effective Pressure (MEP) - Brayton cycle - Simple problems, Turbo jet - thrust - thrust power - propulsion efficiency - Rocket propulsion. **(9)**

GAS AND STEAM TURBINES

Open and closed cycle gas turbine system - practical gas turbines - Regeneration - Intercooling and Reheating - Simple Problems, Principle of impulse and reaction turbines - compounding of turbines - Simple problems. **(10)**

STEAM POWER CYCLE AND BOILERS

Ranking cycle, Properties of steam - steam tables and charts, Study of boilers - fire tube, water tube boilers- Mounting - Accessories. **(8)**

REFRIGERATION AND AIR CONDITIONING

Vapour compression refrigeration cycle on p-h diagram - COP - heat pump, Psychrometry - Air-Conditioning processes - application. **(6)**

TOTAL : 45

TEXT BOOKS

1. *Rudramoorthy. R, Thermal Engineering, Fifteenth Edition, Tata McGraw Hill, New Delhi, 2012.*
2. *Kothandaraman C.P., Domkundwar S., Engineering Thermodynamics , Second Edition, Dhanpath Rai and Sons, New Delhi, 2003.*

REFERENCES

1. *Rajput.R .K., Thermal Engineering, Ninenth Edition, Laxmi Publication Pvt. Ltd, New Delhi ,2013.*
2. *Ballaney.P.L., Thermal Engineering, Fifth Edition, Khanna publishers, New Delhi, 2010.*

19CHE31 - CARBON CAPTURE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of course, students will be able to

CO1 : *Discuss the impacts of climate change and the measures that can be taken to reduce emissions.*

CO2 : *Discuss carbon capture and carbon storage and Explain the fundamentals of power generation.*

CO3 : *Explain methods of carbon capture from power generation and industrial processes.*

CO4 : *Explain different carbon storage methods: storage in coal seams, depleted gas reservoirs and saline formations.*

CO5 : *Explain Carbon dioxide compression and pipeline transport.*

INTRODUCTION

The Carbon Cycle, Mitigating Growth of The Atmospheric Carbon Inventory, The Process of Technology Innovation. Carbon Capture, Carbon Storage. **(9)**

FUNDAMENTALS OF POWER GENERATION

Physical and Chemical Fundamentals, Fossil-Fuelled Power Plant, Combined Cycle Power Generation, Future Developments in Power-Generation Technology. **(9)**

CARBON CAPTURE FROM POWER GENERATION

Introduction, Pre-combustion Capture, Post-combustion Capture, Oxy- fuel Combustion Capture, Chemical Looping Capture Systems, Capture-Ready and Retrofit Power Plant, Approaches to Zero-Emission Power Generation. **(9)**

MEMBRANE SEPARATION SYSTEMS

Physical and Chemical Fundamentals, Membrane Configuration and Preparation and Module Construction, Membrane Technology RD&D Status, Membrane Applications in Pre-combustion Capture, Membrane and Molecular Sieve Applications in Oxy-fuel Combustion, Membrane Applications in Post-combustion CO2 Separation, Membrane Applications in Natural Gas Processing **(9)**

CRYOGENIC AND DISTILLATION SYSTEMS

Physical Fundamentals, Distillation column configuration and operation, Cryogenic oxygen production for oxy-fuel combustion, Ryan-Holmes process for CO2 - CH4 separation, R&D in cryogenic and distillation technologies. **(9)**

TEXT BOOK

1. *Carbon Capture and Storage Stephen A. Rackley Elsevier 2010.*

19CHE32 - MATERIAL SCIENCE AND TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of course, students will be able to

CO1 : *Demonstrate selection criteria of materials based on their relevant applications in process industries.*

CO2 : *Explain various mechanical properties of material with their end use*

CO3 : *Construct Phase diagrams for various unary and binary situations and to interpret properties from Iron-Carbide diagrams.*

CO4 : *Explain properties of ferrous and non-ferrous metals and its composites.*

CO5 : *Explain nanomaterials and their applications.*

INTRODUCTION

Structure - Property relationship - Selection criteria and processes: General criteria of selection of materials in process industries. Properties: Mechanical, Thermal, Physical, Chemical, Electrical, Magnetic and Technological properties. Processing of Metals and Alloys- Casting, Hot and cold rolling, Forging, Extrusion, Deep drawing. **(9)**

MECHANICAL BEHAVIOUR

Elastic, Anelastic and Viscoelastic Behaviour - Introduction to Slip, Slip planes, Plastic Deformation by Slip: Critical resolved shear stress, Mechanism of Creep, Creep Resistant Materials - Fracture: Ductile and Brittle, Fatigue fracture, Griffith's theory, S-N curves, Fracture toughness. **(9)**

PHASE DIAGRAMS AND PHASE TRANSFORMATIONS

Gibb's Phase rule : Uniary and Binary phase diagrams , Al2CO3 - Cr2O3 , Pb-Sn, Ag-Pt and Iron- Iron Carbide Phase Diagram - Lever rule - Invariant reactions- TTT diagrams - Micro structural changes - Nucleation and growth - Martensitic transformations - Solidification and Crystallization - Glass transition - Recrystallization and Grain growth **(9)**

FERROUS, NON-FERROUS METALS AND COMPOSITES

Pig iron, Cast iron, Mild Steel-Manufacturing process, properties &, Applications Stainless steels, Special Alloy steels-properties and uses; Heat treatment of plain-carbon steels Manufacturing methods of Lead, Tin and Magnesium. Properties and applications in process industries. FRP-Fiber Reinforced Plastics (FRP), manufacturing methods; Asphalt and Asphalt mixtures; Wood. **(9)**

NANOMATERIALS

Introduction to Nanotechnology- Zero Dimensional Nano Structures - Nano particles - One .Dimensional Nano Structures- Nano wires and Nano rods - Two Dimensional Nano Structures, Films - Special Nano Materials - Nano Structures fabricated by Physical Techniques - Characterisation and Properties of Nano Materials - Applications of Nano Structures. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Khanna O P, "Material Science and metallurgy" Dhanpat Rai Publications (1995)*
2. *Raghavan V, "Materials and Engineering" Prentice Hall of India, Newdelhi (2006)*
3. *Brenner D, "Hand book of Nanoscience and technology" (2002)*
4. *Material Science & Engineering, Callister*

REFERENCES

1. *Henry R Clauster, "Industrial and Engineering Materials" McGraw Hill Book Co. (1975)*
2. *Kingery W D and Bowen H K and Unimann D R, "Introduction to Ceramics" John Wiley and Sons, Second edition (1991)*
3. *Fahrner W R, "Nanotechnology and Nanoeletronics" Springer International edition(2005)*
4. *Budinsky K G and Budinsky K M "Engineering Materials- Properties and Selection" Prentice Hall of India (2002)*
5. *Arumugam M, "Material Science" Anuradha Technical Book Publishers (1997)*

19CHE33 - BIOPROCESS TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of course, students will be able to

CO1 : *Explain the mechanism of fermentation process*

CO2 : *List and differentiate different inoculum for bacterial and fungal process*

CO3 : *Explain the various microbial kinetics used in bioprocess technology*

CO4 : *Design bioreactor for given duty'*

CO5 : *Design bio reactor with various configurations.*

BIOPROCESS DEVELOPMENT

An interdisciplinary challenge, Biotechnology & Bioprocess Engineering, steps in bioprocess development, Microbial culture, Screening and selection for fermentation processes; Preservation and improvement of industrially important microorganisms, Strain development. **(9)**

MEDIA FOR INDUSTRIAL FERMENTATIONS

Media ingredients, medium formulation, oxygen requirements, antifoams, medium optimization, Ingredients for mammalian cell culture and plant cell culture. Inoculum production for bacterial and fungal processes. Media sterilization, Batch Process (thermal death kinetics), continuous sterilization process; sterilization of fermenter and other ancillaries, filter sterilization of air and media. **(9)**

INOCULUM DEVELOPMENT FOR INDUSTRIAL FERMENTATION & MICROBIAL KINETICS

Introduction, Criteria for transfer of inoculum, development of inocula for bacterial processes, yeast processes and mycelial processes. Inoculum development for plant fermenter, aseptic method of inoculation, achievement and maintenance of aseptic conditions. Fermentation Material and Energy balance, Microbial growth kinetics: Microbial growth cycle, measurement of growth, Batch culture, continuous culture, fed-batch culture, applications and examples. **(9)**

DESIGN OF BIOREACTORS

Basic objective of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Process parameters and measurement techniques: measurement of temperature, pressure and pH, DO, foam etc.; flow rate of liquid and gases; Automation (processes computerization). Validation of Fermentor. **(9)**

BIOREACTOR CONFIGURATIONS AND TYPES

Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed, Membrane reactor, Photobioreactor, Solid state fermenter, Animal and plant cell bioreactors. Scale up and Scale down studies of bioreactors. Heat and Mass transfer in Bioprocess, Relationship in between heat transfer, cell concentrations and stirring conditions, Measurement of KLa, Rheological properties of fermentation broths, Factors affecting broth viscosity, Mixing in Fermenters. **(9)**

TEXT BOOKS

1. *Comprehensive biotechnology, vol 1, 2, 3 and 4 Murray moo young, Pergamon press2004.*
2. *Principles of fermentation technology P.F. Stanburry& Whitaker Pergamon Press, II Ed, Butterworth Heinemann-Elsevier, 2005.*
3. *Bioprocess Engineering, Basic Concepts, II Ed. Michael L Shuler, FikretKargi, Prentice Hall of India pvt. Ltd. 2002.*
4. *Pauline M. Doran, Bioprocess Engineering Principles, Academic Press an Imprint of Elsevier.*
5. *Coulson & Richardson's Chemical Engineering, R.K. Sinnotl, III Ed. Vol 6 ButterworthHeinemann-Elsevier Pub, 1999.*

REFERENCES

6. *Coulson & Richardson's Chemical Engineering, J F Richardson & J H Harker, 5th Ed, Vol 2, Butterworth- Heinemann-Elsevier Pub, 2003.*
7. *Manual of Industrial Microbiology & biotechnology, Arnold Demain& Julian E. Davis, II Ed, ASM Press. Washington DC, 1999.*
8. *Current developments in Solid Substrate fermentation, Ashok Pandey, Carlos Ricardo Soccol, Christian Larroche - 2008.*
9. *Industrial Biotechnology by Rita Singh, S. Ghosh, Global Vision Publishing Ho, 2004*
10. *Industrial Biotechnology: Sustainable Growth and Economic success by WimSoetaert, Erick J. Vandamme.*

19CHE34 - PILOT PLANT AND SCALE-UP METHODS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Understand the techniques to solve problems relevant to the general practice of chemical engineering and engineering design.*

CO2 : *Experience in the process of original chemical engineering design in the three areas of equipment design, process design, and plant design through the process of formulating a design solution to a perceived need and then executing the design and evaluating its performance including economic considerations and societal impacts.*

CO3 : *Understand the effects of scale on the relative rates of mass, heat and momentum transfer, mixing effects, utility of various reactor operating modes and the acquisition of reliable kinetic, thermodynamic and transport data.*

CO4 : *Ability to use different approaches for process scale - up and perform a power analysis and understand flow regimes basic to scale up.*

PRINCIPLES OF SIMILARITY, PILOT PLANTS AND MODELS

Introduction to scale up methods, pilot plants and models and principles of similarity. **(9)**

DIMENSIONAL ANALYSIS AND SCALE - UP CRITERION

Dimensional Analysis, Regime concept, similarity criterion and scale up methods used in chemical engineering. **(10)**

SCALE - UP OF MIXING AND HEAT TRANSFER EQUIPMENT

Typical problems in scale - up of mixing equipment and heat transfer equipment. **(9)**

SCALE - UP OF CHEMICAL REACTORS

Kinetics, Reactor Development and scale - up techniques for chemical reactors. **(9)**

SCALE - UP OF DISTILLATION COLUMN AND PACKED TOWERS

Scale - up of distillation columns and packed towers for continuous and batch process. **(8)**

TOTAL : 45

TEXT BOOKS

1. *John stone,Thring, Pilot plants models and scale - up methods in chemical Engineering, McGraw - Hill, New York, 1962.*
2. *Marko Zlokarnik, Dimensional Analysis and scale - up in Chemical Engineering, Springer - Verlag, Berlin, Germany, 1986.*

REFERENCE

1. *Donald. G. Jordan. Chemical Process Development (Part 1 and 2), Interscience Publishers, 1988.*

19CHOC01 - CRITICAL THINKING

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Demonstrate the logical connection between the ideas.*

CO2 : *Distinguish relevant from non-relevant data, fact from opinion.*

CO3 : *Solve problems by accessing information and presenting arguments in a logical way*

CRITICAL THINKING PROCESS

Critical Thinking - Characteristics of Critical Thinker - Critical Thinking Process -Critical Thinking Styles - Logical Fallacies - Inductive and Deductive Reasoning. **(9)**

CRITICAL THINKING SKILLS

Critical Thinking Skills set - Solving Problems - Critical argumentation **(6)**

TOTAL: 15

Pedagogy

Lecture, Exercises

Evaluation and Grading

Exercises … 50%

Case Action Plan … 50%

REFERENCES

1. *De Bono, Edward (2015) Lateral Thinking : Creativity Step by Step, (International Edition), Harper Perennial Publishers*
2. *Tidd, Joe, and Bessant, R. John (2015). Managing Innovation : Integrating Technological, Market and Organizational Change, 5/e, New Delhi : Wiley India.*
3. *Christensen, M. Clayton and Raynor, E. Micheael (2013). The Innovators Solution, Boston : Harvard Business School Press.*
4. *Khandwalla, N. Pradip (2009). Life long Creativity - An Unending Quest, New Delhi : McGraw Hill Education.*

PO-CO Mapping

COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	2	-	2	2	3	-	-	-	3	2	2	2
CO2	-	2	2	-	2	2	3	-	-	-	3	2	2	2
CO3	-	2	2	-	2	2	3	-	-	-	3	2	2	2

3 - High Correlation, 2 - Medium Correlation, 1 - Low Correlation

19CHOC02 - CREATIVITY & INNOVATION

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

The course is intended to kindle the spirit of creativity and innovation among students. The student mind is largely conditioned to approach issues in logical and sequential order. This course will provide opportunities for students to be spontaneous and creative and think out of the box.

CO1 *: Apply the techniques of creativity in decision making and problem solving under various scenarios*

CO2 *: Analyze various methods that enhance creative ability*

CO3 *: Design solutions to problems through the systematic process of innovation*

THE CREATIVITY PHENOMENON

The Realm of Creativity - Creativity Process - Components of Creativity - Enhancing Creative Intelligence - Mastering Creative Problem Solving - Existential, Entrepreneurial and Empowerment Creativity - Acquiring a Creative Persona - Techniques of Creative Problem Solving **(8)**

THE PRACTICE OF INNOVATION

Purposeful Innovation - Impetus to innovate - Sources of Innovation Opportunity - Types and Patterns of Innovation - Designing and Implementing Innovation Strategies **(7)**

TOTAL : 15

Pedagogy

Lecture, Journaling, Exercises

Evaluation and Grading

Article Review	…	20%
Presentation	…	30%
Exercises	…	50%

REFERENCES

1. *De Bono, Edward (2015). Lateral Thinking: Creativity Step by Step, (International Edition), Harper Perennial Publishers*
2. *Tidd, Joe, and Bessant, R. John (2015). Managing Innovation: Integrating Technological, Market and Organizational Change, 5/e; New Delhi: Wiley India*
3. *Christensen, M. Clayton, and Raynor, E. Michael (2013). The Innovators Solution, Boston: Harvard Business School Press*
4. *Khandwalla, N. Pradip (2009). Lifelong Creativity - An Unending Quest, New Delhi: McGraw Hill Education*

PO-CO Mapping

COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	2	-	-	-	3	2	2	2
CO2	-	-	3	-	-	-	-	-	-	-	3	2	2	2
CO3	-	-	3	-	3	-	3	-	-	-	3	2	2	2

3 - High Correlation, 2 - Medium Correlation, 1 - Low Correlation,

19CHOC03 - LEADERSHIP

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

This course introduces the students to the foundations of leadership, the role of a leader in the changing business environment and the stories of remarkable leaders from various walks of life. The leaders are those who have left their mark and made a difference in whatever area they chose to influence - political, social, business, environmental etc. It is important to understand their contributions towards the development of societies and economies.

CO1 *: Explain the impact of changes in the business environment on business (K2)*

CO2 *: Apply theories of leadership to create an effective team environment (K3)*

CO3 *: List the characteristics of effective leadership (K4)*

Unit I

Leadership Theories, Characteristics of a Leader, Leadership in Teams **(7)**

Unit II

Leadership and Motivation, Leadership and Values, Vision **(8)**

TOTAL: 15

Pedagogy

Discussion, Seminar, Role Play

Evaluation and Grading

Presentation … 50%

Assignment … 50%

REFERENCES

1. *Hurley, Kathleen and Priscilla, Shumway (2015). Real Women, Real Leaders: Surviving and Succeeding in the Business World, New Jersey: WileyIndia*
2. *Yukl, Garry (2013). Leadership in Organizations, 8/e; New Jersey: Pearson Education*
3. *Sandberg, Sheryl (2013). Lean In: Women, Work, and the Will to Lead, New York: Knopf Doubleday PublishingGroup*
4. *HBR (2011). HBR's 10 Must Reads - On Leadership, USA: Harvard Business Publishing*
5. *Barsh, Joanna, Susie, Cranston and Geoffrey, Lewis (2011). How Remarkable Women Lead - The Breakthrough Model for Work and Life, New York: McKinsey & Company, Inc*

PO-CO Mapping

COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	3	-	3	-	3	2	2	2
CO2	-	-	-	-	-	-	3	-	3	-	3	2	2	2
CO3	-	-	-	-	-	-	2	-	2	-	3	2	2	2

3 - High Correlation, 2 - Medium Correlation, 1 - Low Correlation

19CHOC04 - EMOTIONAL INTELLIGENCE

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

UNIT 1

Emotional Intelligence: Concept of Emotional Intelligence, Understanding the history and origin of Emotional Intelligence, Contributors to Emotional Intelligence, Science of Emotional Intelligence, EQ and IQ, Scope of Emotional Intelligence. **(5)**

UNIT 2

Components of Emotional Intelligence: Self-awareness, Self-regulation, Motivation, Empathy, Social skills. Emotional Intelligence Competencies, Elements of Emotional Intelligence, Models of Emotional Intelligence: The Ability-based Model, The Trait Model of Emotional Intelligence, Mixed Models of Emotional Intelligence. **(5)**

UNIT 3

Emotional Intelligence at Work place: Importance of Emotional Intelligence at Work place, Cost -savings of Emotional Intelligence, Emotionally Intelligent Leaders, Case Studies Measuring Emotional Intelligence: Emotionally Intelligence Tests, Research on Emotional Intelligence, Developing Emotional Intelligence. **(5)**

TOTAL : 15

REFERENCES

1. *Daniel Goleman (1996). Emotional Intelligence - Why it can Matter More than IQ. Bantam Doubleday Dell Publishing Group*
2. *Daniel Goleman (2000). Working with Emotional Intelligence.Bantam Doubleday Dell Publishing Group*
3. *Liz Wilson, Stephen Neale & Lisa Spencer-Arnell (2012). Emotional Intelligence Coaching. Kogan Page India Private Limited*

19CHOC05 - HEALTH AND LIFESTYLE

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

UNIT 1

Introduction to Health Health is wealth; Role of lifestyle habits on health; Importance of adolescence; Stages, Characteristics and changes during adolescence; Nutritional needs during adolescence why healthy lifestyle is important for adolescence. Eating Habits - eating disorders, skipping breakfast, junk food consumption. **(5)**

UNIT 2

Food and Nutritional Requirements during Adolescence Fluid intake; nutrition related problems; lifestyle related problems, Role of physical activity; resting pattern and postures, Personal habits - alcoholism, and other tobacco products, electronic addiction etc. **(5)**

UNIT 3

Need for a Positive Life Style Change Peer pressure & procrastination, Stress, depression, suicidal tendency. **(5)**

TOTAL : 15

TEXTBOOKS

1. *B.Srilakshmi, "Dietetics", New age international (P) ltd, publishers, 2010.*
2. *"Nutrient requirement and Recommended Dietary Allowances for Indians", published by Indian Council of Medical Research, ICMR, 2010.*

REFERENCE BOOK

1. *K Park "Textbook of preventive and social medicine", 2010. WHO Report on Adolescent Health: 2010.*

19CHOC06 - PSYCHOLOGY FOR ENGINEERS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

UNIT 1

Psychology of Adolescents: Adolescence and its characteristics.

UNIT 2

Learning, Memory & Study Skills: Definitions, types, principles of reinforcement, techniques for improving study skills, Mnemonics.

UNIT 3

Attention & Perception: Definition, types of attention, perception.

TOTAL : 15

TEXTBOOKS

1. *S. K. Mangal, "General Psychology", Sterling Publishers Pvt. Ltd.2007*
2. *Baron A. Robert, "Psychology", Prentice Hall of India. New Delhi 2001*

REFERENCES

1. *Elizabeth B.Hurlock, Developmental Psychology-A life span approach, 6th edition.*
2. *Feldman, Understanding Psychology, McGraw Hill, 2000.*
3. *Clifford Morgan, Richard King,John Scholper,"Introduction to Psychology", Tata Mcgraw Hill, Pvt Ltd 2004.*

19CHOC07 - FUNDAMENTALS OF NANOSCIENE

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OVERVIEW

The general goal of the course is to provide an introduction to and an overview over nanotechnology. This course introduces the fundamentals of nano-scale engineering and manufacturing. Current and future applications of nanostructured materials will be reviewed with respect to their impact in commercial products and technologies.

INTRODUCTION

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thin films-multilayered materials. **(5)**

PREPARATION METHODS

Bottom-up Synthesis-Top-down Approach. **(5)**

CHARECTERISATION TECHNIQUES:

X-ray diffraction technique, Scanning Electron Microscopy, Transmission Electron Microscopy, Surface Analysis techniques. **(5)**

TOTAL : 15

PEDAGOGY

Lecture, Exercises

EVOLUTIONAL GRADING

Tests / Quiz	:	50%
Assignments / Seminar Presentations	:	50%

TEXT BOOKS

1. *A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.*
2. *N John Dinardo, "Nanoscale characterization of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000*

REFERENCES

1. *G Timp (Editor), "Nanotechnology", AIP press/Springer, 1999.*
2. *AkhleshLakhtakia (Editor), "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007.*

19CHOC08 - AN INTRODUCTION TO ENVIRONMENTAL ETHICS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students will be able to:

CO1 : *Understand the philosophical and ethical views as they relate to the environment.*

CO2 : *Identify the ethical issues, analyse environmental laws and justice.*

CO3 : *Examine applications of ethics in environmental issues.*

ETHICS AND THE ENVIRONMENT

Introduction, Ethics and the Environment, Environmental ethics approach and world views - Foundations for an Environmental Ethics, History and Its Pioneers, types of environmental ethics. **(5)**

ENVIRONMENTAL JUSTICE

Ethical Issues and Environmental Justice, Principles of Environmental Justice, Environmental Laws and Regulations. **(5)**

APPLICATION OF ETHICS IN ENVIRONMENTAL ISSUES

Ethical contributions to contemporary environmental issues, Environmental standard establishment and maintenance. **(5)**

TOTAL : 15

REFERENCES

1. *Environmental Ethics, Andrew Light and Holmes Rolston III, eds. Blackwell Publishing, 2003.*
2. *The Economy of the Earth: Philosophy, Law, and the Environment, 2nd edition, Mark Sagoff. Cambridge University Press, 2008.*

MAPPING

COURSE OUTCOME	PROGRAMME OUTCOMES												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1							1	2						
2								3						1
3								2						1

Strong – 3, Medium – 2, Weak – 1

19CHOC09 - CORPORATE SOCIAL RESPONSIBILITIES

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students will be able to :

CO1 : *Understand the key characteristics of Corporate Social Responsibility (CSR) in the context of present-day management*

CO2 : *Apprise regarding business decision-making by ethical values and respect for people communities and the environment*

CO3 : *Become aware of creating a strategic plan that enables an organization to reach out its internal and external stakeholders with consistent messages*

UNIT I

Corporate Social Responsibility- Definition, concept, linkages to development Growth of CSR-historical & contemporary perspectives, National & International scenario Factors influencing growth of CSR in societies- ideological, socio-economic, legal & environmental perspectives Government initiatives for promoting CSR Impact of globalization & liberalization on CSR initiatives **(6)**

UNIT II

CSR & Development: -CSR activities-nature, types, impact on development programmes- CSR& development organisations-relationships, functioning & impact on organisational functioning Stakeholders' participation & perspectives about CSR **(9)**

TOTAL : 15

Pedagogy

Lecture, Exercises

Evaluation and Grading

Exercises … 50%

Case Studies … 50%

REFERENCES

1. *Grayson D., Hodges A. (2004). Corporate Social Responsibility- Seven Steps to Make Corporate Social Responsibility Work for Your Business. UK: Greenleaf Publishing Limited*
2. *Narang R.K. (2009). Corporate Social Responsibility-Replicable Models on Sustainable Development. New Delhi: The Energy & Resources Institute.*
3. *William B Werther, Jr, David Chandler, 2010 Strategic Corporate Social Responsibility, Stakeholders in a Global Environment, Second Edition, SAGE Publications, New Delhi*

MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1							2	1	3		3	3		3
CO2							2	2	3		2	3		3
CO3							2	1	3		3	3		3

Strong – 3, Medium – 2, Weak – 1

19CHOC10 - COMPOSITE MATERIAL PREPARATION AND CHARACTERIZATION

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *To acquire basic knowledge in material science.*

CO2 : *To understand the basic familiarity in manufacturing process.*

CO3 : *To analyze the various novelty about the strength of materials.*

INTRODUCTION TO COMPOSITES AND FIBERS

Definition - Need - General Characteristics, Applications. Fibers - Glass, Carbon, Ceramic, Aramid fibers and Natural fibers. **(8)**

MATRIX MATERIALS

Matrices - Polymer, Graphite, Ceramic and Metal Matrices - Characteristics of fibers and matrices. Processing of PMC Hand layup process-Compression Moulding process. Processing of MMC-stir casting method. **(7)**

TOTAL : 15

Pedagogy

Lecture, Presentation, Assessment

Evaluation and Grading

Literature review … 20%

Presentation … 30%

Assessment … 50%

References

1. *Mallick, P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", Marcel Dekker Inc, 1993*
2. *Autar K. Kaw, "Mechanics of Composite Materials" CRC Press, 2006.*

COURSE OUTCOME	PROGRAMME OUTCOMES												PSO'S	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO1				3										
CO2		2												
CO3		2	2			1								

19CHOC11 - ENVIRONMENTAL IMPACT ASSESSMENT AND AUDIT

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Gain knowledge to handle the complex industrial environment.*

CO2 : *Explain about Industrial safety and the risk assessment and management.*

CO3 : *Acquire knowledge on environmental audit trails and audit scheduling*

UNIT I

Introduction - Safety, Health and Environment - Principles & Practices - Role of Management Accident Prevention - Incident - accident injury - unsafe acts - Theories/Models of accident - Principles of Prevention - Financial Implication - Reports. **(8)**

UNIT II

Personal Protective Equipment - Needs - Respiratory protective devices - Non respiratory protective devices - Fire Extinguishers & its operations Environmental Audit - ISO regulations - Qualities of Environmental Auditor - Contents of EA reports. **(7)**

TOTAL : 15

PEDAGOGY

Lecture, Exercises

EVALUATION AND GRADING

Case Studies … 50%

Report submission and Seminar … 30%

Test … 20%

REFERENCES

1. *The Factories Act 1948, Madras Bok Agency, Chennai,2000*
2. *National seminar on hazardous waste management organized by National Safety council, Ministry of environment and forests, Government of India, UnitedStates- Asia environmental partnership, Tamilnadu pollution control board and Indian chemical manufacturers association, April 2001.*
3. *W. Kurge: ISO 14001 Certification - Environmental ManagementSystem, PrenticeHall,199*

MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2	2			2	3	3		3
CO2						2	2			2	2	3		3
CO3						2	2			2	3	3		3

(Strong – 3, Medium – 2, Weak – 1)

19CHOC12 - FACTORY AUTOMATION

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

PREREQUISITES

- Basic knowledge in hydraulics and pneumatics
- Basic knowledge in Analog/Digital circuits and electrical drives
- Principles and operations of sensors and transducers
- Basic knowledge in microprocessor based systems

COURSE OUTCOME

At the end of the course students will be able to

CO1 *: Understand the basics of hydraulics, electro hydraulics and its circuits*

CO2 *: Understand the basics of pneumatics, electro pneumatics and its circuits*

CO3 *: Develop an automation system with suitable sensors*

UNIT I HYDRAULICS

Basics of Hydraulics - Components of hydraulics - Types of valves - DCVs - operations - hydraulic Circuits - Electro hydraulics - Solenoids - Relays - Electrical logic circuits - Applications of electro hydraulics - Practices on different types of electro hydraulic circuits. **(9)**

UNIT II AUTOMATION SYSTEM

Introduction to Mechatronics system - over view of Automation System - Types of Automation - role of sensors in automation system. Introduction to PLC H/W - Architectural evolution - Role of PLC in Automation - Ladder Logic - Basics of digital logic - Latching - Timers - counters - Selections of PLC - Practices on Ladder logic using PLC. **(6)**

TOTAL : 15

Evaluation and Grading

S. No	Description	Max. Marks
1.	Continuous Assessment I (Quiz/Practicals/Test)	30
2.	Continuous Assessment II (Quiz/Practicals/Test)	30
3.	Final Assessment (Practicals/Test)	40

REFERENCES

1. *Bosch Rexroth User Manuals*
2. *Esposito Anthony, "Fluid Power with Applications", Pearson Education Inc., New York, 2003.*
3. *W. Bolton "Mechatronics" Pearson education, second edition, fifth Indian Reprint, 2010*
4. *Devadas Shetty and Richard A.Kolk, "Mechatronics systems design", PWS Publishing company 2007*

19CHOC13 - CONTROLLER TUNING

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

PRE-REQUISITE :

Process Control

COURSE OUTCOMES

Students will be able to

CO1 : *Understand various methods of tuning PID controller*

CO2 : *Design of PID controller for SISO and MIMO systems*

CO3 : *Choose optimal controller for chemical processes*

UNIT I

Introduction to tuning of controllers - classification of controllers - open loop and closed loop methods for SISO and MIMO systems - Fractional order control - Relay tuning of PID controllers - Auto tuning of decentralized PID controller. **(8)**

UNIT II

Exercises using Matlab-Simulink. **(7)**

TOTAL : 15

Pedagogy

Lecture, Practical

Evaluation and Grading

Practical session - 75%

Internal exam - 25%

TEXT BOOKS

1. *M. Chidambaram, Nikita Saxena, Relay Tuning of PID Controllers: For Unstable MIMO Processes, Springer, 2018.*
2. *Cheng-Ching Yu, Autotuning of PID controllers: Relay feedback approach, 2nd edition, Springer, 2006.*
3. *Seborg, D. E., Edgar, T. F., Millechamp, D. A., Doyle III, F. J., Process Dynamics and Control, 3rd Edition, Wiley, 2014.*

CO - PO Mapping :

	Programme Outcomes												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	3	1		3	1			2		2		2	
CO2	2	3	3		3	2			2		2		2	
CO3	1	2	1		2	1			2		2		3	

19CHOC14 - NEURAL NETWORKS AND FUZZY SYSTEMS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Understanding the principles of neural networks and fuzzy logic fundamentals; Design the required and related systems.*

CO2 : *Acquire understanding and knowledge of soft computing models and algorithms and so they will be able to design program systems using these techniques to solve various real-world problems.*

CO3 : *Appreciate the importance of tolerance of imprecision and uncertainty for design of robust and low-cost intelligent systems.*

INTRODUCTION TO NEURAL NETWORKS

Artificial Neural Networks: Basic properties of Neurons, Neuron Models, Feed forward networks - Perceptrons, Multilayer networks - Exact and approximate representation, Back propagation algorithm, Competitive learning and self-organizing networks, Hybrid Learning; Computational complexity of ANNs. **(5)**

INTRODUCTION TO FUZZY LOGIC

Fuzzy Controllers: Preliminaries - Fuzzy sets and Basic notions - Fuzzy relation calculations - Fuzzy members - Indices of Fuzziness - comparison of Fuzzy quantities - Methods of determination of membership functions. **(5)**

ANN & FUZZY BASED CONTROL

ANN based control: Introduction: Representation and identification, modeling the plant, control structures - supervised control, Model reference control, Internal model control, Predictive control, Fuzzy Controllers: Preliminaries - Fuzzy sets in commercial products - basic construction of fuzzy controller, case studies. **(5)**

TOTAL : 15

REFERENCES

1. *Laurene V. Fausett, "Fundamentals of Neural Networks, Algorithms and Applications", Prentice Hall, 1994*
2. *Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley International, 3rd Edition, 2010.*
3. *Kosco B, "Neural Networks and Fuzzy Systems: A Dynamic Approach to Machine Intelligence", Prentice Hall of India, New Delhi, 1992.*
4. *George J. Klir and Folger T.A, "Fuzzy sets, Uncertainty and Information", Prentice Hall of India, New Delhi, 2000.*

19CHOC15 - INTERNET OF THINGS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Ability to design fully connected products by integrating Internet services and physical objects.*

CO2 : *Ability to analyze, design and develop prototypes of Internet-connected products using appropriate tools.*

CO3 : *Identifying, classifying and describing different kinds of Internet-connected product and its concepts.*

INTRODUCTION

Smart Objects - Challenges for Smart Objects - IP for Smart Objects: motivation and main challenges - Security for Smart objects - Web services for Smart Objects - Connectivity models for Smart Object Networks - Introduction to the Internet of Things: application scenarios, current solutions. **(4)**

SMART OBJECTS & ROUTING

Communication for Smart Objects : IEEE 802.15.4: main features, topologies, addressing and MAC frame format - Low Power and Lossy Networks (LLN): Introduction to 6LoWPAN - 6LoWPAN architecture - 6LoWPAN adaptation layer - IPv6 addressing in 6LoWPAN-Mesh-under and route-over solutions - Routing Requirements - Routing metrics - DODAG formation - RPL Messages - CoAP. **(7)**

APPLICATIONS

Case Study -Smart Cities and Urban automation - Home Automation - Building Automation - Structural Health Monitoring - Chemical Industries. **(4)**

TOTAL : 15

TEXT BOOK

1. *RajKamal, "Internet of Things - Architecture and Design Principles", 2017.*

REFERENCES

1. *J.P. Vasseur, A. Dunkels, "Interconnecting Smart Objects with IP: The Next Internet", Morgan Kaufmann, 2010.*
2. *Z. Shelby, C, "Bormann. 6LoWPAN: The Wireless Embedded Internet", Wiley, 2009*
3. *Z. Shelby, K. Hartke, K. Hartke, "The Constrained Application Protocol (CoAP)", RFC 7252, 2014.*

19CHOC16 - PROCESS AUTOMATION AND FAULT DIAGNOSIS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

PREREQUESTIE : PROCESS CONTROL

COURSE OUTCOMES

CO1 : *Ability to explain different approaches to Fault Detection and Diagnosis to design and detect sensor and actuators faults using structured residual approach as well as directional structured residual approach*

CO2 : *Ability to detect faults in sensor and actuators using Parameter Estimation*

CO3 : *Ability to explain various types of fault tolerant control schemes*

INTRODUCTION

Introduction, Functional architecture of Process Monitoring and Diagnostic Systems, Normal and Faulty Systems and Signal Models, Residual Generation for Linear and Nonlinear Dynamic Systems, State Estimation: Observers, Kalman Filters, Fault Detection and Diagnosis using Parameter Estimation **(5)**

FAILURE DIAGNOSIS

Failure Diagnosis using DES Models: Formulation and Concept of Diagnosis. Diagnosers and Diagnosability. Introduction to Failure Diagnosis using Hybrid Systems models. **(5)**

CASE STUDIES

Case Studies and Examples from Automotive, Aerospace and Industrial Systems, Application of PMFD : Fault tolerant Control of Aerospace Systems, Adaptive Supervisory Control of Industrial Processes. **(5)**

TOTAL : 15

REFERENCES

1. *S. X. Ding, "Model -based Fault Diagnosis Techniques: Design Schemes, Algorithms and Tools", Springer, 2008, ISBN : 978-3-540-76304-8*
2. *Janos J. Gertler, "Fault Detection and Diagnosis in Engineering Systems", ISBN: 0-8247-9427-3.*
3. *T. Söderström and Petre Stoica " System Identification", Prentice-Hall , 1989, ISBN : 978-0-138-81236-2.*
4. *C. K Chui and G. Chen, "Kalman Filtering with real -Time Applications", Springer, 1999, ISBN : 978-3-540-87848-3.*
5. *M. Basseville and A. Benvesisle, "Detection of Abrupt changes in Dynamic Systems", ISBN: 0-387-16043-4.*
6. *Ron Patton, Paul Frank and Robert Clark, "Fault Diagnosis in Dynamic Systems Theory and Applicat ions", Prentice Hal l , 1989, ISBN: 0-L3-308263-6.*

19CHOC17 - PROCESS CONTROL IN PETROCHEMICAL INDUSTRIES

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

PREREQUESTIE : PROCESS CONTROL

COURSE OUTCOMES

CO1 : *To understand the principle of petroleum exploration process.*

CO2 : *To identify the measurement problems involved in petroleum exploration process.*

CO3 : *To analyse the control mechanisms involved in the process.*

PETROLEUM EXPLORATION

Petroleum Exploration - Petroleum recovery techniques -oil-gas separation-Processing of wet gases - refining of crude oil. **(5)**

MEASUREMENTS IN PETROCHEMICAL INDUSTRIES

Measurements in refineries and petrochemical industries - selection and maintenance of measuring instruments - special measurement problems. **(5)**

CONTROL IN PETROCHEMICAL INDUSTRIES

Process control in refineries and petrochemical industries - Control of distillation column - control of Catalytic crackers and pyrolysis unit - Automatic control of polyethylene production - Control of Vinyl chloride and PVC production. **(5)**

TOTAL : 15

REFERENCES

1. *Waddams A.L, "Chemicals from Petroleum",Butter and Tanner Ltd., 1968.*
2. *Balcen J.G. and Mumme K.I., "Process Control Structures and Applications", New York. 1968.*
3. *Austin G.T. Shreves, "Chemical Process industries", McGraw Hill international student edition Singapore. 1985.*

19CHOC18 - POWER PLANT INSTRUMENTATION

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *To understand the basics of piping and instrumentation diagram.*

CO2 : *A Brief outline of the Boiler control.*

CO3 : *To identify the sensors and actuators used in a nuclear power plant.*

INTRODUCTION

Piping and instrumentation diagram of a thermal power plant, basic process on a boiler, Fuel measurement-review of pressure and temperature measurement steam and water flow measurement - instrument applications in power stations: review of indicating and recording instrument applications in power stations: review of indicating and recording instruments, water level gauge for boiler drums, closed circuit television instrument, gas analysis meters, smoke instruments, dust monitor-measurement of impurities in feed water and steam generator coolant controls and instruments instrument maintenance aspects. **(5)**

BOILER CONTROL

Boiler control objectives-combustion of fuels (gaseous liquid, and solid), excess air, combustion chemistry and products of combustion, requirement for excess combustion, air-circulation of efficiency of boiler: input/output method-stream temperature control systems super heaters and de-super heaters. **(5)**

NUCLEAR POWER PLANT INSTRUMENTATION

Piping and instrumentation diagram of different types of nuclear power plants-radiation detection instruments process sensors for nuclear power plants-spectrum analyzers-nuclear reactor control systems and allied instrumentation. **(5)**

TOTAL : 15

TEXT BOOK

1. *B.G.Liptak, Instrumentation in process industries, Vol. I and II, Chilton books co, 1973.*
2. *Sam G. Dukelow. The control of boilers, Instrument Society of America press.*

REFERENCE BOOK

1. *A.Sherryet. Al. (Editors), Modern power station practice, Vol.6 (Instrumentation controls and testing), Pergamon Press, 1971.*

19CHOC19 - INDUSTRIAL AUTOMATION

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

PREREQUESTIE : PROCESS CONTROL

COURSE OUTCOMES

CO1 : *To understand the use of Industrial Automation*

CO2 : *To Analyze the use of Programmable logic controllers in an industry.*

CO3 : *To provide a brief overview on Distributed Control Systems.*

COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS

Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, and Computer based data acquisition system, Internet of things (IoT) for plant automation **(5)**

PROGRAMMABLE LOGIC CONTROLLERS

Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries. **(5)**

DISTRIBUTED CONTROL SYSTEM

Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS. **(5)**

TOTAL : 15

REFERENCES

1. *Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies*
2. *Process Control Instrumentation Technology By. C.D. Johnson, PHI*
3. *Industrial control handbook, Parr, Newnem*
4. *Programmable logic controller, Dunning, Delmar*

19CHOC20 - BIOMEDICAL INSTRUMENTATION

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

PREREQUESTIE : PROCESS CONTROL

COURSE OUTCOMES

CO1 : *To understand the fundamentals of Biomedical Engineering.*

CO2 : *To identify the Non electrical parameter measurement and diagnostic procedures.*

CO3 : *To analyze the Electrical parameters and the instruments used in Biomedical field.*

FUNDAMENTALS OF BIOMEDICAL ENGINEERING

Cell and its structure - Resting and Action Potential - Nervous system and its fundamentals - Basic components of a biomedical system- Cardiovascular systems- Respiratory systems - Kidney and blood flow - Biomechanics of bone - Biomechanics of soft tissues - Basic mechanics of spinal column and limbs -Physiological signals and transducers - Transducers - selection criteria - Piezo electric, ultrasonic transducers - Temperature measurements - Fibre optic temperature sensors. **(5)**

NON-ELECTRICAL PARAMETERS MEASUREMENT AND DIAGNOSTIC PROCEDURES

Measurement of blood pressure - Cardiac output - Heart rate - Heart sound - Pulmonary function measurements - spirometer - Photo Plethysmography, Body Plethysmography - Blood Gas analysers, pH of blood -measurement of blood pCO2, pO2, finger-tip oxymeter - ESR, GSR measurements. **(5)**

ELECTRICAL PARAMETERS ACQUISITION AND ANALYSIS

Electrodes - Limb electrodes -floating electrodes - pregelled disposable electrodes - Micro, needle and surface electrodes - Amplifiers, Preamplifiers, differential amplifiers, chopper amplifiers - Isolation amplifier - ECG - EEG - EMG - ERG - Lead systems and recording methods - Typical waveforms - Electrical safety in medical environment, shock hazards - leakage current-Instruments for checking safety parameters of biomedical equipments. **(5)**

TOTAL : 15

TEXT BOOKS

1. *Leslie Cromwell, Biomedical Instrumentation and Measurement, Prentice hall of India, New Delhi, 2007.*
2. *Joseph J.carr and John M. Brown, Introduction to Biomedical Equipment Technology, John Wiley and sons, New York, 4th Edition, 2012.*
3. *Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw-Hill, New Delhi, 2 nd Edition, 2003.*

REFERENCES

1. *John G. Webster, Medical Instrumentation Application and Design, John Wiley and sons, New York, 1998.*
2. *Duane Knudson, Fundamentals of Biomechanics, Springer, 2nd Edition, 2007.*
3. *Suh, Sang, Gurupur, Varadraj P., Tanik, Murat M., Health Care Systems, Technology and Techniques, Springer, 1st Edition, 2011.*
4. *Ed. Joseph D. Bronzino, The Biomedical Engineering Hand Book, Third Edition, Boca Raton, CRC Press LLC, 2006.*
5. *M.Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003.*

19CHOC21 - ENERGY MATERIALS, DEVICES AND SYSTEMS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OBJECTIVE

To understand the concepts of energy storage materials, their characterization and applications in energy storage devices. To analyze the design of solar photovoltaic device and fuel cells for developing innovative ideas towards energy materials and devices.

COURSE OUTCOMES

After the course completion, students will be able to

CO1 : *Understand the recent technologies in energy storage*

CO2 : *Analyze various devices and mechanism for energy conversion from renewable sources*

CO3 : *Develop novel materials for energy conversion and storage application*

NANOMATERIALS FOR ENERGY CONVERSION AND STORAGE

Advanced materials and devices for energy storage: Carbon Nano-Tubes (CNT), fabrication of CNTs, CNTs for hydrogen storage, CNT-polymer composites, ultra capacitor, Polymer membranes for fuel cells, PEM fuel cell, Acid/alkaline fuel cells, Batteries. **(8)**

ENERGY CONVERSION AND STORAGE DEVICES

Device fabrication technologies, fundamentals of solar cells, recent advances in photovoltaics, spectral response and IV characterization. **(7)**

TOTAL : 15

Pedagogy

Lecture, Presentation, Assessment

Evaluation and Grading

Literature review	…	20%
Presentation	…	30%
Assessment	…	50%

REFERENCES

1. *Robert F. P. Advanced Semiconductor Fundamentals, 2nd Edition, Pearson,2002*
2. *Duncan W. B., Dermot O., and Richard I. W. Energy Materials, 1st Edition, Wiley,2011.*
3. *Christoph B. Ullrich S. and Vladimir D. Organic Photovoltaics: Materials, Device Physics, and Manufacturing Technologies, 2nd Edition, Wiley?VCH,2014.*
4. *San P. J. and Pei K. S.Nanostructured and Advanced Materials for Fuel Cells, 1st Edition, CRC Press,2013*
5. *Daniel C. and Besenhard J. O. Handbook of Battery Materials, 1st Edition Wiley? VCH,2011*

MAPPING OF COURSE OUTCOMES WITH PROBRAM OUTCOMES

COURSE OUTCOME	PROGRAMME OUTCOMES												PSO'S	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO1	3													
CO2		2												
CO3		2	2			1								

19CHOC22 - SURFACE ENGINEERING OF NANOMATERIALS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OBJECTIVES

To impart knowledge in surface modification of nanomaterials to improve its thermal, electrical properties and to enhance the compatibility of nanomaterials with some matrix as reinforcing fillers in composites for high performance applications.

COURSE OUTCOMES

After the course completion, students will be able to

CO1 : *Understand the fundamentals of surface engineering*

CO2 : *Analyze the performance enhancement of the surface engineered materials*

CO3 : *Identify appropriate technique for modification of nanomaterial to improve its properties*

SURFACE ENGINEERING - FUNDAMENTALS

Fundamentals of surface engineering, physical modifications, chemical modifications, Application of surface engineering to nanomaterials. **(7)**

SURFACE ENGINEERING - METHODS

Deposition and surface modification methods, Advanced coating practices, characterization of nano coatings, thin films for surface engineering, microencapsulation, applications and current trends in surface engineering of nanomaterials. **(8)**

TOTAL : 15

Pedagogy

Lecture, Presentation, Assessment

Evaluation and Grading

Literature review	…	20%
Presentation	…	30%
Assessment	…	50%

REFERENCES

1. *Gabor A. Somorjai, Yimin Li, Introduction to Surface Chemistry and Catalysis, John Wiley & Sons, New Jersey, 2010.*
2. *HaraldIbach, Physics of Surfaces and Interfaces, Springer-Verlag, Berlin, 2006.*
3. *Pankaj Vadgama, Surfaces and interfaces for biomaterials, First Edition, CRC Press, Boca Raton, 2005.*
4. *Peter J. Blau, Friction Scienceand Technology- From concepts to applications, Second Edition, CRC Press, Boca Raton, 2009*
5. *B. Bhusan, Modern Tribology Handbook, CRC Press, Boca Raton, 2005.*

Mapping of COs with POs

COURSE OUTCOME	PROGRAMME OUTCOMES												PSO'S	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO1	2													
CO2		2												
CO3			1	2		1								

19CHOC23 - NANO SENSORS: BASIC COMPONENTS, CHARACTERIZATION AND APPLICATION.

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

- *To acquire the basic knowledge and skills needed in this course and to provide a basis for more advanced nano techniques to solve complex problems.*
- *Analyze the importance of nanoscale materials for sensing applications and various approached used for characterizing sensors-based nanomaterials.*
- *Develop tailoring nanomaterials for a specific sensing application.*

UNIT I

Definition of nano materials, Nanostructures 0-D, 1-D, 2-D, 3-D structures. **(6)**

UNIT II

Human senses, component and classification of sensors, parameters for sensor characterization, sensors based on nanoparticles for detection of DNA and bio molecules. **(6)**

UNIT III

Chemi-Resistors based on nanoparticles, medical and biological applications of gold nanoparticles. **(3)**

TOTAL : 15

Pedagogy

Lecture, Presentation, Assessment

Evaluation and Grading

Literature review … 20%

Presentation … 30%

Assessment … 50%

REFERENCES

1. *Vinod Kumar Khanna, Nano sensors: Physical, Chemical, and Biological (2012),CRC press, Taylor and Fransis group.*
2. *Kevin C, Honeychurch, Nanoensors for chemical and biological applications: sensing with nano tubes, nano wires and nano particles (2014), Wood head Publishing*

MAPPING OF Cos with POs

COURSE OUTCOME	PROGRAMME OUTCOMES												PSO'S	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO1	1	2		2									2	
CO2		2												
CO3		2	2			1							2	

19CHOC24 - NANOPOLYMERS - SYNTHESIS, CHARACTERIZATION AND APPLICATIONS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

Students will be able to

CO1 : *Explain the significance of nanopolymers and its environmental impacts*

CO2 : *Investigate about the synthesis and various characterization techniques of nanopolymers*

CO3 : *Analyse the influence of nanopolymers on water treatment technologies*

INTRODUCTION TO NANOPOLYEMRS

Introduction; Classification of polymers; physical and chemical properties; application of polymers in various fields - an overall view; advantages and disadvantages during exploitation; hazards, health impacts and safety measures **(5)**

SYNTHESIS AND CHARACTERIZATIONS

Classification of methodologies for the synthesis of nanopolymers - polymerization techniques, size reduction processes, materials handling and storage; different forms of nanopolymers - powder, hydrogels, membranes; characterization - mass spectroscopy, nuclear magnetic resonance, x-ray diffraction, scanning electron microscopy, transmission electron microscopy, gel permeation chromatography, Fourier transform infrared spectroscopy, UV - visible spectroscopy **(5)**

APPLICATIONS IN WASTEWATER TREATMENT

Hydrogels in fluidized bed reactors - advantages and disadvantages; membranes in reverse osmosis processes in wastewater treatment plants - advantages and disadvantages; recycling and reuse of nanopolymers. **(5)**

TOTAL : 15

TEXT BOOK

1. *Oleg V. Stoyanov, A. K. Haghi, Gennady Efremovich Zaikov, Nanopolymers and Modern Materials: Preparation, Properties, and Applications, 1st Edition, Apple Academic Press, 2013*

REFERENCES

1. *Mostafa Rajabi, Fahimeh Najafi, Omid Moradi, Behrooz Mirza, Nanopolymers, Chapter 8: Nanopolymers: Graphene and Functionalization, Elsevier publications, 2018*
2. *Stoyko Fakirov, Nano-size Polymers, Springer International Publishing, 2016*

CO/PO

CO/PO	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO1	3	1	1	1								2	2	
CO2	3	1	2	3	1							3	2	
CO3	3	1	3	3	1							3	2	

19CHOC25 - AN APPROACH TO NANOTRIBOLOGY AND NANOMECHANICS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Focuses on the latest scientific developments and discoveries in the field of nano mechanics.*

CO2 : *Ability to understand the various characterization techniques such as Atomic Force Microscope, Scanning Probe Microscope.*

CO3 : *To analyze and understand the industrial importance of nanotribology and nano medicine.*

UNIT I

Introduction : Measurement techniques and application, Scanning Probe Microscopy-Principle of operation, Instrumentation and probes, Biomedical sensing with the Atomic Force Microscope **(6)**

UNIT II

Nano mechanics : Depth-sensing nano-indentation Techniques for Nano mechanical characterization, Nano mechanical properties of nanostructures and scale effects. **(6)**

UNIT III

Industrial Applications: micro/nanotribology and micro/nano mechanics of magnetic storage devices, nanotribology and nano mechanics of MEMS/NEMS and BioMEMS/BioNEMS materials and devices. **(3)**

TOTAL : 15

Pedagogy :

Lectures, Exercise

Evaluating and Grading :

Article Review - 20%

Assignments - 30%

Exercise - 50%

REFERENCES

1. *Bharat Bhushan, Nanotribology and Nano mechanics An Introduction (2017 fourth edition), Springer Publications, Germany.*

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

COURSE OUTCOME	PROGRAMME OUTCOMES										PSO'S			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO1		2		2			3							1
CO2		2		2			3							1
CO3		2		2		1	3							1

19CHOC26 - NANOMATERIALS AND NANOFIBERS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Synthesis and fabricate of nanofiber membranes by electrospinning method.*

CO2 : *To study the basic concepts of polymer blend with nanoparticles*

CO3 : *Characterize the nanoparticles and nanofiber composites*

CO4 : *To study the mechanical properties of nanofiber membrane*

CO5 : *Implantable therapeutic system*

ELECTROSPINNING

Basic principle and introduction of electrospinning process and parameters. **(3)**

PREPARATION OF POLYMER BLENDS AND NANOPARTICLES

Definition of polymer blends and nanoparticles - effect of Metal nanoparticles on properties of polymers, determination morphology. Advantage and disadvantage of blended and embedded nanoparticles with nanofiber membranes. **(3)**

CHARACTERIZATION TECHNIQUES

FTIR, XRD, DLS, TGA, TEM, SEM and contact angle. **(3)**

MECHANICAL PROPERTIES OF THE NANOFIBER MEMBRANES

Mechanical properties of stress - strain behaviour, tensile strength and young's modulus. **(3)**

BIOLOGICAL INTERACTION WITH NANOFIBER MEMBRANES

Biocompatibility, toxicity, cytotoxicity, interaction of the materials. **(3)**

TOTAL : 15

TEXT BOOKS

1. *BIOMATERIALS SCIENCE, An Introduction to Materials in Medicine, Edited by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons,*
2. *Biomaterials and Nanotechnology for Tissue Engineering by S Sethuraman, U M Krishnan, A Subramanian, 2016, CRC Press*

REFERENCES

1. *P. J. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead Publishing Limited, Cambridge, (2007).*
2. *W.N.Chang, Nanofibers Fabrication, Performance and Applications, Nova Science Publishers Inc., (2009).*

19CHOC27 - BIOMASS CONVERSION TO BIOFUELS AND BIOENERGY

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Understanding various renewable feedstock of importance, their availability and attributes for biofuel production*

CO2 : *Understanding of the broad concept of second and third generation biofuel production from biomass and other low-cost agro-residues and other wastes.*

CO3 : *Perform and interpret life cycle analysis and environmental impact assessment for biofuel from any feedstock*

INTRODUCTION

Fundamental concepts in understanding biofuel and biotechnology production - Various biofuels and bioenergy from biomass - Feedstock - types, availability, characterisation and attributes for bioenergy - Biofuel production - Biomass pre-processing - Drying, densification and size reduction. **(5)**

CONVERSION OF BIOMASS TO ENERGY

Biomass conversion to heat and power - thermal gasification of biomass, anaerobic digestion - Biomass conversion to biofuel - thermo chemical conversion, syngas fermentation - Biochemical conversion to ethanol - biomass pre-treatment - Different enzymes, enzyme hydrolysis, and their applications in ethanol production - Biodiesel production from oil seeds, waste oils and algae. **(5)**

ENVIRONMENTAL SIGNIFICANCE OF BIOFUEL PRODUCTION

Environmental impacts of biofuel production - Energy balance and life-cycle analysis of biofuel production - Value-added processing of biofuel residues and co-products. **(5)**

TOTAL : 15

TEXT BOOK

1. *Biorenewable Resources: Engineering New Products from Agriculture. Robert C. Brown. Wiley-Blackwell Publishing (2003).*

REFERENCES

1. *Anaerobic Biotechnology for Bioenergy Production: Principles and Applications. Samir K. Khanal. Wiley-Blackwell Publishing (2008).*

19CHOC28 - BIOFUEL : FATE AND FUTURE

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Understanding the concept of release of biofuel and its impact on the environment*

CO2 : *Understanding the interaction of biofuel with petroleum fuel and the environment*

CO3 : *Understanding and planning long term release response strategies and closures.*

INTRODUCTION - BIOFUEL RELEASE

Definition of key terms - Biofuel summary - Current and projected volumes of biofuel - Biofuel toxicity - Biofuel release scenarios and causes - Release prevention. **(5)**

FATE AND TRANSPORT OF BIOFUELS IN THE ENVIRONMENT

Physical and chemical properties of biofuel - Biodegradation - Biofuel interaction with petroleum fuels - Physical transport. **(5)**

LONG TERM RESPONSE STRATEGIES FOR BIOFUEL RELEASE

Regulatory thresholds and / or potential hazards - Risk assessment and management - Active remedy evaluation and selection - Closure requirements - Timing and duration of long-term response. **(5)**

TOTAL : 15

REFERENCES

1. *Biofuels: Release Prevention, Environmental Behaviour, and Remediation; The Interstate Technology & Regulatory council, Biofuels team, 2011.*

19CHOC29 - DIMENSIONAL ANALYSIS AND THEORY OF MODELS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

PREREQUISITES

Chemical Process Calculations, Fluid Mechanics

COURSE OUTCOMES

Students will be able to

CO1 : *Apply principles of dimensional homogeneity to check consistency of empirical equations used in science and Engineering*

CO2 : *Develop empirical relationship from first principles or from specific experimental observations*

CO3 : *Validate dimensional consistency of any equations used in current research conclusions*

Unit - I

Principles of dimensional homogenity, Geometric similarity - Singular dimensional matrix - Dimensional homogeneity - Buckingham's theorem - reduction of dimensionless form.

Introduction to models and testing - dynamic, geometric and kinematic similarity. **(7)**

UNIT - II

Applications of dimensional analysis in fluid mechanics - velocity distribution in conduit - Pumps and compressors

Application of dimensional analysis in real world physical problems - Transient convective heat transmission to a body in a fluid - Condensation in a vertical pipe. **(8)**

ASSESSMENT

Assignment and internal examination - 50%

External examination - 50%

TEXT BOOKS

1. *Henry L Langhaar, Dimensional Analysis and Theory of Models, John Wiley & sons, 1951*
2. *Jonathan Worstell, Dimensional analysis: Practical Guides in Chemical Engineering, Elsevier, 2014.*

CO - PO Mapping

	Programme Outcomes												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3											1	1
CO2	3	3											1	1
CO3			2	2									1	1

19CHOC30 - PINCH TECHNOLOGY

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

PRE-REQUISITE

Heat Transfer

COURSE OUTCOMES

Students will be able to

CO1 : *Identify the locations of energy minimization in heat exchanger networks*

CO2 : *Obtain energy targets by constructing composite curves*

CO3 : *Arrange the heat transfer equipment in most efficient manner*

INTRODUCTION

Pinch analysis - process synthesis - pinch point - composite curves - energy targeting: problem table algorithm - shifted composite curve - capital cost - total cost targeting - process modification. **(8)**

PINCH ANALYSIS

Identification of streams - temperature-enthalpy diagram - minimum temperature difference - construction of composite curves - Energy cost target - optimum target - design of heat exchanger network. **(7)**

TOTAL : 15

Pedagogy

Lecture

Evaluation and Grading

Test - 50%

Internal exam - 50%

TEXT BOOKS

1. *Ian C. Kemp, Pinch Analysis and Process Integration, Second edition, Elsevier, 2007.*
2. *Rokni Masoud (2016), Introduction to Pinch Technology, Technical University of Denmark.*
3. *V. UdayShenoy, Heat Exchanger network synthesis, Gulf Publishing Co, USA, 1995.*
4. *D.W. Linnhoff et al., User Guide on Process Integration for the efficient use of Energy, Institution of Chemical Engineers, U.K., 1994.*

CO - PO Mapping

	Programme Outcomes												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	1	1	3	1				1		3	
CO2	2	3	3		2	2					1		2	
CO3	1	2	1		1	2					1	1	2	

19CHOC31 - DRUG DELIVERY SYSTEMS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *Understand the basic properties of nanomaterials*

CO2 : *Nanomaterials and its biological applications*

CO3 : *To study the toxicity of material with cells*

CO4 : *Learn nanoparticles as drugs to targeted sites with controlled release of drugs*

CO5 : *To study drug release from the nanomaterials*

TRANSDERMAL DRUG DELIVERY SYSTEMS

Permeation through skin, factors affecting permeation, permeation enhancers, basic components of TDDS, formulation approaches. **(5)**

NASOPULMONARY DRUG DELIVERY SYSTEMS

Nasal and Pulmonary routes of drug delivery, formulation of Inhalers (dry powder and meterd dose).**(5)**

TARGETED DRUG DELIVERY

Concepts and approaches, introduction to liposomes, niosomes, monoclonal antibodies and their applications. **(5)**

TOTAL : 15

TEXT BOOKS

1. *B. Wang, Drug Delivery: Principles and Applications, Wiley Intersceince, 2005.*
2. *M.Salzman, Drug Delivery: Engineering Principles for Drug Therapy.*

REFERENCES

1. *A.M.Hillery, Drug Delivery and Targetting, CRC Press, 2002.*
2. *Bio-Applications of Nanoparticles Warren C.W. Chan.*

19CHOC32 - RESEARCH SKILLS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : *Understand the concept of performing research, literature survey procedure and skills for pursuing research.*

CO2 : *Identify the research topic, advisor, time span, benefits of research and admission procedure.*

CO3 : *Write a research article and publishing it in a suitable journal and making presentations.*

UNIT I

What is Research and What makes a Good Research Question? - What is Literature Review and Why Do We Need to Do One? - Why are Planning and Management Skills Important for Research? **(5)**

UNIT II

When should I begin research? - How much time is required? - How do I select a research advisor? - How do I select a research topic? - What are the benefits of research? - How do I register for research programme? **(5)**

UNIT III

How to write a research / review article? - How to write abstract, introduction, methodology, results and discussion - How to format tables and figures? - Ethical issues in scientific publishing - How to avoid plagiarism? - Determining authorship - Submission of Manuscript - Monitoring Peer Review - Acceptance and post publication process. **(5)**

TOTAL : 15

Evaluation and Grading

Literature Survey (Assignment)	-	30%
Presentation	-	40%
Review Article Writing	-	30%

TEXT BOOKS

1. *J.W. Creswell, Research Design: Qualitative, Quantitative and Mixed Methods Approaches, SAGE Publications, Inc., 4th Ed., 2014.*
2. *N. William, Research Methods, Routledge; 2nd Ed., 2017.*
3. *C.R. Kothari, Research Methodology Methods and Techniques, New Age Publications, New Delhi, 2009.*

CO - PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				2						3				1
CO2				3				2		3				1
CO3				3				2		3				1

19CHOC33 - E-WASTE MATERIAL FLOW AND MANAGEMENT PRACTICES

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *To enhance the student understands the concept of e-waste issues and challenges.*

CO2 : *Identify the flow of e-waste from manufacture to recycler.*

CO3 : *To impart ability to identify the methodology to recycle e-waste.*

UNIT I

Introduction - Definition -E-waste components and composition - Material Flow - Source of e-waste generation - Selection of methodology for Inventory - Limitations in e-waste inventory Mechanism of WEEE trade - E-waste life cycle - Material flow model - components of e-waste management - National and Social Policies: Laws and Regulations - Institutional roles in Developed and Developing countries. **(9)**

UNIT II

Collection systems - E-waste Treatment Systems - First Level and Second Level Treatment - Unit Operations in E-waste Management - other advanced recycling methods. **(6)**

TOTAL : 15

Pedagogy

Lecture, Exercises

Evaluation and Grading

Case Studies … 50%

Report submission and Seminar … 50%

REFERENCES

1. *Rakesh Jhori, E-waste: Implications, regulations, and management in India and current global best practices, TERI, 2008.*
2. *E-waste Volume I - Inventory Assessment Manual by United Nations Environmental Programme.*
3. *E-waste Volume II - E-waste Management Manual by United Nations Environmental Programme.*

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2	2			2	3	3		3
CO2						2	2			2	2	3		3
CO3						2	2			2	3	3		3

19CHOC34 - CHEMICALS IN THE ENVIRONMENT : FATE AND TRANSPORT

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *To analyze the behavior of chemicals in the environment.*

CO2 : *To understand the process that govern the behavior of both hazardous and naturally-occurring substances in the environment.*

CO3 : *To acquire basic knowledge about waste water treatment methodologies.*

UNIT I

Control volumes, Mass balance, and advective/dispersive transport, Chemical equilibria, Mass action, Electro neutrality, and Mass conservation, ecosystem characteristics and redox chemistry. **(6)**

UNIT II

River transport, lakes and wetlands and estuaries, Sediment transport, bottom, sediments, Paleolimnology, air-water exchange, major ion chemistry of natural waters. **(6)**

UNIT III

BOD/DO modeling and microbial kinetics, Photochemistry and hydrolysis. **(3)**

Pedagogy

Lecture, Presentation, Assessment

Evaluation and Grading

Literature review … 20%

Presentation … 30%

Assessment … 50%

REFERENCES

1. *Robert L. Swann and Alan Eschenroeder (Eds.), Fate of chemicals in the environment, Compartmental and multimeia mode for predictions, 1983, American Chemical Society.*

MAPPING OF COs with POs

COURSE OUTCOME	PROGRAMME OUTCOMES												PSO'S	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO1		3		2			3						3	
CO2		3					3							
CO3		3	2			1	3						3	

19CHOC35 - AN INTEGRATED APPROACH FOR WASTEWATER TREATMENT

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *To present the basic principles of disinfection, drinking water quality, natural treatment systems.*

CO2 : *To integrate theoretical principles of disinfection with practical aspects of evaluation of disinfection systems.*

CO3 : *To acquire basic knowledge about adsorption process and its methodologies.*

UNIT I

Drinking water quality, Water collection and storage, disinfection, Natural treatment systems.

Quality and analysis of Water: characteristics of water - physical, chemical and biological, kinds of microorganisms, pathogenic microbes, indicator microbes, enumeration of microbes, Coliform bacteria as indicator organisms, Tests for the coliform group (MPN Method) **(9)**

UNIT II

Adsorption: biological materials, nano materials and composites, Case study. **(6)**

TOTAL : 15

Pedagogy

Lectures, Exercise

Evaluating and Grading

Presentation - 20%

Assignments - 30%

Exercise - 50%

REFERENCES

1. *A D Patwardhan, Industrial waste water Treatment, 2008, PHI publishers.*

Mapping of Course Outcomes with Program Outcomes

COURSE OUTCOME	PROGRAMME OUTCOMES												PSO'S	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CO1		2		3			3						3	
CO2		2		3			3							
CO3		2		3		1	3						3	

19CHOC36 - TEXTILE EFFLUENTS : ANALYSIS AND TREATMENT METHODS

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *To learn the operation of textile industries and its influence on depleting the ecosystem*

CO2 : *To analyse the constituents of textile effluents for a safer discharge*

CO3 : *To study the operation of various stages of effleunt treatment plant and to emphasize the standards on effluent discharge*

INTRODUCTION

Introduction to textile industries - a general study; chemicals used for the manufacture of textiles introduction to natural and synthetic dyes - classification and chemical properties; manufacture of textiles; hazardous impacts of the untreated effluents on discharge to ecosystem **(5)**

EFFLUENT ANALYSIS

General testing of organic and inorganic compounds - conductivity, salinity, total dissolved solids, total suspended solids, total toxic organics, turbidity, biochemical oxygen demand and chemical oxygen demand, pH, hardness. **(5)**

EFFLUENT TREATMENT PROCESS

Primary treatment - screening, homogenizing, neutralization and cooling; secondary treatment - aerobic and anaerobic stages, sedimentation, sludge management, disinfection, tertiary Treatment effleunts - pressure sand filter and activated carbon filter, ultrafiltration, softener, reverse osmosis adsorption and degradation - basic studies; standards for discharge - government policies, norms and legislations **(5)**

TOTAL : 15

TEXT BOOKS

1. *Mohd Yusuf, Handbook of Textile Effluent Remediation, 1st Edition, Jenny Stanford Publishing, 2018.*

REFERENCES

1. *S. Kathleen, M. Christopher, L. Lynn. Bergeson, Nanotechnology and the Environment, CRC press 2009.*
2. *Darcy J. Gentleman, Nano and the Environment: Boon or Bane?" Environmental Science and Technology, ACS Publication, Vol. 43, 2009.*

19CHOC37 - ADVANCED RECYCLING AND RECOVERY TECHNOLOGIES FOR E-WASTE

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : *To develop the student, understands the methodology to recycle and recover e-waste.*

CO2 : *To understand the recent research practices involved in metal recovery from e-waste.*

CO3 : *Ability to apply knowledge of various unit operations involved in e-waste management.*

UNIT I

Sorting, Disassembly - Crushing, Diminution -Emerging Technologies -Automated Disassembly, Comminution -Separation - Printed Circuit Boards - Solder removal using IR heater. **(6)**

UNIT II

Need for recycling and recovery -Advanced methods - Plasma Arc Method - Cryo-milling technique, Bioleaching using Micro-organisms - Hydrometallurgical treatments - Pyrometallurgy and Pyrolysis. Characteristics study - Determination of metals using Atomic Absorption Spectroscopy -Proximate and Ultimate analysis **(9)**

TOTAL : 15

Pedagogy

Lecture, Exercises

Evaluation and Grading

Case Studies … 50%

Report submission and Seminar … 50%

REFERENCES

1. *Vidyadhar Ari (June 29th 2016). A Review of Technology of Metal Recovery from Electronic Waste, E-Waste in Transition - From Pollution to Resource, Florin-Constantin Mihai, Intech Open.*
2. *R. E. Hester, R. M. Harrison, Electronic Waste Management, RSC publishing, 2009.*

MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2	2			2	3	3		3
CO2						2	2			2	2	3		3
CO3						2	2			2	3	3		3

19CHOC38 - NPTEL / MOOC CERTIFICATION COURSE

(Chemical Engineering and Allied Courses)

L	T	P	C
1	0	0	1

ASSESSMENT : THEORY

INSTRUCTIONS :

- *A Student can select any NPTEL / MOOC Course that is offered by Chemical and Allied Engineering Branches.*
- *Evaluation pattern will be based on performance in Assignments/ Tutorials and Final Exams conducted by the mentor of the respective NPTEL / MOOC Courses.*
- *Student should submit certificate of NPTEL / MOOC Course for successful completion at end.*

OPEN ELECTIVES

19CEOE01 - TOWN PLANNING AND ARCHITECTURE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : interpret the geometric forms and aesthetic qualities of Architecture

CO2 : integrate the various elements of architecture and orientation of buildings

CO3 : describe the development plans and planning regulations

CO4 : incorporate the development control rules in town and country planning

PRINCIPLES OF TOWN PLANNING

Evaluation of planning - Objects of town planning - principles of town planning- origin of towns - growth of towns - origin - direction - various forms of planning **(9)**

ELEMENTS OF ARCHITECTURE

Introduction of architecture - definition - Evaluation of geometric forms - function and history - Sphere, Cube, Pyramid, Cylinder and Cone - aesthetic qualities of Architecture - Proportion, Scale, Balance, Symmetry, Rhythm and axis - Contrast in Form - Harmony. **(9)**

PRINCIPLES OF ORIENTATION AND PLANNING OF BUILDINGS

Factors affecting orientation - Sun-Wind-Rain - Orientation criteria for Indian conditions - Principles governing the theory of planning - Planning of residential buildings. **(7)**

DEVELOPMENT PLAN

Principles of city planning - levels of planning- scope and contents of regional plan, master plan, detailed development plan and structure plan - preparation and implementation - planning of new towns - slum clearance and urban renewal. **(9)**

PLANNING LEGISLATION AND DEVELOPMENT CONTROL RULES

Planning legislation and administration - Tamil Nadu Town and Country Planning Act, Tamil Nadu Housing Board Act, Tamil Nadu slum clearance and Improvement Act. Zoning regulations - sub division regulations - building regulations - Floor Space Index - minimum plot sizes - open spaces - minimum standard dimensions **(11)**

TOTAL : 45

TEXT BOOKS

1. *RangwalaS.C., "Town Planning", Charotar Publishing House, Anand, 2013.*
2. *Francis D.K., Ching, "Architecture Form, Space and Order", Oxford University Press, 2014.*

ONLINE RESOURCE

1. *https://nptel.ac.in*

19CEOE02 - CLIMATE CHANGE AND ADAPTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : Outline the earth's system which influences the climatic factors of the earth.

CO2 : Infer the evidences and observed changes in the climate and environment on a global scale and in India.

CO3 : Analyse the impacts of climate change on various sectors and the uncertainties over the projected impacts of climate change.

CO4 : Investigate the various adaptation and mitigation options in various sectors and examine the mitigation efforts made in India.

CO5 : Correlate future clean technology and alternate energy options inferred in clean development mechanism.

EARTH'S CLIMATE SYSTEM

Introduction-Climate in the spotlight-The Earth's Climate Machine - Climate Classification - Global wind systems - Trade Wind Systems - Trade Winds and the Hadley Cell - The Weserlies - Cloud formation and Monsoon Rains - Storms and Hurricanes - The Hydrological Cycle - Global Ocean Circulation - El Nino and its Effect - Green House Gases and Global Warming - Carbon Cycle. **(9)**

OBSERVED CLIMATE CHANGE AND ITS CAUSES

Observation of Climate Change - Changes in pattern of temperature, precipitation and sea level rise - Observed effects of Climate Changes - Patterns of Large Scale Variability - Drivers of Climate Change - Feedbacks - The Montreal Protocol - UNFCCC - IPCC - Evidences of Changes in Climate and Environment - on a Global Scale and in India. **(9)**

IMPACTS OF CLIMATE CHANGE

Impacts of Climate Change on various sectors - Agriculture, Forestry and Ecosystem - Water resources - Human Health - Industry, Settlement and Society - Methods and Scenarios - Projected Impacts for different regions - Uncertainties in the Projected Impacts of Climate Change. **(9)**

CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES

Adaptation Strategy/options in various sectors - Water - Agriculture - Infrastructure and Settlement including coastal zones - Human Health - Tourism - Transport - Energy - Key Mitigation Technologies and practices - Energy supply - Transport - Buildings - Industry - Agriculture - Forestry - Carbon sequestration - Carbon Capture and Storage (CCS) - Mitigation Efforts in India and Adaptation funding. **(9)**

CLEAN TECHNOLOGY AND ENERGY

Clean Development Mechanism - Carbon Trading - Examples of future Clean Technology - Biodiesel - Natural Compost - Eco-friendly Plastic - Alternate Energy - Hydrogen - Bio-fuels - Solar Energy - Wind - Hydroelectric Power. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Dash Sushil Kumar, "Climate Change - An Indian Perspective", Cambridge University Press India Pvt. Ltd, 2007.*
2. *UNIPCC Fifth Assessment Report, 2014.*
3. *Jan C. van Dam, Impacts of "Climate Change and Climate Variability on Hydrological Regimes", Cambridge University Press, 2003.*

REFERENCES

1. *Anil Markandya, Climate Change and Sustainable Development: Prospects for Developing Countries, Routledge, 2002.*
2. *Heal, G. M., Interpreting Sustainability, in Sustainability: Dynamics and Uncertainty, Kluwer Academic Publ., 1998.*
3. *Jepma, C.J., and Munasinghe, M., Climate Change Policy - Facts, Issues and Analysis, Cambridge University Press, 1998.*
4. *Dash Sushil Kumar, "Climate Change - An Indian Perspective", Cambridge University Press India Pvt. Ltd, 2007.*

ONLINE RESOURCES

1. *"An Inconvenient truth (2006)"- video*
2. *https://climate.nasa.gov*
3. *https://unfccc.int*
4. *https://environment .gov.au*

19CEOEO3 - METRO SYSTEMS AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : Integrate the basic elements of MRTS, BRTS, LRTS and other transportation systems

CO2 : Illustrate the components of metro rail systems

CO3 : Apply the concepts of ITS in the field of Transportation Engineering

PRINCIPLES OF TRANSPORTATION SYSTEMS

Transportation systems in India - various modes of transport - public transport - Intermediate public transport - types - characteristics - other urban transportation modes - drawbacks- various transit systems **(9)**

MRTS

Definition - Mass Rapid Transit System - History of MRTS - Need for MRTS - connectivity in Indian conditions - cities having MRTS - infrastructure - operations - fares and ticketing - case study. **(8)**

BRTS and LRTS

Bus Rapid Transit System - terminology - history -features - performance - cost - drawbacks - Light Rail Transit System - necessity - types - gauge- capacity integration with cycles - comparison to other rail modes **(9)**

METRO RAIL SYSTEMS

History of Metro trains - Need for Metro rail - connectivity in Indian conditions - cities having Metro - construction techniques adopted in Metro Rail stations - Case study - Delhi Metro (DMRC) - Chennai Metro (CMRL) **(10)**

ITS

Definition - Intelligent Transport System - Principles - Application of ITS technologies in various countries - smart transportation - case studies **(9)**

TOTAL : 45

TEXT BOOKS

1. *Pradip Kumar Sarkar, Vinay Maitri, G. J. Joshi ·"Transportation Planning Principles, Practices and Policies", Prentice Hall India Pvt., Limited 2017*
2. *D. Johnson Victor, S. Ponnuswamy, "Urban Transportation Planning, Operation and Management" Tata McGraw-Hill Education, 2012*
3. *Mashrur A. Chowdhury, Adel Wadid Sadek "Fundamentals of Intelligent Transportation Systems Planning" Artech House · 2003*
4. *Sumit Ghosh, Tony S. Lee, "Intelligent Transportation Systems Smart and Green Infrastructure Design, Second Edition" CRC Press · 2010*

ONLINE RESOURCES

1. *https://nptel.ac.in/content/storage2/courses/105101008/downloads/cete_48.pdf*

19CEOE04 - RENEWABLE ENERGY RESOURCES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : Infer the current energy scenario and future energy usage in India.

CO2 : Interpret the concepts of solar energy, wind energy, tidal energy and biomass energy.

CO3 : Compare the energy utilization from wind energy, solar energy, biomass energy and tidal energy.

CO4 : Correlate the challenges and problems associated with the use of energy sources.

ENERGY PERSPECTIVES

Conventional and non conventional energies - Energy and sustainable development - Global energy scenario - Energy scenario in India - Energy consumption pattern in rural and urban regions in India - Energy efficiency and economy - Energy losses and its control - Renewable energy potential mapping - Plant load factor **(9)**

SOLAR ENERGY PERSPECTIVES

Concept of solar energy - Solar energy to light and to thermal conversions - Total energy and necessary infrastructure - Units and measurement of solar radiation - Temperature dependent collecting devices and their efficacies - Design aspects - Typical applications: heating, cooling, lighting, power generation and cooking. **(9)**

WIND ENERGY PERSPECTIVES

Wind potential in India - Wind turbines and their types - Merits and demerits - Wind power and appropriate coefficient - Efficiency and performance of wind machines -Energy conversion and storage - Synchronous invertors - Various storage aspects: battery, fly wheel, hydrogen and compressed air. **(9)**

BIOMASS ENERGY PERSPECTIVES

Biomass potential in India - Gobar gas and producer gas - Characteristics of biomass - Operation and design of biogas plants - Objectives, principles and operational aspect of biogassifiers - Pyrolysis and incineration - Power generation from municipal solid waste and industrial Sludges - Application of biodiesel plants - Fuel cells. **(9)**

TIDAL ENERGY PERSPECTIVES

Tidal aspects in coastal India - Tidal energy conversion system: mechanical to electrical and thermal to electrical - Tidal force calculation and power generation - conceptualization and potential of geothermal energy - Geothermal vents. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Sukathme, S.P, Nayak J.K., "Solar Energy", Tata McGraw-Hill Book Co., New Delhi, 2017.*
2. *Rai, G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2010.*
3. *P.Kothari, K.C Singal, Rakesh Ranjan "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt.Ltd, New Delhi, 2013.*
4. *Scott Grinnell, "Renewable Energy & Sustainable Design", CENGAGE Learning, USA, 2016.*

REFERENCES

1. *Richard A. Dunlap," Sustainable Energy" Cengage Learning India Private Limited, Delhi, 2015.*
2. *Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.*
3. *Shobh Nath Singh, 'Non-conventional Energy resources' Pearson Education, 2015.*

ONLINE RESOURCES

1. *https://swayam.gov.in/nd1_noc20_ge06/preview*
2. *https://swayam.gov.in/nd2_nou20_cs09/preview*

19CEOE05 - PRINCIPLES OF SUSTAINABLE DEVELOPMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : Identify the components, factors and environmental issues affecting Sustainable development.

CO2 : Assess the role of International summits, conventions and Environmental aspects on Sustainable development.

CO3 : Interpret the necessity and importance of Indian and International Socio -economical and legal aspects in Sustainability.

CO4 : Illustrate the different strategies to achieve Sustainable development.

CO5 : Assess the role of Life cycle Assessment, Cleaner Production and Sustainable Chemistry to achieve sustainable development.

CONCEPTS OF SUSTAINABLE DEVELOPMENT

Sustainable development- Evolution of Environmental awareness and Sustainable development, global Sustainable development goals -components and factors affecting Sustainable development-Demographic dynamics and sustainability- Environmental issues and crisis- ozone layer depletion, global warming and climate change **(9)**

ENVIRONMENTAL ASPECTS

International Environmental summits, conventions and agreements-Tiwari committee recommendation - Role of Pollution Control Board - Transboundary issues - Ecological indicators- Ecological foot print- Carbon foot print - Basic concept of Environmental impact assessment **(9)**

SOCIO ECONOMIC AND JUDICIAL ASPECTS

UN Sustainable development policies through trade- World Trade Organization-International monetary fund and World bank - Circular Economy and Sustainable Development - Socio economic policies for sustainable Development- Role of Judiciary in Sustainable Development - Major Environmental Cases in India - Development of Environmental Policies in India - Environment Protection Act, 1986 - EIA notification 2006 - National Conservation Strategy and Policy Statement on Environment and Development, 1992 - Policy Statement for the Abatement of Pollution, 1992 - National Environment Policy, 2006. SDG India Index - Baseline Report 2018 **(9)**

STRATEGIES FOR SUSTAINABLE DEVELOPMENT

Economic growth and Sustainable Development - Resource depletion and resource protection- - Internet of things and Sustainable Development - Sustainable Management of Forest, Land, water- Natural Disaster management- case studies. **(9)**

CLEANER PRODUCTION, LIFE CYCLE ASSESSMENT - GREEN/SUSTAINABLE CHEMISTRY

Cleaner Production, definition, aim, application-Generic process of Cleaner Production Assessment- Life cycle Assessment - definition, necessity and elements- ISO Environmental standards- Environmental Audit -Green Chemistry - twelve Principles of Green Chemistry - case studies. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Ramakrishnan, P. S., "Ecology and Sustainable Development", National Book Trust, New Delhi, 2001*
2. *Paul Robbins, John Hintz, and Sarah A. Moore, "Environment and Society: A Critical Introduction", Wiley-Blackwell, 2014*
3. *Bimal N. Patel and Ranita Nagar, "Sustainable Development and India", Oxford University Press, 2018.*

REFERENCES

1. *Nick Hanley, Jason F. Shogren and Ben White, "Environmental Economics in Theory and Practice", Macmillan Publishers, UK, 1997*
2. *Tietenberg T. and Lynne Lewis, "Environmental and Natural Resource Economics", Harper Collins, Routledge, 2016*
3. *Kirkby, J.O., Keefe, P., and Timberlake, "Sustainable Development", Earthsean Pub., London, 2001*

ONLINE RESOURCES

1. *https://nptel.ac.in*

19CEOE06 - DISASTER MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After successful completion of the course, student will be able to

CO1 : Identify natural and manmade disasters

CO2 : Explain in detail about causes and effects of natural and manmade disasters.

CO3 : Apply geospatial techniques (including GIS) that can enhance vulnerability assessments

CO4 : Identify and analyse the factors that give rise to differential vulnerabilities and levels of community resilience and suggest necessary mitigation plans

CO5 : Assess and manage these vulnerabilities through disaster planning and policy-making.

NATURAL DISASTERS

Cyclones, Floods, Drought and Desertification - Earthquake, Tsunami, Landslides and Avalanche. **(9)**

MAN MADE DISASTERS

Chemical industrial hazards, major power breakdowns, traffic accidents, Fire, War, Atom bombs, Nuclear disaster- Forest Fire- Oil fire -accident in Mines. **(9)**

GEOSPATIAL TECHNOLOGY

Remote sensing, GIS and GPS applications in real time disaster monitoring, prevention and rehabilitation- disaster mapping. **(9)**

RISK ASSESSMENT AND MITIGATION

Hazards, Risks and Vulnerabilities - Disasters in India, Assessment of Disaster Vulnerability of a location and vulnerable groups- Preparedness and Mitigation measures for various Disasters- Mitigation through capacity building -Preparation of Disaster Management Plans. **(9)**

DISASTER MANAGEMENT

Legislative responsibilities of disaster management- Disaster management act 2005- post disaster recovery & rehabilitation, Relief & Logistics Management; disaster related infrastructure development- Post Disaster, Emergency Support Functions and their coordination mechanism - Role of Engineers in Disaster Management. **(9)**

TOTAL : 45

TEXT BOOKS

1. *R. Subramanian, “Disaster Management” Vikas Publishing House Pvt. Ltd, New Delhi, 2018.*
2. *Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2017.*

REFERENCES

1. *Disaster Management in India-A Status Report- Published by the National Disaster Management Institute, Ministry of Home Affairs, Govt. of India, 2004.*
2. *Murthy D. B. N., "Disaster Management : Text and Case Studies", Deep and Deep Publications (P) Ltd., New Delhi, 2007.*
3. *Sundar I. and Sezhiyan T., "Disaster Management", Sarup and Sons, New Delhi, 2007.*
4. *Singhal J.P. "Disaster Management”, Laxmi Publications, 2010.*

5. *Khanna BK, "All You Wanted To Know About Disasters", New India Publishing Agency, New Delhi, 2005.*
6. *Ramana Murthy, "Disaster Management", Dominant, New Delhi, 2004.*
7. *Rajdeep Dasgupta, "Disaster Management and Rehabilitation", Mittal Publishers, New Delhi, 2007.*

19MEOE01 - DESIGN OF EXPERIMENTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : Demonstrate the fundamental concepts applied with mathematical knowledge, methodologies to bring knowledge of characterize, analyse and solve a wide range of problems between the purpose of a model and the appropriate level of complexity and accuracy.

CO2 : Plan, design and conduct experimental investigations efficiently and effectively; choose an appropriate experiment to evaluate a new product design or process improvement through experimentation strategy, data analysis, and interpretation of experimental results.

CO3 : Analyse the nature of variables, statistical inference, influence parameter selection, factorial concepts, Conduct Design of experiments; interpret the direct and interaction effects using RSM.

INTRODUCTION

Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments. **(7)**

BASIC STATISTICAL CONCEPTS

Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots, choice of sample size. Illustration through Numerical examples. **(9)**

EXPERIMENTAL DESIGN

Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples. **(11)**

ANALYSIS AND INTERPRETATION METHODS

Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples. **(9)**

EXPERIMENT DESIGN USING TAGUCHI'S ORTHOGONAL ARRAYS

Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graphs and Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs. Illustration through Numerical examples. **(9)**

TOTAL :45

TEXT BOOKS

1. *C.F. Jeff Wu & Michael Hamada, "Experiments-Panning, Analysis, and Optimization", 3rd Edition, John Wiley & Sons. Inc., 2021.*
2. *D.C. Montgomery, "Design and Analysis of Experiments", 10th Edition, John Wiley & Sons. Inc. 2019.*

REFERENCES

1. *T.B. Barker, Andrew Milivojevich, "Quality by Experimental Design", 4th Edition, CRC Press, 2021*
2. *https://nptel.ac.in/courses/110/105/110105087/*
3. *https://nptel.ac.in/courses/111/104/111104075/*

19MEOE02 - ENGINEERING OPTIMIZATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : Formulate single or multi-variable engineering optimization problems and comply with the appropriate objective functions.

CO2 : Select the appropriate optimization technique for the specified engineering problems based on number of variables and constraints.

CO3 : Derive, develop and utilize the possible randomness or any other associated factors that would possibly occur during constrained and unconstrained optimization situations.

INTRODUCTION

Problem formulation - design variables, constraints, constraint surfaces, objective functions, objective function surfaces. Classification of optimization - based on existence of constraints, nature of design variables, structure of the problem, nature of equation involved, permissible value of the design variables, deterministic nature of the variables, separability of the functions and the number of objective functions. Example of engineering optimization problems. **(11)**

SINGLE VARIABLE OPTIMIZATION

Optimal criteria - bracketing method - exhaustive search method, region elimination method - interval halving, Fibonacci, golden search method, point estimation method - successive quadratic approximation, gradient search method - Newton Raphson's method. **(10)**

MULTIVARIABLE OPTIMIZATION WITH CONSTRAINTS

Multivariable optimization - semi definite case - saddle point. Multivariable optimization with equality constraints - solution by direct substitution - solution by the method of constrained variation - solution by the method of Lagrange multipliers. Multivariable optimization with inequality constraints - Kuhn-Tucker conditions, constraint qualification. **(12)**

UNCONSTRAINED OPTIMIZATION

Introduction - classification of unconstrained minimization methods - general approach - rate of convergence - scaling of design variables. Direct Search Methods - random search methods - random walk method with direction exploitation - advantages of random search methods. Indirect Search Methods - gradient of a function - evaluation of the gradient - rate of change of function along a direction - steepest descent (Cauchy) method. **(12)**

TOTAL : 45

TEXT BOOKS

1. *S. S. Rao, "Engineering Optimization: Theory and Practice", 5th Edition, John Wiley & Sons, 2019.*
2. *K. Deb, "Optimization for Engineering Design - Algorithms and Examples", 2nd Edition, Prentice Hall India, 2013.*

REFERENCES

1. *J. S. Arora, "Introduction to Optimum Design", 4th Edition, Academic Press, 2016.*
2. *Ashok D. Belegundu &Tirupathi R. Chandrupatla, "Optimization Concepts and Applications in Engineering", 3rd Edition, Kindle Edition, Cambridge University Press, 2019.*

3. *A. Ravindran, K. M. Ragsdell, Reklaitis G.V., "Engineering Optimization: Methods and Applications", John Wiley & Sons, Inc., 2006.*
4. *https://nptel.ac.in/courses/112/105/112105235/*
5. *https://nptel.ac.in/courses/105/108/105108127/*
6. *https://nptel.ac.in/courses/112/101/112101298/*

19MEOE03 - ENGINEERING POLYMERS, COMPOSITES AND ALLIED MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : Choose manufacturing processes for polymers and PMC materials to obtain required shapes by applying product design considerations

CO2 : Find the processes to develop new ceramic and cermet materials for manufacturing of high temperature cutting tools by applying design considerations

CO3 : Develop and characterize the Nano-composites, MMCs, CMCs and PMCs for the engineering applications using secondary processing methods

CO4 : Synthesize, characterize, compaction and sintering of metal powders for application of P/M parts using powder metallurgy techniques

CO5 : Synthesize and characterize the nanostructured materials for fabricating electronic devices, MEMS, magnetic, electronic and optical sensors and fabricating carbon nano structured materials for fuel cell and energy storage applications

SHAPING PROCESSES FOR PLASTICS

Properties of polymer melts - extrusion - production of sheet and film - fibre and filament production (spinning) - coating processes - injection moulding - compression and transfer moulding - blow moulding and rotational moulding - thermoforming. Casting - polymer foam processing and forming - product design considerations. **(8)**

RUBBER-PROCESSING TECHNOLOGY

Rubber processing and shaping - manufacture of tyres and other rubber products - product design considerations. **(5)**

SHAPING PROCESSES FOR POLYMER MATRIX COMPOSITES

Materials for PMC - open mold processes - closed mold processes - filament winding -pultrusion process - other PMC shaping processes. **(4)**

PROCESSING OF CERAMICS AND CERMETS

Processing of traditional ceramics - processing of new ceramics - processing of cermets - product design considerations. **(4)**

APPLICATION OF COMPOSITES

Composites including Nano-composites for electrical, superconducting and device applications, fabrication of Nano-composites, secondary processing and joining of various composite materials for structural applications and their fracture behavior and safety. **(9)**

POWDERS

Production and characterization of powders, compaction of metal powders - die compaction, isostatic pressing, powder forging, powder rolling and extrusion, pressure less compaction techniques, hot pressing and hot isostatic pressing, sintering of powder compacts, liquid phase sintering, sintering furnaces, post sintering operations, applications of P/M parts. **(7)**

INTRODUCTION TO NANOMATERIALS

Nano structured materials, low-dimensional structures: quantum wells, quantum wires, and quantum dots, Nano clusters & Nanocrystals, electronic and optical properties of Nano crystallites, metallic and semiconducting superlattices, synthesis of nanostructured materials, fabrication and characterization of Nano electronic devices and MEMS, basics of synthesis and

characterization of Nano-multi-component systems for sensors (magnetic, electronic and optical) and electrodes, synthesis and fabrication of carbon Nano structures for fuel cell and energy storage applications. **(8)**

TOTAL : 45

TEXT BOOKS

1. *Mikell P. Groover, "Fundamentals of Modern Manufacturing Materials, Processes and Systems", 4th Edition, John Wiley & sons, Inc. 2015.*
2. *Ajayan P. M., Schadler L. S., & Braun P. V, "Nano composite Science and Technology", John Wiley & Sons, Inc., 2014.*

REFERENCES

1. *Charles A. Harper, "Modern Plastics Handbook", McGraw-Hill, 2010.*
2. *Sperling L.H., "Introduction to Physical Polymer Science", 3rd Edition, John Wiley & Sons, 2011.*
3. *Chawla K.K., "Ceramic matrix composites", 1st Edition, Chapman & Hall, 2013.*
4. *Randall M German, "A-Z of Powder Metallurgy (Metal Powders Technology)", Elsevier Science, 2007.*
5. *Upadhyaya G. S., "Powder Metallurgy Technology", Cambridge International Science Publishing, 2002.*

19MEOE04 - INDUSTRIAL ROBOTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : Examine the configuration of a robot and suggest a robot for a particular operation (pick and place, welding, vision, climbing etc.).

CO2 : Calculate the position, velocity and acceleration for a robot manipulator and solve the forward and inverse kinematics.

CO3 : Calculate mass and inertia for the links of a robot manipulator and also find its forward and inverse dynamics.

CO4 : Choose an appropriate vision system for the robot and then extract these images to get the desired output.

CO5 : Write a program to determine path for obstacle avoidance for a specific task and can solve using matrix laboratory software.

INTRODUCTION

Brief history of robots, robot definitions, today's practical importance of robot applications, challenges faced by robots in industrial situations, future scope of robotics. **(3)**

GENERAL CONSIDERATION OF ROBOTIC MANIPULATORS

Introduction - Brief history of robotics- Robot geometrical configurations - wrist and gripper subassemblies - robot drive systems - robot software. **(5)**

KINEMATICS OF ROBOT MANIPULATORS

Homogeneous representation of objects, robot manipulator joint coordinate system, Euler angles and Euler transformations, Denavit- Hartenburg (D-H) representations, direct kinematics in robotics, inverse kinematic solutions, geometrical approach in inverse Kinematics, Jacobian of transformation in robotic manipulation. **(12)**

ROBOT WORKSPACE AND MOTION TRAJECTORY DESIGN

General Structure of robotic workspaces, robotic workspace performance index, extreme reach of robotic hands, robotic task description, robotic motion, trajectory design, general design considerations on trajectories, 4-3-4 trajectory, 3-5-3 trajectory, simulation of robotic workspaces. **(8)**

MOTION CONTROL OF ROBOTIC MANIPULATORS

General arm control system - open and closed loop control systems error controlled robotic dynamics - control structure of amplifier- control of a single axis robotic arm, common control systems for industrial robots, force control of robotic manipulators. **(9)**

ROBOT SENSING AND ROBOT VISION SYSTEM

Desirable features of sensor- range sensors - proximity sensors - tactile sensors-force sensors, torque sensing detectors - TV cameras - illumination techniques - fundamentals of image processing visual data acquisition - image enhancement - image segmentation - image extraction and recognition- object and model matching - image extraction. Typical vision systems, robot programming languages - characteristics of robot- level languages - characteristics of task level languages, simulation languages. **(8)**

TOTAL : 45

TEXT BOOK

1. *Fu.K S, Gonzales .R.C., & Lee.C.S.G., "Robotic Control, Sensing, Vision and Intelligence", McGraw Hill International, 2006.*
2. *Ashitava Ghushal "Robotics : Fundamental Concepts and Analysis", Oxford, 2006.*

REFERENCES

1. *Mikell.P.Groover, Mitchell Weiss, Tooger. N. Nager, & Nicholas G. Odrey, "Industrial Robotics Technology, Programming and Applications", McGraw Hill International, 2004.*
2. *Richard. D. Klafter, Thomas. A. Chmielewski, & Michaelnegin, "Robotic Engineering - An Integral Approach", Prentice Hall of India, 2002.*
3. *https://nptel.ac.in/courses/112/105/112105249/*

19MEOE05 - BUSINESS PROCESS REENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : Gain knowledge about BPR, Factors affecting BPR operations and design BPR techniques.

CO2 : Use BPR tools, utilize concepts of BPR, analyse cost / Benefit and appreciate the need of IT in BPR.

CO3 : Incorporate changes in the business operation based on market demand and implement the same in the manufacturing system.

CO4 : Select an appropriate practice of the business re-engineering project by taking the practical situations into consideration.

CO5 : Provide the most feasible practical solution to the problem keeping in mind the considerations of business automation, value, processes and risks in launching the business reengineering project.

INTRODUCTION TO BPR

Definition; the paradigm shifts in production; the need for BPR, advantages and benefits of BPR, constraining factors, challenges, the positioning concept; the re-engineering visions; The BPR Life Cycle Methodology, Guidelines for BPR steps, Role of Information Technology in BPR; process Improvement and Process Redesign; BPR Experience in Indian Industry. **(9)**

METHODOLOGIES AND TOOLS FOR BPR

Process management; dynamic business re-engineering change framework; steps to reengineer the process. Tools used in Modelling the Business: flow-charting, business activity maps, relational diagrams, benefit/cost analysis. The enabling role of information technology in business re-engineering. Conceptual Foundation of Business Process Re-engineering; Process Identification and Mapping; Role/Activity Diagrams. **(9)**

CHANGE MANAGEMENT

Planned changes in business re-engineering projects; challenges of business change; business change development. Success factors in re-engineering. The assessment of business re-engineering. Process Visioning and Benchmarking. Business process Improvement, Business Process Redesign; Man Management for BPR implementation; Re-organizing People and Managing Change. **(9)**

GOVERNANCE & BPR

Total Quality Management, Risk Management, Organizational Structures, BPR Project Management, The Power of Habit in organizations. The role of eLearning environments. Applications, gaming, BPR facilitation, BPR in Software Development, Basic principles, Relation to BPR. **(9)**

BEST PRACTICES IN BPR

Research & Practice, Perspectives in BPR, Discussion on research challenges, and practice challenges for industry and governments Case studies: Nissan, Chrysler, Hewlett Packard etc. Workflow systems, Imaging technology, Floware, Business design facility tools, Risk and impact measurement. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Davenport, "Process Innovation: Reengineering work through information technology". Harvard Business School Press, 1993.*
2. *Hammer & Champy, "Reengineering the Corporation: A Manifesto for Business Revolution" Harper Business Books, 1993.*

3. *Hammer & Stanton, "The Reengineering Revolution" Harper Collins. London, 1995.*
4. *Henry J Johansson, Patrick McHugh, John Pendlebury & William A. Wheeler, "Business Process Reengineering: Break Point Strategies for Market Dominance", Wiley, New Delhi, 1993.*

REFERENCES

1. *Harmon, P, "Business Process Change: A Guide for Business Managers and BPM and Six Sigma Professionals", Elsevier/ Morgan Kaufmann Publishers, 2007.*
2. *R. Anupindi et al., "Managing Business Process Flows: Principles of Operations Management", Pearson Education Inc, 2006.*
3. *Kock, N.F., "Process Improvement and Organizational Learning: The Role of Collaboration Technologies", Idea Group, 1999.*
5. *Walford, R.B., "Business Process Implementation for IT Professionals and Managers" Artech Business Process Reengineering" Prentice Hall, New Delhi, 1993.*

19MEOE06 - ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

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

CO1 : Analyze the demand and supply and sketch a demand and supply curve.

CO2 : Determine the Breakeven point and find out the strength and weakness of the Market Structure.

CO3 : Sketch the curve for cost behavior for the short run concept.

CO4 : Analyze and specify the causes and provide the solution to each cause.

CO5 : Formulate the steps involved in a recruitment process as a chart and interpret it.

INTRODUCTION

Definition -Nature and Scope-Significance of Economics for Engineers. **(5)**

BASICS OF MICRO ECONOMICS

Demand Analysis and Supply Analysis - Elasticity of Demand and Supply - Case Study in Demand Forecasting - Cost concepts - Classifications - Short run and Long run cost curves - Break-even Analysis. **(8)**

MARKET STRUCTURE

Classification of Market - Perfect Competition-Characteristics -Monopoly - Monopolistic Competition - Oligopoly and Duopoly - Price Discrimination under different markets - Price and output determination in short run and long run. **(8)**

MONEY AND BANKING

Money - Quantity theory of Money -Supply of Money - RBI Measures of Money Supply - Banking - Functions of Commercial Banks and Central Banks- Balance of Payments - Meaning and methods of Exchange control Methods of Foreign Payments - IMF, IBRD, WTO- Agreements of WTO and its Impact on Indian Economy. **(9)**

NATIONAL INCOME

Meaning - National Income - Concepts -Methods of Calculating and Problems in calculating National Income - Inflation - Causes - Measures -Deflation - Stagflation - Phillips Curve - Unemployment New Environment Policy- Liberalisation -Privatisation - Globalisation. **(8)**

HUMAN RESOURCE MANAGEMENT

Principles of Management, Evolution of Management, Development of Managerial Skills- Human Resource Management- Importance- Objectives- Job Analysis- Recruitment- Selection and Placement and Training Development. **(7)**

TOTAL : 45

TEXT BOOKS

1. *Dewett. K. K., & Navalur M.H., "Modern Economic Theory", S. Chand and Company Ltd, New Delhi, 2014*
2. *Lipsey & Chrystal, "Economics", Oxford University Press, 2010*
3. *V. S. Bagad, "Principles of Management", Technical Publication, Pune*

REFERENCES

1. *Paul A Samuelson & William, "Economics", Tata McGraw Hill, New Delhi, 2012.*
2. *Francis Cheriunullem, "International Economics", McGraw Hill Education, 2011.*
3. *William A McEachern & Smrit Kaur, "Micro Economics", Cengage Learning, 2013.*
4. *William A McEachern & Indira A., "Macro Economics", Cengage Learning, 2014.*
5. *Lipsey & Chrystal, "Economics", Oxford University Press, 2010.*
6. *https://nptel.ac.in/courses/112/107/112107209/*

19EEOE01 - ENERGY AUDITING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Exhibit Conceptual knowledge of the technology, economics and regulation related issues associated with energy conservation and energy auditing

CO2 : Compute the thermal efficiency of various thermal utilities and use the energy audit methods learnt to identify the areas deserving tighter control to save energy expenditure.

CO3 : Analyse the cost- benefit of various investment alternatives for meeting the energy needs of productive processes through energy conservation study.

CO4 : Illustrate the energy saving techniques to reduce power consumption of the non- productive loads

CO5 : Advocacy of strategic and policy recommendations on energy conservation and energy auditing.

ENERGY AUDIT

Global energy scenario - Heat and Electrical energy - Role of energy managers in industries - Energy auditing -Types of energy audit- Data to be collected in auditing - Needs, methodology and types of energy audits - Simple payback period - Net present value of saving- Energy audit report **(9)**

ELECTRICAL ENERGY CONSERVATION

Basic Industrial electrical distribution- energy saving and energy efficiency with Transformers, reactive power correction and cable loss reduction- Energy saving in lighting systems -Specific Energy Consumption (SEC) - Load management - Demand Side Management (DSM). **(9)**

HEAT ENERGY CONSERVATION

Energy Audit - Losses in Boiler - Waste heat recovery - Sources of waste heat - High temperature heat recovery - Medium temperature heat recovery - Waste heat recovery applications- Cogeneration- Heating, ventilation and air conditioning systems (HVAC) :Types - energy conservation in cooling towers and Spray ponds. **(9)**

BUILDING, TRANSPORT AND UTILITY ENERGY CONSERVATION

Real buildings systems: Consumption - Cost versus lifecycle cost - Building design - Water supply systems Real Transportation Systems: Energy conservation in transportation - New technologies - Progress in clean diesel technology. Energy conservation inpumps, and fan and blowers - Energy efficient motors. **(9)**

ENERGY AUDIT PLANNING AND MONITORING

Energy Action Planning: Energy management system - Management commitment and Energy conservation policy - Energy performance assessment - Data collection and management - Analysis of data, baseline and benchmarking - Estimation of energy savings potential - Action planning and Training planning.

Monitoring and Targeting: Defining monitoring & targeting, Elements of monitoring & targeting - Data and information, various techniques - Energy consumption, Production and Cumulative sum of differences (CUSUM). **(9)**

TOTAL : 45

TEXT BOOKS

1. *D. P. Sen Gupta, K. R. Padiyar, IndranilSen, M.A, "Recent Advances in Control and Management of Energy Systems", Interline Publishers, Bangalore, 1993.*

2. *AmlanChakrabarti, "Energy Engineering and Management", PHI Learning, New Delhi 2012.*
3. *YP.Abbi and Shashank Jain, "Handbook on Energy Audit and Environment Management", TERI, 2006.*
4. *Frank Krieth and D Yogi Goswami, "Energy Management and Conservation Handbook", CRC Press, 2007.*
5. *C.B. Smith, "Energy Management Principles", Pergamon Press, New York, 1981.*

REFERENCES

1. *"General Aspects of Energy Management and Energy Audit-Unit- 1,2,3,4", BEE Guide book, 2010.*
2. *Hamies, "Energy Auditing and Conservation: Methods, Measurements, Management & case study", Hemisphere, Washington, 1980.*
3. *Diamant R.M, "Total Energy", Pergamon Press, Oxford Press, 1970.*
4. *Albert Thumann, "Fundamentals of Energy Engineering", Prentice Hall, May 1984*
5. *Larry C Whit et.al, "Industrial Energy Management & Utilization", 1st Edition, Springer, 1988.*

19EEOE02 - SOLAR AND WIND ENERGY SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Summarize the solar radiation, measurements and characteristics of solar PV cell.

CO2 : Develop the model of a PV system and its applications.

CO3 : Illustrate the basic types, mechanical characteristics and model of wind turbine.

CO4 : Analyse the electrical characteristics and operation of various wind-driven electrical generators.

CO5 : Utilize various power electronic converters used for hybrid system.

SOLAR RADIATION AND SOLAR CELL FUNDAMENTALS

Basic characteristics of sunlight - solar spectrum - insolation specifics- irradiance and irradiation pyranometer - solar energy statistics- Solar PV cell - I-V characteristics -P-V characteristics- fill factor. Modeling of solar cell- maximum power point tracking. **(9)**

SPV SYSTEM PERFORMANCE AND APPLICATIONS

PV module - blocking diode and by -pass diodes- composite characteristics of PV module - PV array - solar cell array design concepts - Peak power operation-System components. PV- powered fan-PV fan with battery backup - PV-powered pumping system - PV powered lighting systems - grid - connected PV systems. **(9)**

WIND ENERGY FUNDAMENTALS AND COMPONENTS

Wind source-wind statistics-energy in the wind- Basic principle of wind energy conversion - nature of wind - power in the wind -turbine power characteristics- parts of wind turbines- braking systems-tower-Maximum power operation. **(9)**

WIND TURBINE TYPES AND CONTROL

Classification of WECS - Generating Systems - DC generator, Synchronous generator, Induction -generator, Doubly fed Induction generator, Direct -driven generator- generator control - load control. **(9)**

SYSETM INTEGRATION

Energy storage-Power electronic converters for interfacing wind electric generators - power quality issues- Hybrid system: wind - diesel systems, wind-solar systems. **(9)**

TOTAL : 45

TEXT BOOKS

1. *S N Bhadra, S Banerjee and D Kastha, "Wind Electrical Systems", Oxford University Press, 1st Edition, 2005.*
2. *Chetan Singh Solanki, "Solar Photovoltaic's: Fundamentals,Technologies and Applications" PHI Learning Publications, 3rd Edition, 2015.*

REFERENCES

1. *Roger A. Messenger and Jerry Ventre, "Photovoltaic systems engineering", Taylor and Francis Group Publications, 2020.*

2. *M.Godoy Simoes and Felix A. Farret, "Alternative Energy Systems: Design and Analysis with Induction Generators", CRC press, 2nd Edition, 2008.*
3. *Ion Boldea, "The electric generators hand book - Variable speed generators", CRC press, 2015.*

19EEOE03 - ELECTRICAL SAFETY PROCEDURES AND MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Identify and analyze the precautions and protection of electrical hazards

CO2 : Select and use the suitable personal protective equipment according to the working environment

CO3 : Interpret the safety procedures for the specific work place

CO4 : Analyze and apply the various grounding techniques

CO5 : Infer the electrical safety against low voltage and high voltage and to manage the medical equipments

INTRODUCTION AND HAZARDS OF ELECTRICITY

Electrical Safety introduction : Hazard Analysis: Primary and secondary hazards - Arc, blast, shocks - Causes and effects - Summary of causes- Protection and precaution - Injury and death protective strategies - IE Rules 1956 - Basic rules for new installations: power system, Domestic and Industry (Qualitative treatment only) **(9)**

ELECTRICAL SAFETY EQUIPMENT

General inspection and testing procedure for electrical safety equipment - Electrical safety equipment for external protection: Flash and thermal protection - Head and eye protection - Insulation protection. Electrical safety equipment for internal protection: Over voltage, Short circuit, Earth Fault, Leakage current, High/ Low frequency - Single Line diagram of industrial power system with safety control - Electrician's Safety kit and materials. **(9)**

SAFETY PROCEDURES

Introduction - Six step safety method - Job briefings - Energized or De - energized - Safe switching of power systems - General energy control programs - Lockout - Tagout - Voltage measurement techniques - Placement of safety grounds - Flash hazard calculations and approach distances - Calculating the required level of arc protection (flash hazard calculations) - Barriers and warning signs - Tools and test equipment - Field marking of potential hazards - Shock avoidance techniques - One minute safety audit. **(9)**

GROUNDING AND ELECTRICAL MAINTENANCE

Need for electrical equipment grounding - System grounding - Equipment grounding - Types of Earthing - Earth testing for electrical equipment in Power house and Industry - Eight step maintenance program - Maintenance requirements for specific equipment and location - IEC and UL standard. **(9)**

VOLTAGE SAFETY SYNOPSIS AND MEDICAL SAFETY MANAGEMENT

Safety equipment and safety procedures for low voltage and high voltage system - Electrical safety around electronic circuits- Electrical safety for medical equipment like over current safety, Isolation, EMI and harmonics - Battery maintenance procedure- Stationary battery safety - Accident prevention - Accident investigation - First aid - Rescue techniques - Electrical safety program structure and development - Safety meetings - Safety audits. **(9)**

TOTAL : 45

TEXT BOOK

1. *John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel and Al Winfield, "Electrical Safety Handbook", 4th edition, Mc Grew Hill, 2012*

REFERENCE S

1 *Mohamed A El - Sharkawi, "Electric safety: Practice and Standards", CRC press, New York, 2013*

2. *Martha J. Boss and Gayle Nicoll, "Electrical Safety: systems, sustainability and stewardship", CRC press, New York, 2014*

3. *Ray A. Jones and Jane g. Jones, "The Electrical Safety Program Guide", National fire protection association, Quincy, 2011*

4. *Electrical Safety booklets issued by Government bodies*

19EEOE04 - ENERGY EFFICIENT ILLUMINATION SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Understand the properties of light, importance of lighting in various fields, types of light sources and methods of lighting.

CO2 : Perform the calculation of luminance parameters in various applications.

CO3 : Identify the criteria for selection of lighting equipment's and control systems in various applications.

CO4 : Impart design and technology for Interior lighting and Exterior lighting applications

CO5 : Review the various technologies used in Smart lighting systems.

INTRODUCTION : BASICS OF LIGHTING

Lighting Physics - Optical Radiation - Concept of Color - Biological Factors : Human eye and brain response - Different entities of illuminating systems. Properties of Lighting - Natural and Artificial lighting - Good and Bad Lighting - Challenges in Lighting - Good Practices in Lighting - Types of Lighting. **(7)**

LIGHTING CALCULATIONS AND LIGHT SOURCES

Basic Terms in Lighting System - Luminance measurement - Laws of Illumination - Polar Curves - Rousseau's construction - Concept of Photometry - Introduction of lighting software.

Lamps: Incandescent Lamps: Halogen lamps - Discharge Lamps: MV and SV Lamps, Fluorescent Lamps: FTL, CFL - Arc lamps - Special Lamps: LED: Surface Mounted Devices (SMD-LEDs), Chip on Board (COB-LEDs) - Neon lamps - Lasers - Comparison of Lamps - Life Cycle Cost (LCC) Analysis - Efficacy. **(12)**

LIGHTING EQUIPMENTS AND STANDARDS

Luminaries, Wiring, Control gears, Switching boards, Reflectors and Control circuits - Heating, Harmonics and EMI Suppression techniques from lighting equipment - Switching and Dimming control algorithm - Recommendation of Illumination Levels for Various Tasks / Activities / Locations - Role of 3D printing technology for designing luminaries - International Standards and codes of lighting system. **(9)**

LIGHTING APPLICATIONS

Interior lighting: Industrial, Residential, Indoor stadium and Hospitals. Exterior lighting: Flood, Street, Aviation and Transport lighting - Sign and display Board Lighting - Lighting in Agriculture - Lighting in Automobiles. **(8)**

SMART LIGHTING SYSTEMS

Intelligent lighting system - Smart LED lighting systems - LED Smart Projector system - Solar Street Lighting Systems - Role of IoT in lighting system - Concept of Light Fidelity (Li-Fi) - Significance of UV-C lighting in medical - Concept of Artificial Moon for street lighting. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Joseph B. Murdoch, "Illumination Engineering from Edison's Lamp to the Laser", Visions Communications, Washington DC, USA, 2nd Edition, 1994.*
2. *Jack L. Lindsey, "Applied Illumination Engineering", Prentice Hall of India, New Delhi, 3rd Edition, 2008*

3. *Leon Gaster, John Stewart Dow, "Modern Illuminants and Illuminating Engineering", Nabu Press, Washington DC, 1st Edition, 2010.*
4. *Philip Gordon., "Principles and Practices of Lighting Design: The Art of Lighting Composition", Blue Matrix Productions, 2011.*

REFERENCES

1. *Lighting Engineering: Practical Hand Book, INDALUX 2002*
2. *IES Lighting Handbook, 10th Edition, 2011.*
3. *NPTEL Course: Illumination Engineering*
4. *Lighting - Research paper reference from Philips - Lighting Academy and Signify Lighting University.*

19EEOE05 - ELECTRIC VEHICLE TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Apprehend the fundamentals and importance of electric vehicles and its components

CO2 : Select the suitable drive scheme based on the motor and topology for the given specification and applications

CO3 : Design and categorize the battery system for electric vehicles and hybrid electric vehicles

CO4 : Recognize the suitable battery charging scheme for different environments and applications.

CO5 : Describe the significance of E-mobility and its various business opportunities

ELECTRIC VEHICLES

An Overview of Conventional, Battery, Hybrid and Fuel Cell Electric Systems - Conventional IC Engine Vehicle - BEVs - HEVs - Series HEV - Parallel HEV - Series-Parallel HEV - FCEV - EV subsystems - Vehicle Dynamics: Vehicle Load Forces - Basic Power, Energy, and Speed Relationships - Aerodynamic Drag - Aerodynamic Drag and Fuel Consumption - Rolling Resistance - Gradability **(9)**

ELECTRIC PROPULSION

Electric Motors in EVs - Configuration and control of DC motor drives - Induction motor drives- Permanent Magnet motor drives - Switched reluctance motor drives - Transmission configuration, Components - gears, differential, clutch, brakes - regenerative braking - types - Motor sizing.- Matching the electric machine and the internal - combustion engine (ICE), Sizing the propulsion motor, sizing the power - electronics, selecting the energy storage technology, Communications- supporting subsystems **(9)**

BATTERIES

Introduction to Batteries - Energy Storage Requirements in Electric Vehicles: Batteries Types: Lead-Acid Battery - Nickel-Metal Hydride - Lithium-Ion - Battery Operation - Battery Parameters and Comparisons - Battery Packs - Battery Sizing - Battery based energy storage and its analysis - Fuel Cells - Fuel Cell based energy storage and its analysis - Super capacitors- Hybridization of different energy storage devices **(9)**

BATTERY CHARGING

Charging methods for battery- Fast charging - Battery Charging, Protection, and Management System - Termination methods - Charging from grid - Isolated and Non-isolated DC - DC Converters - Bidirectional DC-DC converter - High-frequency transformer based isolatedcharger topology - Transformer less topologies. **(9)**

E-MOBILITY

Energy Management Strategies - Automotive networking and communication, EV and EV charging standards, V2G, G2V, V2B, V2H - E-mobility business - Electrification challenges - Connected Mobility and Autonomous Mobility- Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV). **(9)**

TOTAL : 45

TEXT BOOKS

1. *Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, 2nd Edition CRC Press, 2018.*
2. *Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 3rd Edition, CRC Press, 2021*

REFERENCES

1. *James Larminie, John Lowry, Electric Vehicle Technology Explained, 2nd edition, Wiley, 2012*
2. *Soylu "Electric Vehicles - The Benefits and Barriers", InTech Publishers, Croatia, 2011.*
3. *J.M. Miller, "Propulsion Systems for Hybrid Vehicles", Institution of Electrical Engineers (IEE), 2nd edition, London, UK, 2010.*
4. *R. Stone and J.K. Bell, "Automotive Engineering Fundamentals", SAE International, Warrendale, PA, 2004.*
5. *Viswanathan B. and Scibioh Aulice M, "Fuel cells: Principles and Applications", University Press, 2008.*

19EEOE06 - ENERGY EFFICIENCY IN THERMAL AND ELECTRICAL UTILITIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Preaudit the energy

CO2 : Analyse the possibility of energy savings

CO3 : Analyze the methods of energy savings

CO4 : Design the solutions

CO5 : Identify and perform appropriate energy management

ENERGY EFFICIENCY IN THERMAL UTILITIES - I

- Fuels and Combustion: Introduction to fuels, properties of fuel oil, coal and gas, storage, handling and preparation of fuels, principles of combustion, combustion of oil, coal, and gas.
- Boilers: Types, combustion in boilers, performance evaluation, analysis of losses, feedwater treatment, blowdown, energy conservation opportunities..
- Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.
- Insulation and Refractories: Insulation-types and application, the economic thickness of insulation, heat savings and application criteria, Refractory-types, selection and application of refractories, heat loss.
- FBC boilers: Introduction, mechanism of fluidized bed combustion, advantages, types of FBC boilers, operational features, Retrofitting FBC system to conventional boilers, saving potential. **(9)**

ENERGY EFFICIENCY IN THERMAL UTILITIES - II

- Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate, and flash steam recovery system, identifying opportunities for energy savings
- Cogeneration: Definition, need, application, advantages, classification and saving potentials.
- Waste Heat Recovery: Classification, advantages, and applications, commercially viable waste heat recovery devices, saving potential.
- Energy Management & Audit: Definition, need and types of an energy audit. Energy management (audit) approach-understanding energy costs, benchmarking, energy performance, matching energy use to the requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.
- Material and Energy balance: Facility as an energy system, methods for preparing process flow, material, and energy balance diagrams. **(9)**

ENERGY EFFICIENCY IN ELECTRICAL UTILITIES

- Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses.
- Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy-saving opportunities with energy- efficient motors.

- Energy-Efficient Technologies in Electrical Systems: Maximum demand controllers, automatic power factor controllers, energy-efficient motors, soft starters with energy savers, variable speed drives, energy-efficient transformers, electronic ballasts, occupancy sensors, energy-efficient lighting controls. **(9)**

ENERGY EFFICIENCY IN THERMO ELECTRIC UTILITIES - I

- Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities
- HVAC and Refrigeration System: Vapor compression refrigeration cycle, refrigerants, the coefficient of performance, capacity, and factors affecting Refrigeration and Air conditioning system performance and savings opportunities.
- Vapor absorption refrigeration system: Working principle, types and comparison with vapor compression system, saving potentially
- Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.
- Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. **(9)**

ENERGY EFFICIENCY IN THERMO ELECTRIC UTILITIES - II

- Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy-saving opportunities assessment of cooling towers.
- Lighting System: Light source, choice of lighting, luminance requirements, and energy conservation avenues.
- Diesel Generating system: Factors affecting the selection, energy performance assessment of diesel conservation avenues **(9)**

TOTAL : 45

ENERGY PERFORMANCE ASSESSMENT FOR EQUIPMENT AND UTILITY SYSTEMS

Open Book examination on the following energy performance assessments for equipment and utility systems:

- Boilers, Furnaces
- Cogeneration, Turbines (gas, steam)
- Heat Exchangers
- Electric Motors, Variable Speed Drives
- Fans and Blowers, Water Pumps, Compressors
- HVAC systems
- Lighting Systems
- Performing Financial Analysis.
- Applications of Non-conventional & Renewable Energy Sources (NRES)
- Waste minimization and resource conservation

TEXT BOOKS

1. *Mehmet Kanolu, Yunus A. Çengel, "Energy efficiency and management for engineers", McGraw- Hill Education, 2020*
2. *Stephen A. Roosa, Steve Doty, Wayne C. Turner, "Energy Management Handbook", 9th edition, River Publishers, Taylore and Francis Group, 2020*
3. *Energy Efficiency in Thermal Utilities, Bureau of Energy Efficiency (BEE), Guide books*
4. *Energy Efficiency in Electrical Utilities, Bureau of Energy Efficiency (BEE), Guide books*

REFERENCES

1. *Rajiv Shankar, "Energy Auditing in Electrical Utilities", Viva Books, 2017*
2. *Wayne C. Turner," Energy Management Handbook", Eighth Edition, 2012*
3. *Stephen A. Roosa, Steve Doty, "Energy Management Handbook", 2018*
4. *General Aspects of Energy Management and Energy Audit, Bureau of Energy Efficiency (BEE), Guide books*
5. *Energy Performance Assistance for Equipment and Utility Systems, Bureau of Energy Efficiency (BEE), Guide books*

19ECEOE01 - SIGNAL PROCESSING AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Compute the Discrete Fourier Transform (DFT) of a given discrete time sequence using Radix-2 Fast Fourier Transform algorithms and design FIR/IIR Filters

CO2 : Apply source coding procedure to calculate coding efficiency based on entropy & mutual information and outline different pulse analog modulation techniques

CO3 : Analyze various equalization techniques and compare its performance

CO4 : Calculate channel capacity using Shannon's channel capacity theorem and develop channel error control codes

CO5 : Analyze speech processing methods in time and frequency domain and design codec methods for speech compression techniques

ORTHOGONAL TRANSFORMS AND DIGITAL FILTER STRUCTURES

DFT-DCT-Properties of DFT- Computation of DFT, FFT and structures-Decimation in time-Decimation in frequency - Linear convolution using DFT

Basic FIR/IIR filter structures-FIR/IIR Cascaded lattice structures-Parallel allpass realization of IIR transfer functions- Sine cosine generator - Computational complexity of filter structures **(10)**

DATA COMPRESSION

Information entropy-Source coding-Huffman algorithm-Delta Modulation-Adaptive Delta Modulation- Continuously Variable Slope Delta Modulation-Differential Pulse Code Modulation - Adaptive Differential Pulse Code Modulation. **(8)**

SIGNAL PROCESSING IN COMMUNICATION RECEIVER

Temporal Equalization-Space Time Equalization-Frequency Domain Equalization-Symbol Timing Recovery- Channel Quality Estimation- Automatic Frequency Control-Overall Receiver Block. **(9)**

ERROR CORRECTING CODES & CHANNEL CODING

Error Correcting codes-Error Correction-Linear Blocks Codes-Cyclic Codes- Bose, Chaudhari and Hocquenghem Codes-Convolution Codes-Viterbi Decoding-Interleaving Codes-Concatenated Codes- Turbo Codes. **(9)**

SPEECH CODING

Speech Coding-Adaptive Predictive Coding-Sub Band Coding,-Vocoders-Liner Predictive Coding- Image Coding-Joint Photo Graphic Expert Group (JPEG)-Moving Pictures Expert Group (MPEG), the layer-3 of MPEG-1 Algorithms(MP3),Lempel- ZIV Algorithms - Recognition techniques:Speech Recognition and Image recognition. **(9)**

TOTAL : 45

TEXT BOOKS

1. *V. Oppenheim, R. W. Shafer and J.R.Buck, "Discrete-Time Signal Processing", Pearson Education, 3rd Edition, 2011.*
2. *Simon Haykin, "Digital Communications Systems", 1st Edition, Wiley, 2013.*

REFERENCES

1. *Sanjit. K. Mitra and Sanjit Kumar Mitra, "Digital Signal Processing - A computer based approach", Tata McGraw Hill, 4th Edition, 2011.*
2. *Todd K Moon, "Error Correction Coding - Mathematical methods and Algorithms", John Wiley & Sons, 2005.*
3. *Roberto Togneri, Christopher J.S DeSilva, "Fundamentals of Information Theory and Coding Design", CRC press, 2003*
4. *L.R.Rabiner and R.W.Schaffer "Digital Processing of Speech signals" Prentice Hall 1978*
5. *Nirmal K. Bose, Calyampudi Radhakrishna Rao, "Signal Processing and Its Applications" North-Holland, 1993*

19ECEOE02 - SMART SENSORS AND IoT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Explain the classification ,types,packaging and testing of smart sensors

CO2 : Interpret the construction and working principles of Electronic sensors

CO3 : Exemplify the working of different types of light radiation sensors .

CO4 : Illustrate the key concepts of temperature ,gas and airquality sensors used to measure the parameters.

CO5 : Interpret the characteristics, functional blocks and architecture of IoT to develop an IoT based applications.

SMART SENSORS BASICS

Sensor Classification, Performance and Types, Error Analysis characteristics- Semiconductor Packaging- Hybrid Packaging- Packaging for Monolithic Sensors- Reliability Implications-Testing Smart Sensors- HVAC Sensor Chip- Amplification and Signal Conditioning- Integrated Signal Conditioning- Digital conversion- MCU Control-MCUs for Sensor Interface- Techniques and System Considerations- Sensor Integration. **(9)**

ELECTRONIC SENSORS

Resistance strain gauge - piezoelectric pressure gauge - characteristics- load cells-torque sensor- Piezo-resistive and capacitive pressure sensor- optoelectronic pressure sensors- vacuum sensors- Capacitor plate sensor, Inductive sensors, LVDT- Hall effect- Doppler detectors- liquid level detectors, flow sensors - ultrasonic sensor- flow sensors. **(9)**

GHT RADIATION SENSORS

Electronic and Optical properties of semiconductor as sensors - LED - Semiconductor lasers- Fiber optic sensors- Thermal detectors - Photo multipliers- photoconductive detectors- Photo diodes- Avalanche photodiodes - CCDs - Intensity sensor - Interferometers-Phase sensor: Phase detection, Polarization maintaining fibers. **(9)**

TEMPERATURE, GAS AND AIR QUALITY SENSORS

Bimetallic strip- Bourdon temperature gauge- thermocouples- Resistance thermometers- thermistors- bolometer- Pyroelectric detector-Engine combustion process- Catalytic exhaust after treatment, Emission limits- Exhaust sensors and Engine control - Exhaust sensors for OBD- Hydro-Carbon Sensors- NOx-Sensors-Oxygen Sensors- Measurement of oxides of sulphur,oxides of nitrogen unburnt hydrocarbons, carbonmonoxide, dust mist and fog- smoke sensors. **(9)**

IoT AND ITS APPLICATIONS

IoT Definition - Characteristics - IoT Functional Blocks -IoT Architecture -Physical design of IoT - Logical design of IoT- Sensing & Actuation -Basics of Networking - Communication Protocols- Machine-to-Machine - Communication models & APIs.

Domain specific applications of IoT: Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture, Smart Traffic Control and Smart water management. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Jacob Fraden," Handbook of modern sensors: physics, designs, and applications", 5th Edition, Springer, 2016.*
2. *Randy Frank, "Understanding Smart Sensors", Artech House, 2nd Edition, Boston, 2011.*

REFERENCES

1. *Arshdeep Bahga, Vijay Madisetti, "Internet of Things - A hands-on approach", Universities Press, 2015.*
2. *Jon. S. Wilson, "Sensor Technology Hand Book", Elsevier, 1st Edition, Netherland, 2011.*
3. *John G Webster, "Measurement, Instrumentation and sensor Handbook", CRC Press, 2nd Edition, Florida, 2017.*
4. *John P. Bentley," Principles of Measurement systems", 3rd Edition, Pearson Education Asia Pvt. Ltd, 2009.*
5. *D. Patranabis," Sensors and Transducers", 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2006.*
6. *Ernest O Doebelin, Dhanesh N Manik, "Measurement Systems, Application and Design", McGraw Hill, 6th Edition, 2007.*

19ECEOE03 - CONSUMER ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Understand the various types of microphones and loudspeaker.

CO2 : Explain the principle and working of Monochrome TV.

CO3 : Describe the Colour TV scanning process and camera tube.

CO4 : Illustrate LCD, LED TV, working of cable TV and DTH.

CO5 : Interpret the significant technical considerations using a broad systems perspective.

AUDIO SYSTEMS

Microphones Carbon, moving coil, wireless microphone; Loudspeakers - Direct radiating Electrostatic and horn loudspeaker; Multi-speaker system; Sound Recording - Magnetic Recording, Digital Recording, Optical Recording (CD system and DVD). **(9)**

MONOCHROME TV

Elements of TV communication system, Scanning process, Scanning methods and Aspect Ratio, Need of synchronizing and blanking pulses, Composite Video Signal, Camera Tube: Vidicon. **(9)**

COLOUR TELEVISION

Primary, secondary colours, Concept of Mixing, Colour Triangle, Camera tube, PAL TV Receiver, Concept of Compatibility with Monochrome Receiver, NTSC, PAL, SECAM. **(9)**

LCD AND LED TELEVISION

Basic principle and working of LCD & LED TV, Cable Television: Working of Cable TV, DTH **(9)**

DOMESTIC & CONSUMER APPLIANCES

Operation of Microwave Oven, Automatic Washing Machine, Photostat Machine, Digital Camera, Vacuum cleaner, Food Processors, Scanner. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Bali S.P., "Consumer Electronics" Pearson Education, 2017.*
2. *Bali R and Bali S.P. "Audio video systems: principle practices & troubleshooting", Khanna Book Publishing Co. (P) Ltd., 2010.*

REFERENCES

1. *Gulati R.R., "Modern Television practices" New Age International Publication (P) Ltd.2011.*
2. *Gupta R.G, "Audio video systems" Tata Mc graw Hill, 2nd Edition, 2010.*
3. *Whitaker Jerry & Benson Blair, "Standard Handbook of Audio engineering" McGraw-Hill Professional, 3rd Edition, 2010.*
4. *Amit Dhir, "The Digital Consumer Technology Handbook", Elsevier Science, 2004.*

19ECEOE04 - ROBOTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

Upon completion of this course, students will be able to demonstrate an ability to

CO1 : Describe the concepts of robotics, safety measures and homogeneous transformation.

CO2 : Formulate the concepts of mechanical drives and sensors in robotics.

CO3 : Describe the types of sensors and Robotic Vision

CO4 : Develop robotics programming, classifications and its applications.

CO5 : Exemplify the concepts of artificial intelligence.

ROBOT KINEMATICS

Introduction - Robotics and programmable automation - Historical background - Laws of Robotics - Robot definitions - Robotics system and Robot anatomy - Specifications of Robots - Safety measures in Robotics. **(10)**

ROBOTIC DRIVERS AND CONTROLS

Robot drives, actuators and control - Functions of drive systems - General types of fluids - Pump classification - Pneumatic systems - Electrical drives - DC motors - Stepper motors - Drive mechanism. **(9)**

SENSORS AND MACHINE VISION

Need for sensing systems- Principles and Applications of the following types of sensors- Position and displacement sensors - Potentiometers, Encoders, Linear Variable Differential Transformer, Force and Torque sensors- Wrist sensor, Joint sensor, Tactile array sensor, Slip sensors- Proximity sensors- Range finders- Imaging sensors- Inductive Proximity switch- Acoustic sensors- Opto-electronic sensors- Lighting Techniques, Robot Vision- Sensing and Digitizing, Image Processing and analysis- Preprocessing, Segmentation, Description, Recognition, Interpretation and Applications of robot vision system **(9)**

ROBOTIC LANGUAGE AND PROGRAMMING

Robot language and programming. Robot language - Classification of Robot languages - Computer control and robot software - VAL system and language. Applications of Robots: Capabilities of Robots - Robotics applications - Obstacle avoidance. **(8)**

ARTIFICIAL INTELLIGENCE IN ROBOTICS

The history of Artificial Intelligence- Artificial and Natural Intelligence- Artificial Intelligence and Automated manufacturing- The application domains of Artificial Algorithms- Risks and Benefits of AI- Agents and Environments- Knowledge representation. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Satya Ranjan Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill, 2nd Edition, 2012.*
2. *Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Pearson Education, 2014.*

REFERENCES

1. *Robin.R.Murphy, "Introduction to AI Robotics", The MIT Press, Canbridge, Massachusetts, London, England, Second Edition, 2019.*
2. *Jadran Lenarcic, Jean-Pierre Merlet, "Advances in Robot Kinematics 2016", Springer International Publishing AG, 2018.*

3. *Peter McKinnon, "Robotics", CreateSpace Independent Publishing Platform, 2016.*
4. *Ritu Tiwari, Anupam Shukla, Rahul Kala, "Intelligent Planning for Mobile Robotics: Algorithmic Approaches", Information science reference, United states of America, 2013.*
5. *David. L. Pool and Alan. K. Mackworth, "Artificial Intelligence: Foundations of Computational agents", Cambridge University, 2011.*

19ECEOE05 - INFORMATION THEORY AND CODING TECHNIQUES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Explain the information content in a discrete memoryless source through parameters such as entropy and mutual information.

CO2 : Estimate a channel's capacity based on Shannon's channel capacity theorem

CO3 : Analyze various channel encoding and decoding methods

CO4 : Design and develop an error control coding methods for random error and burst error detection and correction techniques

CO5 : Understand different applications in coding techniques

INFORMATION THEORY AND SCHEMES FOR SOURCE CODING

Uncertainty Information and Entropy - Basic Properties of entropy - Information rate - Conditional entropy - Joint Entropy - Mutual Information - Channel capacity of a Gaussian channel

SOURCE CODING : Prefix codes - Necessary conditions for source coding - Kraft Mcmillan Inequality- Huffman Coding- Shannon Fano Coding Efficiency calculations. **(9)**

MEMORYLESS FINITE SCHEMES FOR CHANNEL CODING

Discrete Memoryless Channel - Channel models - BSC and BEC channels - Cascaded channels - Channel capacity of discrete and analog channels - Channel capacity of a Gaussian channel-Bandwidth-S/N trade-off-Channel coding theorem - Information capacity theorem - Code rate and redundancy-Parity check codes - Rate Distortion Theory. **(9)**

LINEAR BLOCK CODES AND CYCLIC CODES

Rationale for coding - Types of codes - Matrix description of linear block codes - Syndrome decoding - Minimum distance considerations -Repetition codes - Dual codes- Cyclic codes :Generator polynomial - Parity check polynomial - Encoder of cyclic codes - Calculation of syndrome - Cyclic codes for error correction. **(10)**

CONVOLUTIONAL CODES

Convolutional codes : Tree codes- Trellis codes- Viterbi decoding of convolutional codes - Catastrophic Error Propagation in Convolutional Codes -Performance Bounds for Convolutional Codes - Coding Gain - Convolutional Code Trade off - Soft Decision Viterbi Decoding -Feedback Decoding - Sequential Decoding **(9)**

CODING TECHNIQUES IN DATA COMPRESSION

Static and Dynamic Huffman coding - Arithmetic coding - Run length encoding- Lempel-Ziv coding -Image compression techniques -JPEG standard for Lossy and Lossless compression- Video compression standards. **(8)**

TOTAL : 45

TEXT BOOKS

1. *Roberto Togneri, Christopher J.S DeSilva, "Fundamentals of Information Theory and Coding Design", CRC press, 2003.*
2. *Ranjan Bose, "Information Theory Coding and Cryptography", Tata McGraw Hill, 3rd Edition 2016.*

REFERENCES

1. *Richard B.Wells, "Applied Coding and Information Theory for Engineers", Pearson Education, 1st Edition Indian reprint, 2009.*
2. *Khalid Sayood, "Introduction to Data Compression", 4th Edition, Elsevier, 2012.*
3. *Bernard Sklar, "Digital Communications: Fundamentals and Applications", Pearson Education, 2nd Edition, 2009.*
4. *Thomas M. Cover and Joy A. Thomas, "Elements of Information Theory", John Wiley & Sons, 2nd Edition, 2006.*
5. *Reza F M, "An Introduction to Information theory", McGraw Hill, 2000.*
6. *Todd K Moon, "Error Correction Coding - Mathematical methods and Algorithms", John Wiley & Sons, 1st Edition, 2021.*

19ECEOE06 - WIRELESS SENSOR NETWORKS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Outline the challenges & issues in the wireless sensor network and its subsystems and interpret network architecture and its components

CO2 : Describe the essential principles of the MAC protocols for Wireless Sensor Networks

CO3 : Elucidate the Routing & localization tracking inWireless Sensor Networks

CO4 : Discuss the features of WSN Operating systems

CO5 : Illustrate the methodologies to provide WSN based solution for various critical issues.

SENSOR NETWORKS - INTRODUCTION & ARCHITECTURES

Challenges for Wireless Sensor Networks-Enabling Technologies for Wireless Sensor Networks- Characteristic requirements for WSN - WSN architecture - Commercially available sensor nodes -Imote, IRIS, Sunspot -Physical layer and transceiver design considerations in WSNs-Single Node Architecture -Energy Consumption of Sensor Nodes- Sensor Network Scenarios- Optimization Goals and Figures of Merit. **(9)**

DATA LINK LAYER

Fundamentals of MAC protocols- Issues in designing a MAC Protocol for WSN - Low duty cycle protocols and wakeup concepts - Contention based protocols:PAMAS - Schedule-based protocols:LEACH - Sensor MAC - Berkeley MAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4- Link Layer protocols - fundamentals task and requirements, error control, framing, link management, Address and Name Management, Assignment of MAC Addresses, Unique,Content-based and geographical addressing. **(10)**

ROUTING AND TRACKING

Routing Challenges and Design Issues in Wireless Sensor Networks- Taxonomy :Data-centric routing SPIN - Energy aware routing, Gradient-based routing -Hierarchical Routing LEACH -Location Based Routing GAF, Data aggregation - Various aggregation techniques

A Tracking Scenario - Problem formulation - Distributed representation and inference of states- Tracking multiple objects - Sensor models - Topology control - Clustering - Time synchronization - Localization and Localization Services **(10)**

EMBEDDED OPERATING SYSTEMS FOR WSNs

Embedded Operating Systems: Operating Systems for WSNs - Introduction - Operating System Design Issues- Introduction to Tiny OS - NesC - Interfaces and Modules- Configurations and Wiring - Generic Components -Programming in Tiny OS using NesC, Emulator TOSSIM. **(7)**

APPLICATIONS OF WSN

WSN Applications - Home Control - Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications - Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling **(9)**

TOTAL : 45

TEXT BOOKS

1. *Kazem Sohraby, Daniel Minoli and Taieb Znati, " Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, First Edition, 2007.*
2. *Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.*

REFERENCES

1. *Anna Hac, "Wireless Sensor Network Design", John Wiley & Sons, First Edition, 2003.*
2. *C.S.Raghavendra Krishna, M.Sivalingam and Taribznati, "Wireless Sensor Networks", Springer Publication, 2004.*
3. *Paolo Santi, "Topology Control in Wireless Adhoc and Sensor Networks", John Wiley & Sons, 2005.*
4. *Philip Levis, David Gay,"TinyOS Programming", Cambridge University Press, 2009 Contiki - Open Source Operating System for IoT - http://www.contiki-os.org/*

19ECEOE07 - AUTOMOTIVE EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Design modules for hybrid vehicle using automotive system components.

CO2 : Design control system in automotives by appropriate choice of Microcontrollers, Sensors and actuators.

CO3 : Examine the communication protocols for real time applications

CO4 : Understand the safety and comfort in Automobiles as per the government test procedures.

CO5 : Understand the communication and diagnostic protocols

AUTOMOTIVE SYSTEMS

Overview of Automotive industry - Tools and Processes - Introduction to modern automotive systems -Spark and Compression Ignition Engines - Automotive Transmissions - Vehicle braking fundamentals -Steering Control - Overview of Hybrid Vehicles - Analog and Digital Systems - Basic measurements systems. **(9)**

SENSORS AND ACTUATORS

Sensors: Characteristics, response and modeling - Actuators - Microcontroller and Digital Signal Processors used for automotive applications. **(9)**

EMBEDDED COMMUNICATION

Embedded Automotive Protocols: CAN, LIN, FLEXRAY, MOST **(9)**

SAFETY SYSTEMS

Active Safety Systems: ABS, TCS, ESP, brake assist - Passive Safety Systems: Airbag systems, Advance Driver Assistance system (ADAS) -Computer vision techniques - Connected cars technology - Trends towards Autonomous vehicles. **(9)**

FUNDAMENTALS OF DIAGNOSTICS

Basic wiring system and Multiplex wiring system, Self-Diagnostic system - various On board and off board diagnostics in Automobiles - Diagnostics tools - Diagnostics Protocols: KWP20000 and UDS. **(9)**

TOTAL : 45

TEXT BOOK

Ronald K Jurgen, "Automotive Electronics Hand Book", McGraw- Hill, 2nd Edition 1999.

REFERENCES

1. *William B. Ribbens, Ph.D, "Understanding Automotive Electronics", Elsevier Publications, 7th Edition, 2012.*
2. *Tom Denton, "Advance Automotive Diagnosis", 2nd Edition, Elsevier 2006.*
3. *BOSCH Automotive Handbook, 8th Edition.*
4. *Denton. T, "Automobile Electrical and Electronics Systems", SAE (Society for Automobile Engineers) International, 3rd Edition, 2004.*
5. *Jack Erjavec, "Automotive Technology: A Systems Approach", Delmar Cengage Learning, 5th Edition, 2009.*

19ECEOE08 - 5G TECHNOLOGIES AND APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : describe the evolution of cellular systems from 2G to 4G

CO2 : explain the motivation, targets of 5G technology and its standardization

CO3 : elaborate the 3GPP releases and 5G radio access network architecture

CO4 : discuss the services offered by 5G deployment and its design approaches

CO5 : understand the role between 5G and emerging next generation wireless technologies

EVOLUTION OF CELLULAR SYSTEMS

Evolution from 2G to 3G and 3G to 4G - Circuit Switch to Packet Switch - ITU Standardization Process- - Evolution of LTE and releases. **(9)**

INTRODUCTION TO 5G

Motivation for 5G - 5G targets - Technology components - Spectrum - capabilities - The role of 3GPP in standardization - use cases - 5GPPP (Public-Private Partnership) **(9)**

5G RADIO ACCESS NETWORK

Radio access - 3GPP Releases - 5G New Radio (NR) - Requirements - 3GPP phases for IMT-2020 - NR air interface - 5G RAN architecture **(9)**

5G SERVICES

Enhanced Mobile Broadband (eMBB) systems - Massive Machine Type Communication (MMTC) system - Ultra Reliable and Low Latency Communication (URLLC) systems - Design approaches **(9)**

EMERGING TECHNOLOGIES IN 5G

Massive MIMO - Network Function Virtualization - Software Defined Networking - Cognitive radio -Millimetre Wave - Heterogeneous network - Internet of Things **(9)**

TOTAL : 45

TEXT BOOKS

1. *Saad Asif, "5G mobile Communications Concepts and Technologies", CRC Press,2018*
2. *Biljana Badic, Christian Drewes, Ingolf karls, Markus Mueck, "Rolling out 5G Use cases, Applications and Technology Solutions", Apress, 2016*

REFERENCES

1. *Antti Toskala, Harri Holma, Takehiro Nakamura, "5G Technology 3GPP New Radio", Wiley & Sons Ltd. 2020.*
2. *Devaki Chandramouli, Juho Pirskanen, Rainer Liebhart, "5G for the Connected World", Wiley,2019*
3. *Haesik Kim, "Design and Optimization for 5G Wireless Communications", Wiley, 2020*
4. *Ramjee Prasad, "5G Outlook Innovations and Applications", River Publications, 2016*
5. *Anwer Al-Dulaimi, "5G Networks Fundamental Requirements, Enabling Technologies, and Operations Management", Wiley, 2018*
6. *Mauro Boldi, Olav Queseth, Patrick Marsch, Ömer Bulakci, "5G System Design Architectural and Functional Considerations and Long Term Research", Wiley,2018*

19ECEOE09 - VEHICULAR COMMUNICATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Understand basic principles, technologies, and system architecture of vehicular ad-hoc networks (VANET)

CO2 : Analyze Physical Layer and MAC Layer for signal propagation for vehicular communication

CO3 : Describe the various routing mechanisms and protocols to fulfill vehicular networking requirements.

CO4 : Explain the challenges and issues in establishing cellular V2X connection and mobility management.

CO5 : outline vehicular communication platforms for various emerging applications

INTRODUCTION TO VEHICULAR RADIO NETWORKS

Basic principles and challenges-Mobile Wireless Communications and Networks-Need for Vehicular Communications-VANET activities- Network Architecture for Vehicular Communications. **(9)**

PHYSICAL LAYER AND MAC LAYER

Signal Propagation-Doppler spread and its impact on OFDM Systems-Proposed MAC approaches and standards, Intelligent Transportation Systems: IEEE 802.11p-ITS-IVC **(10)**

VANET ROUTING PROTOCOLS

Opportunistic packet forwarding-topology based routing- geographic routing **(8)**

VEHICULAR MOBILITY MANAGEMENT

Connected Vehicles& Connected Autonomous Vehicles- Dedicated Short Range Communication-flow and traffic models-Standards and Regulations- DSRC Protocol Stack, Cellular V2X **(9)**

EMERGING VANET APPLICATIONS

Vehicle to Infrastructure Safety Applications-communication paradigms-message coding and composition-data aggregation-Security and Privacy **(9)**

TOTAL : 45

TEXT BOOKS

1. *H. Hartenstein and K. P. Laberteaux, VANET: Vehicular Applications and Inter-Networking Technologies, John Wiley & Sons Ltd., 1st Edition 2010.*
2. *Luca Delgrossi, Tao Zhang, "Vehicle Safety Communications: Protocols, Security, and Privacy", John Wiley & Sons Ltd 1st Edition 2012.*

REFERENCES

1. *P. H.-J. Chong, I. W.-H. Ho, Vehicular Networks: Applications, Performance Analysis and Challenges, Nova Science Publishers, 2019.*
2. *C. Sommer, F. Dressler, Vehicular Networking, Cambridge University Press, 2015.*
3. *Popescu-Zeletin R, Radusch I and Rigani M.A, "Vehicular-2-X Communication",Springer,2010.*
4. *M. Watfa, Advances in Vehicular Ad-Hoc Networks: Development and Challenges, Information Science Reference, 2010.*
5. *H. Moustafa, Y. Zhang, Vehicular Networks: Techniques, Standards, and Applications, CRC Press, 2009.*
6. *Xiang W, "Wireless Access in Vehicular Environments Technology", Springer, 2015*

19ECEOE10 - SENSING FOR AUTOMOTIVE SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : Acquaint with the basic automotive system components and need for automotive sensors.

CO2 : Discuss the fundamentals of various Power train sensors in automotive systems.

CO3 : Comprehend various sensors for chassis management.

CO4 : Understand the sensors for vehicle management & security systems in Automobiles.

CO5 : Examine the vehicle communication protocols standards in automotive applications.

AUTOMOTIVE SYSTEMS

Introduction to Modern Automotive Systems- Electronics in Automobiles - Combustion Engines- Power-train- braking systems - Transmission- Applications and Challenges in the automotive. **(9)**

POWERTRAIN AUTOMOTIVE SENSORS

Exhaust temperature sensor - λ sensors - PM sensor - NOx sensor - fuel quality sensor- level sensor- torque sensor-speed sensor- manifold pressure sensor - mass flow sensor. **(9)**

CHASSSIS SENSORS

Wheel speed sensors/direction sensors- steering position sensor (multi turn)- acceleration sensor (inertia measurement)- brake pneumatic pressure sensor- ABS sensor- electronic stability sensor. **(9)**

SENSORS FOR VEHICLE MANAGEMENT & SECURITY SYSTEMS

Gas sensors (CO2)- Temperature/humidity sensor- air bag sensor- key less entering sensor- radar sensors. Tire pressure monitoring systems- Two wheeler and Four wheeler security systems. **(9)**

VEHICLE COMMUNICATION STANDARDS

Automotive Protocols : CAN, LIN, FLEXRAY, MOST **(9)**

TOTAL : 45

TEXT BOOK

John Turner, Automotive Sensors, 2010, Momentum Press, 1st Edition, New York.

REFERENCES

1. *Automotive Electrics, Automotive Electronics: Systems & Components, 2014, 5th Edition, BOSCH.*
2. *Ronald K Jurgen, "Automotive Electronics Hand Book", McGraw- Hill, 2nd Edition 1999.*
3. *Automotive Sensors Handbook, 8th Edition, 2011, BOSCH*
4. *Jiri Marek, Hans-Peter Trah, Yasutoshi Suzuki, Iwao Yokomori, "Sensors for Automotive Technology", 4th Edition, Wiley, New York, 2010.*
5. *Jack Erjavec, "Automotive Technology: A Systems Approach", Delmar Cengage Learning, 5th Edition, 2009.*

19CSOE01 - CUSTOMER RELATIONSHIP MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : State the evolution of marketing and define CRM architecture explaining customer acquisition, retention and segmentation.

CO2 : Describe the business value, its costs and deploying data mining for CRM.

CO3 : Understand the type of collecting and connecting the customer data with proper guidelines for privacy.

CO4 : Demonstrate the scoring process and apply the various CRM optimization techniques to optimize the CRM process in order to improve customer profitability.

CO5 : Evaluate CRM tools using tool assessment and methodology to choose the appropriate tool for real time applications.

INTRODUCTION

Most profitable Customer - CRM: Custom centered database, Managing campaigns, Evolution of marketing, Closed loop marketing, CRM architecture - Customer profitability - Customer acquisition - Cross selling - Customer retention - Customer segmentation. **(9)**

BUILDING THE BUSINESS CASE

Introduction - Uncovering the needs for data mining - Defining the business value - The costs - Deploying Data mining for CRM: Introduction - Define the problem - Define the user - Define the data - Scope the project - Trial - Quality assurance - Education Launch - Continuation. **(10)**

COLLECTING CUSTOMER DATA

Introduction - Three types of customer data - Collecting customer data - Connecting customer - Customer data and privacy - Privacy and data mining - Guidelines for privacy - Legal issues associated with data mining. **(8)**

SCORING YOUR CUSTOMER

Introduction - Process - Scoring architectures and configurations - Preparing the data - Integrating scoring with other applications- Optimizing the CRM process: Introduction - Improved customer profitability through optimization - Optimized CRM - Complete loop - Optimal CRM process - Optimization techniques. **(8)**

OVERVIEW OF DATA MINING AND CRM TOOL MARKETS

Introduction - Data mining market place - Taxonomy of data mining tools - Tool assessment attributes and methodology - Tool evaluation -Data mining tool: WEKA -CRM tools - Next generation for CRM. **(10)**

TOTAL : 45

TEXT BOOKS

1. *Alex Berson, Stephen Smith, Kurt Thearling, "Building Data mining Applications for CRM", Tata McGraw Hill, Fifteenth Reprint, 2008.*
2. *Ian H.Witten ,Eibe Frank, Mark A.Hall, "Data Mining Practical Machine Learning Tools and Techniques", Morgan Kaufmann, Fourth Edition, 2016*

REFERENCES

1. *Francis Buttle, Stan Maklan "Customer Relationship Management: Concepts and Technologies", Routledge, Fourth Edition, 2019.*
2. *Roger J. Baran, Robert J. Galka, "CRM: The Foundation of Contemporary Marketing Strategy", S.Chand (G/L) & Company Ltd, Second Edition, 2017.*

19CSOE02 - FUNDAMENTALS OF SOFTWARE ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Describe the various software life cycle models and choose an appropriate model for a given application.

CO2 : Identify the functional requirements, prepare data flow, ER diagrams and Software Requirement Specifications.

CO3 : Employ suitable architectural styles, software design methodologies, coding standards and practices in developing practical applications

CO4 : Discuss various testing techniques and their application in defect removal.

INTRODUCTION

The Software Engineering Discipline - Software Development Projects - Software Life Cycle Models: Use of Life Cycle Models - Classical Waterfall Model-Iterative Waterfall Model-Prototype model-Evolutionary Model-Spiral Model **(9)**

SOFTWARE REQUIREMENTS AND ANALYSIS

Requirements Analysis and Specification - Requirements Gathering and Analysis- Value of good SRS - Requirement process- Requirement Specification - desirable characteristics, components and Structure of requirements document - Functional Specification with use cases - basics - developing Use Cases -DFDs - Data Dictionary - ER Diagrams. **(8)**

SOFTWARE DESIGN

Design concepts - Cohesion and Coupling- The Open-Closed Principle - Function Oriented Software Design : Structured charts - Structured design methodology - Detailed Design: Logic / Algorithm design - State Modeling of Classes. **(10)**

CODING

Programming principles and guidelines - Structured programming - Information hiding - Some programming practices - Coding standards - Code inspection - Planning- Self review - Group review meeting. **(7)**

TESTING

Testing Fundamentals -Black Box Testing: Equivalence Class Partitioning - Boundary Value Analysis - White box Testing: Control Flow based criteria - Data Flow based Testing - Levels of Testing: Unit Testing - Integration Testing - System Testing - Acceptance Testing. **(11)**

TOTAL : 45

TEXT BOOKS

1. *Pankaj Jalote, "Software Engineering A Precise Approach", Wiley India, Third edition 2012.*
2. *Rajib Mall, "Fundamentals of Software Engineering", PHI Learning Private Limited, Third Edition 2013. (Introduction only)*

REFERENCES

1. *Roger.S.Pressman "Software Engineering A Practitioner's Approach", McGraw Hill International Edition, Seventh Edition, 2014.*
2. *Ian Sommerville, "Software Engineering", Dorling Kindersley (India) Private Ltd., Eighth Edition, 2008*

19CSOE03 - INTERNET PROGRAMMING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Gain knowledge in overview of www and web based applications.

CO2 : Design and develop dynamic and Interactive web page using DHTML.

CO3 : Design and develop web applications using servlets.

CO4 : Gain knowledge on E-business models and E-marketing.

BASIC WEB CONCEPTS

Basic Web Concepts - Web based Client/Server model -Web Protocols- Working of web browser - Browser & Server Communication - Review of HTML: Markup Languages, Introduction to HTML- forms - frames - tables. **(9)**

CLIENT SIDE PROGRAMMING

Client-side Programming (Review of JavaScript): Introduction, Writing Comments, Variables, Operators, Statements, Alert, Confirm, and Prompt Boxes, Functions, Event and Error Handling, Introduction to Built-in Classes, Form Validation, Cookies. **(9)**

DYNAMIC HTML

Dynamic HTML :Introduction - cascading style sheets-object model and collections - event model - filters and transition - data binding - data control - ActiveX control - handling of multimedia data. **(9)**

SERVER SIDE PROGRAMMING

Servlets - Deployment of simple servlets - Web server (Java web server / Tomcat / Web logic) - HTTP GET and POST requests - Session tracking - Cookies - JDBC - Simple web applications - Multi-tier applications. **(9)**

WEB BASED APPLICATIONS AND ITS TECHNOLOGIES

Rails: Overview of Rails-Ajax: Overview of Ajax Rails with Ajax- e-Business Models-e-Marketing-online payments-Security. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Deital & Deital, "Internet and World Wide Web-How to Program", Pearson Education Fifth Edition, 2011.*
2. *Robert W.Sebesta, "Programming with World Wide Web", Pearson Education, Eighth Edition, 2015.*

REFERENCES

1. *Scot Johnson, Keith Ballinger, Davis Howard Chapman, "Special Edition Using Active Server Pages", Prentice Hall of India, paperback 1999.*
2. *Ravi Kalakota and Andrew B Whinston, "Frontiers of e-commerce", Addison Wesley, paperback 1999.*
3. *Jeffrey C. Jackson," Web Technologies: A Computer Science Perspective", Pearson Education, Reprint 2011.*
4. *Elliotte Rusty Harold, "Java Network Programming", O'Reilly Publishers, Fourth Edition 2013.*

19CSOE04 - INTRODUCTION TO DATA WAREHOUSING AND DATA MINING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Describe the basic concepts, architecture, data models of database management systems and data warehouse.

CO2 : Demonstrate the multidisciplinary fields of data mining and illustrate the techniques for data preprocessing.

CO3 : Find frequent item set and generate association rules for the given transactions.

CO4 : Analyze different types of data using classification and clustering techniques.

BASIC CONCEPTS OF DATABASE SYSTEM

Purpose of DBMS - Applications - Views of data - Data Abstraction - Instances and Schemas - Data Models - Database Languages - Relational Databases - Database Architecture - Database users and administrators - History of Database systems. **(8)**

DATA MINING

Data Mining - On What Kind of Data-Data Mining Functionalities - Classification of Data Mining Systems - Data Mining Task Primitives - Integration of a Data Mining System with a Database or Data Warehouse System-Major Issues in Data Mining. **(9)**

DATA WAREHOUSING

Data Warehouse - Introduction-Multidimensional Data Model-Data Warehouse Architecture -Data Warehouse Implementation from Data Warehousing to Data Mining. **(8)**

DATA PREPROCESSING AND ASSOCIATION RULES

Data Preprocessing: Needs Preprocessing the Data - Data Cleaning- Data Integration and Transformation-Data Reduction-Discretization and Concept Hierarchy Generation. Association Rules: Basic concepts - Apriori Algorithm - Generation of association rules from frequent item sets - FP Tree Algorithm - Pattern evaluation methods **(10)**

CLUSTERING AND CLASSIFICATION

Cluster analysis - Partitioning Methods - K-Means and K-Medoid algorithm - CLARA - CLARANS - Hierarchical clustering - BIRCH - Density based clustering - DBSCAN - Decision tree induction. **(10)**

TOTAL : 45

TEXT BOOKS

1. *Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", Tata McGraw Hill, Sixth Edition, 2013. (Basic Concepts of Database System only)*
2. *Jiawei Han & Micheline kamber, "Data Mining-Concepts and Techniques" Morgan Kaufmann Publishers, Third Edition, 2012.*

REFERENCES

1. *Arun K Pujari, "Data Mining Techniques" Universities Press India Ltd., Third Edition, 2012.*
2. *Dunham, "Data Mining- Introductory and Advanced Topics", Pearson Education, New Delhi, First Edition, 2006.*
3. *Sam Anahory, Dennis Murray, "Data Warehousing in the Real World ", Pearson Education, Seventh Indian Reprint New Delhi,2003.*
4. *George M. Marakas, "Modern Data Warehousing, Mining, & Visualization Core concepts", Pearson Education, First Edition, 2003*
5. *Paulraj Ponnaiah, "Data Warehousing Fundamentals", Wiley Publishers, Singapore, First Edition, 2001.*

19CSOE05 - INTRODUCTION TO EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Examine the characteristics and challenges in embedded system development

CO2 : Identify the parameters affecting CPU performance and develop optimized code

CO3 : Demonstrate the scheduling of given set of real-time tasks using the appropriate scheduling algorithm

CO4 : Design embedded system for simple applications

INTRODUCTION

Characteristics of embedded computing applications- Challenges in embedded computing design - Performance in embedded computing. Embedded System Design Process - Computer Architecture Taxonomy - ARM Processor -Assembly Language Programming. **(10)**

CPU PERFORMANCE

I/O Primitives - Busy -Wait I/O - Interrupts - Memory System Mechanisms: Cache, Memory Management Unit and Address Translation - Pipelining - CPU Power Consumption **(8)**

DEVELOPMENT AND DEBUGGING

Development environments - Debugging Techniques - Debugging challenges - System Level Performance analysis - Program Level Performance analysis - Program Optimization **(9)**

SCHEDULING

Scheduling states of a Process-Running Periodic Processes - Preemption - Priorities- Rate Monotonic Scheduling - Earliest Deadline First Scheduling - Priority Inversion - Data dependency. **(10)**

NETWORKS

Bus Standards: I2C, CAN Bus, Field Bus. CASE STUDY: Alarm Clock, Elevator Controller. **(8)**

TOTAL : 45

TEXT BOOK

1. *Marilyn Wolf, "Computers as Components: Principles of Embedded Computing System Design", Morgan Kaufman, Third Edition, 2012*

REFERENCES

1. *Rajib Mall, "Real-Time Systems: Theory and Practice", Pearson Education, First Edition, 2009. (For Scheduling)*
2. *David. E. Simon, "An Embedded Software Primer", Pearson Education, First Edition, 2012*
3. *Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill, Third Edition, 2014.*

19ITOE01 - DIGITAL COMPUTER BASICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Explain various schemes of number system representations, code conversions and perform arithmetic operations.

CO2 : Describe Boolean Algebra, formulate and simplify Boolean expressions using K-Maps and illustrate the logic gates realization.

CO3 : Describe the working of basic combinational circuits and sequential circuits.

CO4 : Describe the structure and functioning of various memory schemes.

NUMBER SYSTEMS

Binary Numbers, Number Base Conversions, Octal and Hexadecimal Numbers.

Complements of Numbers - Signed Binary Numbers. Binary Codes : Binary-Coded Decimal (BCD) Code, Gray Code, ASCII Character Code, Error Detecting Code. BCD Addition - Decimal Arithmetic. Binary Storage and Registers. **(9)**

BINARY LOGIC AND BOOLEAN ALGEBRA

Definition of Binary logic. Boolean Algebra - Basic Definitions - Theorems and Properties of Boolean Algebra - Canonical and Standard Forms. Digital Logic Gates : Integrated Circuits. Gate-Level Minimization: Map Method - Four Variable K-Map - Product of Sums Simplification. Realization of Boolean functions using Gates **(9)**

COMBINATIONAL CIRCUITS

Adder : Half Adder - Full Adder - Binary Parallel Adder - BCD Adder. Subtractor : Half Subtractor - Full Subtractor. Code Conversion. Decoders - De-Multiplexer - Encoders - Multiplexers. **(10)**

SEQUENTIAL CIRCUITS

Storage Elements - Latches, Flip Flops - RS, D, JK and T flip -flops- Triggering of flip -flops - Characteristic Tables - Characteristic Equations. Registers - Shift Registers. Counters: Binary ripple counter - Up down binary counter. **(9)**

MEMORY AND PROGRAMMABLE LOGIC

Random Access Memory - Memory Decoding - Read Only Memory - Types of ROMs, Programmable Logic Array, Programmable Array Logic **(8)**

TOTAL : 45

TEXT BOOK

1. *M. Morris Mano and Michael D. Cieti,"Digital Design with an Introduction to the Verilog HDL, Pearson Education, Fifth Edition, 2013.*

REFERENCES

1. *M. Morris Mano, "Digital Logic and Computer Design", Pearson Education, First Edition, 2008.*
2. *Thomas L.Floyd, "Digital Fundamentals", Pearson Education, Tenth Edition, 2011.*

19ITOE02 - PROGRAMMING IN JAVA

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Describe the fundamental aspects of object oriented programming paradigm.

CO2 : Develop java programs using features like methods, classes, constructors, overloading and string handling.

CO3 : Write exception handling routines for practical applications.

CO4 : Describe multithreading, synchronization and networking features of Java.

CO5 : Demonstrate use of applets and database connectivity in developing practical Applications.

OBJECT ORIENTED PROGRAMMING

Introduction to object oriented languages - Evolution of object oriented languages - Object oriented programming paradigm - Basic concepts of object oriented programming - Procedural Vs object oriented programming. **(6)**

INTRODUCTION TO JAVA

Java and Internet - Byte Code - Features of Java - Java Development Environment- Java Programming: Methods and Classes- Constructor - Garbage Collection - Overloading - Inheritance - Overriding - Packages and Interfaces - Java IO systems - String Handling : String and String Buffer. **(12)**

EXCEPTION HANDLING

Exception Handling: Fundamentals of Exception handling and types - Built in Exceptions - User defined Exceptions. **(5)**

MULTI THREADS

Multithreaded Programming: Thread Model -Thread properties -Thread priorities - Synchronization- Inter thread communication- Networking :Inet address- Datagrams - Sockets - URL connections. **(11)**

APPLET AND DATABASE CONNECTIVITY

Introduction to Abstract Window Tool kit - Applet class - HTML applet tags - Parameter passing - Audio clip interface - Event class: Keyboard and Mouse events handling. **(11)**

TOTAL : 45

TEXT BOOK

1. *Herbert Schilt :"Java 2 - Complete references ", Tata McGraw Hill, ftinth Edition, McGraw Hill Education, 2014.*

REFERENCE

1. *Deitel H.M and Deitel P.J, "Java - How to Program", Prentice Hall of India, Ninth Edition, 2012.*

19ITOE03 - FUNDAMENTALS OF DATABASE SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Describe the database system concepts and explain the key features of Relational data models.

CO2 : Describe the features of Entity Relationship diagram and draw Entity Relationship diagram for the given real world application

CO3 : Design a normalized database system and carry out data retrieval using SQL.

CO4 : Demonstrate various transaction concepts and various concurrency control mechanisms

DATABASE SYSTEMS

Data Vs Information-Introducing the database and DBMS- Importance of Database Design- Files and File systems-Problems with File System Data Management, Database Systems. Relational Database Model: Logical view of Data- Keys- Integrity Rules- Relational Set Operators- Data Dictionary and the system catalog -Codd's relational database rules. **(10)**

RELATIONAL MODEL

Entity Relationship Model: Entities-Attributes-Relationship-Connectivity and cardinality- Existence Dependence-Relationship Strength-Weak Entities-Relationship participation- Relationship Degree-Recursive Relationship-Developing an ER Diagram. **(8)**

STRUCTURED QUERY LANGUAGE

Introduction to SQL- Data Definition Commands- Data Manipulation Commands-Advanced Data Definition and SELECT Commands - Virtual Tables -Creating Views- Joining Database Tables. **(8)**

DATABASE DESIGN

Database Tables and Normalization- Need for Normalization- Normalization Process- Improving the Design-Surrogate Key Considerations, High level Normal Forms, Normalization and Database Design-Denormalization. **(10)**

TRANSACTION MANAGEMENT

Transaction Concepts: Transaction Properties- Transaction Concurrent Executions. Concurrency control with Locking Methods: Lock Granularity-Lock Types-Two-Phase Locking to Ensure Serializablity-Deadlocks-Database Recovery Management-RAID. **(9)**

TOTAL : 45

TEXT BOOK

1. *Peter Rob, Coras M.Colonel, "Database Systems: Design, Implementation and Management", Thompson Learning Course Technology, Tenth Edition, 2012.*

REFERENCES

1. *Abraham Silberschatz, Henry F.Korth,S.Sudharshan,"Database System Concepts", McGraw-Hill, Sixth Edition, 2013.*
2. *Ramez Elmasri, Shamkant B. tJavathe, "Fundamentals ofDatabase Systems", Pearson Education, Sixth Edition, 2013.*
3. *Raghu Ramakrishnan, Johannes Gehrke, "Database ManagementSystems", McGraw Hill Education, Third Edition, 2014.*
4. *Thomas M.Connolly and Carolyn E.Begg, "A Practical Approach to Design, Implementation and Management", Pearson, 6th Edition, 2004.*

19ITOE04 - CLOUD COMPUTING FUNDAMENTALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Understanding the client- server, distributed collaborative and cloud computing architecture along with cloud storage and services.

CO2 : Classify the different virtualization environments and techniques.

CO3 : Illustrate various services deployed from a cloud architecture supported by different providers.

CO4 : Analyze the major security challenges and privacy problems in the cloud and virtual environment.

INTRODUCTION

Understanding Cloud Computing- history of cloud computing: Client/Server computing, Peer to peer computing, Distributed computing and Collaborative computing.- Understanding cloud architecture, cloud storage and services-Pros and cons of cloud computing. **(9)**

VIRTUALIZATION

Introduction-Characteristics of Virtualized Environments - Taxonomy of Virtualization Techniques - Virtualization and Cloud Computing - Pros and Cons of Virtualization - Technology Examples **(9)**

CLOUD COMPUTING ARCHITECTURE

Cloud reference model: Architecture, Infrastructure / Hardware as a service, Platform as a service-Software as a service, Types of cloud: Public clouds, Private clouds, Hybrid Cloud, Community Clouds. **(9)**

CLOUD SERVICES

Discovering Cloud services Development services and tools: Amazon, Google App Engine, IBM, Salesforce.com, Other Cloud Services development tool **(9)**

CLOUD SECURITY

Security Overview - Cloud SecurityChallenges - Software as a Service Security - Security Governance - Risk Management - Security Monitoring - Security Architecture Design - Data Security - Application Security - Virtual Machine Security. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Michael Miller "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online",1st Edition, Pearson Education, New Delhi, 2009.*
2. *Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi, "Mastering Cloud Computing", Tata McGraw Hill, 2013. (Virtualization, Cloud Computing Architecture)*
3. *John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010. (Cloud Security)*

REFERENCES

1. *Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.*
2. *Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2002.*
3. *Kai Hwang, Geoffrey C Fox,Jack GDongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2002.*

19ITOE05 - INFORMATION SECURITY FUNDAMENTALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Identify and analyze the security threats and attacks and applydevice suitable security policies and standards.

CO2 : Assess the risks and apply suitable risk control strategies.

CO3 : Employ appropriate intrusion detection and prevention systems to ensure information security.

CO4 : Discuss various national and international laws of information security and its framework.

INTRODUCTION, NEED FOR SECURITY

Introduction to Information Security - The History of Information Security- Critical Characteristics of Information - NSTISSC Security Model - Components of an Information System - Securing Components - Balancing Information Security and Access - The Systems Development Life Cycle - The Security Systems Development Life Cycle. The Need for Security: Introduction Business Needs First -Threats -Attacks. **(9)**

RISK MANAGEMENT AND INFORMATION SECURITY

Introduction - An Overview of Risk Management - Risk Identification -Risk Assessment - Risk Control Strategies - Selecting a Risk Control Strategy - Risk Management Discussion Points - Recommended Practices in Controlling Risk. **(9)**

POLICIES, STANDARDS, PRACTICES AND BUSINESS CONTINUITY

Introduction - Information Security Policy, Standards and Practices -The Information Security Blueprint: ISO 17799/BS 7799, ISO 27001and itscontrols, NIST SecurityModels, Design of Security Architecture - Security Education, Training and Awareness Program - Continuity Strategies. **(6)**

SECURITY TECHNOLOGY

Introduction - Intrusion Detection and Prevention Systems: IDPS Terminology, Use of IDPS, Strengths and Limitations of IDPS - Honey Pots, Honey Nets, and Padded Cell Systems - Scanning and Analysis Tools, Access Control Devices **(6)**

BIOMETRIC CONTROLS

Biometrics - Nature of Biometrics Identification/Authentication Techniques - Biometric Techniques - Matching and Enrollment Process in Biometrics - Benefits Over Traditional Authentication Methods. **(6)**

SECURITY OF WIRELESS NETWORKS

Attacks on Wireless Networks: Other Security Risks in Wireless Networks, Management and Mitigations for Wireless Networks Attacks. **(7)**

LAWS AND LEGAL FRAMEWORK

Introduction - Information Security and the Law: The Rising Need -Understanding the Laws for Information Security:A Conceptual Framework - The Indian ITAct - Laws for Intellectual Property Rights (IPR) -Health Insurance Portability and Accountability Act (HIPAA) - Building Security into Software/System Development Life Cycle. **(7)**

TOTAL : 45

TEXT BOOKS

1. *Michael E Whitman and Herbert J Mattord, "Principles of Information Security", Course Technology, New Delhi, Fourth Edition, 2012 Reprint.*

2. *Nina Godbole, "Information Systems Security-Security Management, Metrics, Frameworks and Best Practices", Wiley India Pvt. Ltd., New Delhi, First Edition, 2009.(Biometric Controls, Security of Wireless Networks, Laws and Legal Framework)*

REFERENCES

1. *Thomas R.Pettier, "Information Security Fundamentals", Auerbach Publications, Second Edition, 2013.*
2. *Vicki Krause and Harold F.Tipton, "information Security Management Handbook", Auerbach Publications, Sixth Edition,2008.*
3. *Mark Merkow and Jim Breithaupt,"Information Security - Principles & Practices", Second Edition, Pearson Education, 2014.*

19ITOE06 - INTRODUCTION TO HUMAN COMPUTER INTERACTION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Describe the importance and need for effective user friendly Graphical User Interfaces (GUI).

CO2 : Choose suitable interactions devices/tools to meet application specific requirements.

CO3 : Design Graphical User Interfaces(GUI) using apt components and apply the design guidelines for user-friendly navigation and presentation.

CO4 : Asses graphical user interfaces for compliance against the screen design guidelines.

INTRODUCTION

Importance of User Interface: Definition-Importance of good design-Benefits of good design-Human-centered development and Evaluation-Human Performance models-A Brief history of screen design **(9)**

THE GRAPHICAL USER INTERFACE & DESIGN PROCESS

GUI: Popularity of graphics - The concept of direct manipulation - Graphical system - Characteristics - Web user - Interface Popularity - Characteristics and Principles of User Interface.

Design process: Human Interaction with computers - Importance of Human Characteristics - Human Consideration - Human Interaction Speeds and Understanding Business Junctions. **(9)**

SCREEN DESIGNING

Design Goals - Screen Planning and Purpose - Organizing Screen Elements - Ordering of Screen Data and Content - Screen Navigation and Flow - Visually Pleasing Composition - Amount of Information - Focus and Emphasis - Presenting Information Simply and Meaningfully - Information retrieval on web - Statistical Analysis - Technological considerations in Interface Design. **(9)**

WINDOWS & COMPONENTS

Windows: New Navigation Schemes - Selection of Window - Selection of DevicesBased on Screen Based Controls. Components: Text and Messages - Icons and Increases - Multimedia - Colors - Uses -Problems - Choosing colors. **(11)**

SOFTWARE TOOLS AND INTERACTION DEVICES

Specification Methods - Interface Building Tools - Keyboard and Function Keys - Pointing Devices Speech Recognition. **(7)**

TOTAL : 45

TEXT BOOKS

1. *Wilbert O Galitz, "The Essential Guide to User Interface Design", Third Edition, Wiley India Pvt., Ltd., 2007.*
2. *Ben Shneidermann, "Designing the User Interface", Fifth edition, Pearson Education Asia, 2013. (Software Tools and Interaction Devices)*

REFERENCE

1. *Alan Dix, Janet Finlay, G D Abowd and Russel Beale, "Human Computer Interaction", Pearson Education, Third Edition*

19ITOE07 - ENTERPRISE RESOURCE PLANNING CONCEPTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

CO1 : Describe the operational aspects of ERP system and its related technologies.

CO2 : Demonstrate the steps required for ERP Project management and implementation process by choosing the right vendors/consultants, employee training and monitoring.

CO3 : Categorize the business modules of an ERP package in order to define the functionality of various departments in a company.

CO4 : Analyze the ERP market place and its vendors, and assess how Enterprise Application Integration (EAI), e-business help the company use ERP to its utmost benefit.

INTRODUCTION

Enterprise - An Overview - Introduction to ERP - Benefits Of ERP - ERP and Related Technologies - Business Process Reengineering (BPR) - Data Warehousing - Data Mining - OLAP--SCM. **(9)**

ERP IMPLEMENTATION

ERP Implementation Lifecycle - Implementation Methodologies - ERP deployment methods - Package Selection - Process Definition - Vendors and Consultants - Contract with Vendors, Consultants and Employees - Training and education- Project Management and Monitoring. **(10)**

THE ERP BUSINESS MODULES

Business modules of an ERP Package - Finance - Manufacturing - Human Resources - Plant Maintenance - Materials Management - Quality Management - Sales and Distribution. **(9)**

THE ERP MARKET & ERP - PRESENT AND FUTURE

ERP Marketplace and Marketplace Dynamics - ERP Vendors - SAP AG, Oracle Corporation, Microsoft Dynamics, EPICOR, QAD, RAMCO Systems - Enterprise Application Integration (EAI)- ERP and E-Business- Future Directions and Trends in ERP. **(9)**

SAP

Gateway to SAP: Architecture of SAP R/3 -SAP Integrated-Three Tier Architecture - SAP Easy Access - Understanding ABAP Workbench **(8)**

TOTAL : 45

TEXT BOOKS

1. *Alexis Leon, "ERP Demystified", Tata McGraw Hill, New Delhi, Third Edition, 2014.*
2. *Dreamtech Press, "SAP R/3, Black Book", Dreamtech Software Team, 2006. (SAP)*

REFERENCES

1. *Ellen F.Monk, Bret Wagner, "Concepts in Enterprise Resource Planning", Course Technology Ptr, Fourth Edition, 2011.*
2. *Vinod Kumar Garg and Venkitakrishnan N.K., "Enterprise Resource Planning - Concepts and Practice", Prentice Hall of India, New Delhi, Second Edition, 2012.*

19CHOE01 - INDUSTRIAL SAFETY ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : Practice the safety norms and inspect turning machines, boring machines, milling machine, planning machine, grinding machines, CNC machines and wood working machinery to create risk free working environment.

CO2 : Assess the adequacy of machinery guarding to eliminate or reduce the hazards from the point operation, flying chips and sparks and moving parts.

CO3 : Apply the safety concepts in welding, gas cutting, storage and handling of gas cylinders, metal forming processes, etc.,

CO4 : Predict, identify and evaluate, hazardous conditions and practices safety rules in in cold forming and hot working of metals

CO5 : Employ the safety rules in inspection and testing process and take plan the preventive measures in health and welfare of workers' aspects in engineering industry.

SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards. **(9)**

PRINCIPLES OF MACHINE GUARDING

Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS - guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening. Selection and suitability: lathe - drilling - boring - milling - grinding - shaping - sawing- shearing presses - forge hammer - flywheels - shafts - couplings -gears - sprockets wheels and chains pulleys and belts - authorized entry to hazardous installations-benefits of good guarding systems **(9)**

SAFETY IN WELDING AND GAS CUTTING

Gas welding and oxygen cutting, resistance welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing - explosive welding, selection, care and maintenance of the associated equipment and instruments - safety in generation, distribution and handling of industrial gases-colour coding - flashback arrestor - leak detection-pipeline safety-storage and handling of gas cylinders. **(9)**

SAFETY IN COLD FORMING AND HOT WORKING OF METALS

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes. Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills - hot bending of pipes, hazards and control measures. Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes. **(9)**

SAFETY IN FINISHING, INSPECTION AND TESTING

Heat treatment operations, electro plating, paint shops, sand and shotblasting, safety in inspection and testing, dynamic balancing, hydrotesting, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal

monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry-pollution control in engineering industry-industrial waste disposal **(9)**

TOTAL : 45

TEXT BOOKS

1. *Wells G.L.,R.M.C. Seagrave-Flow sheeting for safety, Indian Institute of Chemical Engineering, London U.K,1977.*
2. *TrevurKletz Butterworth, Learning from accidents, - London, 1988.*
3. *John Barton and Richard Rogers, Chemical reaction Hazards - A guide to safety, Institution of Chemical Engineering London, 1997.*
4. *Philip Hagan "Accident Prevention Manual for Business and Industry", N.S.C.Chicago, 13th edition 2009.*

REFERENCES

1. *Rohatgi A.K, Safety handling of Hazardous Chemicals Enterprises, Bombay, 1986.*
2. *Shukla S.K., Envirohazards and Techno Legal aspects, Shashi Publications, Jaipur India, 1993.*
3. *John V.Grimaldi and Rollin H.Simonds," Safety Management", Richard D Irwin, 1994.*
4. *Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997.*
5. *"The Indian boilers act 1923 with amendments", Law Publishers (India) Pvt. Ltd., Allahabad.*
6. *"Health and Safety in welding and Allied processes", Welding Institute, UK, High Tech. Publishing Ltd., London, 1989.*
7. *"Safe use of wood working machinery", HSE,UK,2005.*

19CHOE02 - RISK ANALYSIS AND HAZOP

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : Identify individual hazards in a process and deduce the associated risks.

CO2 : Identify radiation intensity and effects of explosion

CO3 : Perform risk analysis of various types of problems

CO4 : Evaluate effect about key hazard identification techniques

CO5 : Apply risk analysis techniques and Hazop study

INTRODUCTION AND DISPERSION MODELS

Risk analysis introduction, quantitative risk assessment, rapid risk analysis - Comprehensive risk analysis - Emission and dispersion - Leak rate calculation. Single and two-phase flow - Dispersion model for dense gas - Flash fire - Plume dispersion - Toxic dispersion model - Ealuation of risk. **(9)**

RADIATION INTENSITY

Radiation - Tank on fire - Flame length - Radiation intensity calculation and its effect on plant, people and property radiation VCVCE - Explosion due to over pressure - Effects of explosion, risk contour -Effects, explosion, BLEVE - Jet fire - Fire ball.**(9)**

RISK ANALYSIS

Overall risk analysis - Generation of meteorological data - Ignition data - Population data - Consequences analysis and total risk analysis - Overall risk contours for different failure scenarios - Disaster management plan - Emergency planning - On site and off site emergency planning, risk management ISO 14000, EMS models case studies - Marketing terminal, gas processing complex, refinery. **(9)**

HAZARD ANALYSIS

Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough - Mexico - Madras - Vizag - Bopal analysis **(9)**

CASE STUDIES

Hazop - Guide words, parameters, derivation - Causes - Consequences - Recommendation - Coarse Hazop study - Case studies - Pumping system - Reactor - Mass transfer system. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Ragavan K.V., Khan A.A., Methodologies in Hazard identification and assessment -Manual, CLRI publication, 1990.*
2. *Marcel.V.C., Major Chemical Hazard, Ellis Hawood Ltd., Chi Chester, UK, 1987.*
3. *Skeleton B., Process Safety Analysis, Institution of chemical Engineers, U.K., 1997.*

REFERENCE

1. *Daniel A Crowl., Louvar J.F., Chemical Process Safety: Fundamentals with Applications, Prentice Hall, New Jersey, 2002.*

19CHOE03 - GREEN TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : Outline the green technology concepts and relevance in twenty first century requirements.

CO2 : Defend the environmental and sustainability issues, role of CSR and CER and Indian corporate structure and environment.

CO3 : Recall the indicators of sustainability and their use and can also find the alternate theories.

CO4 : Criticize the environmental reporting, ISO 14001, ISO 14064, financial initative by UNEP, etc.

CO5 : Analyse the green tax incentives and rebates, business redesign and its models.

INTRODUCTION

The concept of green technology; evolution; nature, scope, importance and types; developing a theory; green technology in India; relevance in twenty first century. **(9)**

SUSTAINABILITY & ENVIRONMENT

Organizational environment; internal and external environment; Indian corporate structure and environment; how to go green; spreading the concept in organization; environmental and sustainability issues for the production of high-tech components and materials, life cycle analysis of materials, sustainable production and its role in corporate social responsibility (CSR) and corporate environmental responsibility (CER). **(9)**

ECOSYSTEM APPROACHES

Approaches from ecological economics; indicators of sustainability; ecosystem services and their sustainable use; bio-diversity; Indian perspective; alternate theories **(9)**

ACTS OF GREEN TECHNOLOGY

Environmental reporting and ISO 14001; climate change business and ISO 14064; green financing; financial initiative by UNEP; green energy technology; green product technology. **(9)**

GREEN ECONOMICS

Definition; green techniques and methods; green tax incentives and rebates (to green projects and companies); green project technology in action; business redesign; eco-commerce models. **(9)**

TOTAL : 45

REFERENCES

1. *Green Technology and Green Technologies: Exploring the Causal Relationship by Jazmin Seijas Nogarida, 2008.*
2. *Green Marketing and Technology: A global Perspective by John F. Whaik, 2005.*
3. *The Green Energy Technology Book by Leo A. Meyer.*
4. *Green Project Technology by Richard Maltzman and David Shiden.*
5. *Green Marketing by JacquelinOttman.*
6. *Green and World by Andrew S. Winston.*

19CHOE04 - CORROSION SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : Classify the types of corrosion and theories and also relate the various controlled corrosion process.

CO2 : Examine the factors involved in the corrosion and control methods of various corrosion.

CO3 : Analyse the mechanism of corrosion and evaluate the effects like pH, temperature, flow rate on corrosion.

CO4 : Design and develop the corrosion control methods like cathodic protection, sacrificial anode and impressed current anodes and anodic protection.

CO5 : Predict the different corrosion testing, monitoring and inspection tests by surface analytical studies.

INTRODUCTION

Introduction, classification, economics and cost of corrosion. emf series, galvanic series, corrosion theories derivation of potential Current relations of activities controlled and diffusion controlled corrosion process. Potential - pH diagram, Fe-H2O system, application and limitation. Passivation - Definition, anodic passivation theory of passivation, oxidation laws, effects of oxygen and alloying on oxidation rates. **(9)**

CORROSION CONTROL METHODS

Forms of corrosion - Definition, factors and control methods of various forms of corrosion such as pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, fretting corrosion, hydrogen embitterment, corrosion processes and control methods in fertilizers, petrochemical, chemical building industries **(9)**

MECHANISM OF CORROSION

Environmental aspects, atmospheric corrosion - Classification, factors influencing atmospheric corrosion, temporary corrosion preventive methods, corrosion in immersed condition, effect of dissolved gases, salts, pH, temperature, and flows rates on corrosion, marine corrosion, underground corrosion. Biological corrosion, definition, mechanism of corrosion, control of bio-corrosion. **(9)**

CORROSION PREVENTION

Corrosion control aspects, electrochemical methods of protection-theory of cathodic protection design of cathodic protection, sacrificial anodes, impressed current anodes, anodic protection. Corrosion inhibitors for acidic, neutral and alkaline media, cooling water system - Boiler water system. Organic coating, surface preparation, natural, synthetic resin, paint, formulation and application. Design aspects in corrosion prevention, corrosion resistant materials. **(9)**

CORROSION TEST

Corrosion testing, monitoring and inspection, laboratory corrosion tests, accelerated chemical tests for studying different forms of corrosion. Electrochemical methods of corrosion rate measurements by DC and AC methods, corrosion monitoring methods, chemical and electrochemical removal of corrosion products, newer techniques to study corrosion processes, inspection methods by NDT. Surface analytical techniques such as AES, ESCA, SEM. Evaluation of paints by conventional and electrochemical methods. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Roberge P. R., Corrosion Engineering, McGraw Hill, New York, 2008.*
2. *Fontana M.G., Greene N.D., Corrosion Engineering, Third Edition, McGraw Hill, NewYork, 2005.*
3. *Uhling H. H., Revie R.W., Corrosion and Corrosion Control, John Wiley and Sons, Inc, 1985.*

REFERENCE

1. *Banarjee.S.N., An introduction to corrosion and corrosion inhibitors, Oxonian Press Ltd., New Delhi, 1985.*

19CHOE05 - INTRODUCTION TO CHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : Express the fundamentals of chemical engineering and to solve problems.

CO2 : Ability to develop basic fluid concepts, transfer and separation operations.

CO3 : Design equipment for transport and separation processes.

CO4 : Apply material and Energy balance to precisely calculate material required for a process.

CO5 : Apply steady state balances to develop process flow sheets.

OVERVIEW OF CHEMICAL ENGINEERING

Concepts of unit operations and unit processes, and more recent developments, The Chemical Industry-scope, features & characteristics. Flow sheets, and symbols for various operations. **(9)**

MATERIAL AND ENERGY BALANCE CALCULATIONS

Material balances in simple systems involving physical changes and chemical reactions; systems involving recycle, purge, and bypass, combustion reactions, Forms of energy, optimum utilization of energy, Energy balance calculations in simple systems. Introduction to Computer aided calculations-steady state material and energy balances, combustion reactions. **(9)**

BASIC FLUID CONCEPTS

Dimensions and Units, Velocity and Stress Fields, Viscosity and surface tension, Non Newtonian viscosity, Dimensional Analysis (Buckingham PI theorem), Types of flows, Methods of Analysis, Fluid Statics. pipe flow, Pumps, Agitation and Mixing, Compressors. **(9)**

HEAT TRANSFER OPERATIONS

Review of conduction, resistance concept, extended surfaces, lumped capacitance; Introduction to Convection, natural and forced convection, correlations; Radiation; Heat exchangers- Fundamental principles and classification of heat exchangers, Evaporators. **(9)**

MASS TRANSFER OPERATIONS

Fundamental principles and classification of Distillations, Adsorption, Absorption, Drying, Extraction, Membrane Process. Energy and Mass Conservation in process systems and industries. Introduction to chemical reactors. **(9)**

TOTAL : 45

REFERENCES

1. *G.T. Austin, R.N. Shreve, Chemical Process Industries, 5th Ed., McGraw Hill, 1984.*
2. *W.L. McCabe, J.C. Smith and P. Harriott, Unit Operations of Chemical Engineering, 6th Edition, McGraw Hill, 2001.*
3. *R. M. Felder and R.W. Rousseau, Elementary Principles of Chemical Processes, 3rd Ed., John Wiley, New York,2004.*
4. *L.B. Anderson and L.A. Wenzel, Introduction to Chemical Engineering, McGraw Hill, 1961.*
5. *H.S. Fogler, Elements of Chemical Reaction Engineering, 4th Ed., Prentice-Hall, 2006.*

19CHOE06 - NANOMATERIAL SYNTHESIS AND CHARACTERIZATION LABORATORY

L	T	P	C
0	0	6	3

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : To synthesize several nanomaterials in different methods in lab scale.

CO2 : To understand and operate the instruments for material characterization.

CO3 : To interpret the properties of synthesized nanomaterials by analyzing the results

EXPERIMENTS

1. Chemical synthesis of Ag nanoparticles; UV-Visible absorption of the colloidal sol.
2. Chemical synthesis of CdS nanoparticles; Optical absorption spectra; Band gap estimation from the band edge.
3. Synthesis of ceria nanofibres by Solvothermal method.
4. Synthesis of silica nanoparticles using Stober method.
5. Synthesis of Au nanoparticles by simple chemical method.
6. Synthesis of Fe_3O_4 nanoparticles by simple reduction method.
7. Effect of reducing agent on the synthesis of metal nanoparticles.
8. Aqueous to organic phase transfer of Ag and CdS nanoparticles; Confirmation by UV-Visible absorption.
9. Effect of concentration on the synthesis of silver nanoparticles.
10. Effect of reducing agent on gold nanoparticles.
11. Fabrication of silver nanofilms.
12. Synthesis of polyvinyl alcohol fibres by electrospinning method.
13. Synthesis of Au and Ag nanoparticles at aqueous-organic liquid interface; UV-visible spectroscopy of the colloidal film; comparison with the corresponding colloidal sol.
14. Sol gel synthesis of $ZnO/TiO_2/CdO$ nanoparticles.
15. A bioroute to Au nanoparticles.
16. Sol-gel spin coating route to SnO_2 nanothin films: surface roughness measurement by AFM.
17. Hydrothermal synthesis of ZnS Nanorods: Nanorods formation by SEM analysis.
18. Fabrication and wettability characterization of nanostructured soft polymer surfaces.
19. Preparation of nanofluids.
20. Determination of viscosity of nanofluids.
21. Evaporation studies of nanofluids.
22. Measurement of stability of nanofluids.
23. Optical properties of nanofluids.
24. Measurement of onset of natural convection in nanofluids.
25. Thermal conductivity measurement of nanofluids.

TOTAL : 60

REFERENCES

1. *Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, Nanofluids: Science and Technology, Wiley, 2007.*
2. *Vincenzo Bianco, Oronzio Manca, Sergio Nardini, Kambiz Vafai, Heat Transfer Enhancement with Nanofluids, CRC Press, 2017.*
3. *Amy S., Thermal Energy Storage Using Phase Change Materials: Fundamentals and Applications Fleischer, Springer, 2015.*
4. *Mohsen Sheikholeslami and Davood Domairry Ganji, Applications of Nanofluid for Heat Transfer Enhancement, Elsevier, 2017.*
5. *S.M. Sohel Murshed, Carlos Nieto de Castro, Nanofluids: Synthesis, Properties and Applications, Nova Science Publishers, 2014.*
6. *T. Pradeep, A Textbook of Nanoscience and Nanotechnology. Tata McGraw-Hill Education, 2003.*
7. *P.R. Chandran, M. Naseer, N. Udupa, N. Sandhyarani. Size controlled synthesis of biocompatible gold nanoparticles and their activity in the oxidation of NADH. Nanotechnology. 8, 23(1), 2011.*
8. *I.A. Ibrahim, A.A. Zikry, M.A. Sharaf. Preparation of spherical silica nanoparticles: Stober silica. J. Am. Sci. 6(11), 985-9, 2010.*
9. *X. Chen, S.S. Mao. Titanium dioxide nanomaterials: synthesis, properties, modifications, and applications. Chemical reviews. 11, 107(7), 2891-959, 2007.*
10. *Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, Nanofluids: Science and Technology, Wiley, 2007.*

19CHOE07 - MULTIVARIATE STATISTICS LABORATORY

L	T	P	C
0	0	6	3

ASSESSMENT : PRACTICAL

COURSE OUTCOMES

After completion of the course, students are able to

CO1 : Design experiments to obtain statistical principles of Univariate examples.

CO2 : Apply the concepts of statistics to draw conclusions from data

CO3 : Assess practical knowledge to carry out meaningful interpretation of data from real life

CO4 : Conduct experiments to solve complex engineering problems effectively as an individual or team work.

CO5 : Perform as a leader with good ethical principles to meet societal needs in the field of chemical engineering.

LIST OF EXPERIMENTS

1. Point and Interval Estimation for Normal and Chi-Square Distribution using Excel and R.
2. Point and Interval Estimation for T-Distribution and F-Distribution using Excel and R.
3. K-means Clustering.
4. One-way ANOVA Model in Excel and R.
5. Linear Regression
6. Logistic Regression
7. Naive Bayesian Classifier
8. Decision Trees
9. Simulation of Principal component analysis using Excel and R.
10. Simulation of Fischer Discriminant Analysis using Excel and R.
11. Modeling the Change by Differential Equations using R and Excel.
12. Modeling the Change by Difference Equations using R and Excel.
13. Multivariate Normal & Hoteling's T2 Distribution.
14. Multivariate Analysis of Variance (MANOVA).
15. Correspondence Analysis using R.

TOTAL : 60

REFERENCES

1. *Apostol T.M. (1985) Mathematical Analysis, Narosa,Indian Ed.*
2. *Courant R. And John F. (1965) Introduction to Calculas and Analysis, Wiley.*
3. *Miller K.S. (1957) Advanced Real Calculas, Harper, New York.*
4. *Rudin, Walter (1976) Principles of Mathematical Analysis,McGraw Hill.*
5. *Malik S.C. (2005) Principles of Real Analysis, New Age International (p)Ltd.*
6. *Bartle R.G. (1976) Elements of Real Analysis*

19MOE01 - GRAPH THEORY AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : The students will be able to understand the idea of graph theory and to solve the real time problem.

CO2 : To relate the Graph theory Algorithms' in their field of engineering and apply the same in the irrespective mainstream.

CO3 : To become familiar with Special graphs for modeling the networks.

CO4 : Able to design and solve Coloring concepts for defined problems.

CO5 : Model the networks using graph theory.

GRAPHS ANDSUB GRAPHS

Graph-Standard Concepts in Graphs - Sub graphs - Complete Graph - Bipartite Graph - Isomorphism - Adjacency Matrix and Incidence Matrix-Walk, Trail and Path - Bipartite Graph - Connectedness - The Shortest Path Problem - Dijkstra's Algorithm **(9)**

TREES

Trees- Characterization - Blocks - Block Graphs - Cayley's Formula - Spanning Trees - Spanning Tree Algorithms - Kruskal's and Prim's Algorithm **(9)**

EULERIAN AND HAMILTONIAN GRAPHS

Eulerian graphs - Euler's theorem - Hamiltonian graphs - Dirac's and Ore's theorems - Closure of a graph - Bondy -Chvatal theorem - Traveling salesman problem - The Chinese Postman Problem - Fleury's Algorithm. **(9)**

COVERING AND COLORING

Covering - Independent Sets - Matching - Perfect Matching- Applications - The Personal Assignment Problem - Coloring - Chromatic Number - Four Color Problem - Chromatic Polynomials - Application. **(9)**

DIRECTED GRAPHS

Digraph - orientation - strongly, weakly and unilaterally connected digraphs - directed acyclic graph - adjacency matrix and incidence matrix of graph - Network Flows - Transport Networks - Max - Flow Min-Cut Theorem - Activity Network **(9)**

TOTAL : 45

TEXT BOOKS

1. *Gary Chatrand and Ping Zhang, Introduction to Graph Theory, Mc Graw Hill Education (India), 2017.*
2. *Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall of India Private Limited, 2004.*

REFERENCES

1. *Douglas B.West, "Introduction to Graph Theory" Second Edition, Prentice Hall of India Private Limited, 2001.*
2. *Balakrishnan. R, Ranganathan. K , "A Text book of GraphTheory", Second Edition, Springer Newyork, 2012.*
3. *Clark. J. and Holton. D.A, "A First Look at GraphTheory", Allied Publishers,1995.*
4. *Frank Harary, Graph Theory, 10th Edition, Narosa Publishing House, 2001.*

19MOE02 - METHODS OF APPLIED MATHEMATICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : The students will be able to understand the idea of integral equations and to solve the real time problems.

CO2 : To familiarize the students with basic concept of ordinary differential equations, special functions and solve problems associated with engineering applications.

CO3 : To achieve an understanding of the basic concepts of boundary value problems and characteristic function representations and method of solving them.

CO4 : Able to construct and solve a mathematical model for heat flow problems in real life situation

CO5 : Able to use the concepts of Calculus of variations and basic concepts for solving equations involving functional

INTEGRAL EQUATIONS

Relation between integral and differential equations - Green's function. Fredholum's equation with separable Kernals Hilbert Schmidt theory, interactive methods for solving equations of second kind. **(9)**

SECOND ORDER ORDINARY DIFFERENTITAL EQUATIONS AND SPECIAL FUNCTIONS

Singular points, Series solutions and the methods of Frobenius, Bessel Equation, Bessel Functions, modified Bessel functions and their properties, Ber and Bei functions. **(9)**

BOUNDARY PROBLEMS AND CHARACTERISTIC FUNCTION REPRESENTATIONS

Sturm - Liouviller problems. Orthogonal functions and expansions in series of Orthogonal functions. Stodola and Vianello method for Sturm - Liouviller problems, Fourier - Bessel and Legendre Series **(9)**

PARTIAL DIFFERENTITAL EQUATIONS

Linear and quasi - linear equations of the first and second order. Characteristics of first and second order linear equations. Heat flow equations. Problems in one, two and three dimensions - Fourier method. **(9)**

INTEGRAL TRANSFORM METHODS

Calculus of variations - Variational notation, Constraints and Lagarangian multipliers, variable and points, Rayleigh - Ritz method. **(9)**

TOTAL : 45

TEXT BOOKS

1. *M.K. Venkatraman, Higher Mathematics for Engineering and Science, Third Edition, The National Publishing Company, 2014.*
2. *F.B. Hildebrand: Advanced Calculus for applications second Edition (EEE).Prentice Hall of India P.Ltd., 2014.*

REFERENCES

1. *F.B. Hildebrand - Methods of Applied Mathematics, Second Edition. Prentice Hall of India P.Ltd., 2012.*
2. *David Borthwick : An introduction to partial differential equation Springer International Publishing 2017.*
3. *Mattias Blennow: Mathematical methods in Physics and Engineering, CRC Press, 2018.*

19MOE03 - LINEAR AND NON - LINEAR PROGRAMMING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : The students will be able to understand the idea of linear Programming problems and to solve the real time problems.

CO2 : To familiarize the students with basic concept of Transportation models and solve problems associated with engineering applications.

CO3 : To achieve an understanding of the basic concepts of Assignment problems and method of solving them.

CO4 : Able to construct and solve a Game theory models in real life situation

CO5 : Able to use the concepts of Non-linear Programming problems for solving Constrained and unconstrained equations.

LINEAR PROGRAMMING

Formulation of LPP - Graphical methods for two variables - The Simplex method - Artificial Variables Techniques - Big M - method - The Two Phase method - Dual Simplex Method **(9)**

TRANSPORTATION MODEL

Mathematical formulation of a Transportation problem - Methods for finding initial basic feasible solution - North West corner rule - Least cost method - Vogel's Approximation method - Modified distribution method - Degeneracy in Transportation problems. **(9)**

ASSIGNMENT PROBLEM

Mathematical formulation of an Assignment problem - Hungarian Method - Unbalanced Assignment Models -Maximization case in Assignment Problems - Restrictions in Assignments - Travelling Sales man Problem. **(9)**

GAME THEORY

Two person zero - sum Games - The Maxmini - Minimax Principle - Saddle Point and value of the game -Games without saddle points, Mixed Strategies - Matrix Oddment method for n×n games - Dominance Property - Graphical Method of 2×n or m×2 games. **(9)**

NON - LINEAR PROGRAMMING

Non - linear Programming Algorithm - Unconstrained Non - linear Algorithms - Constrained Non -linear Lagrange multipliers, Kuhn - Tucker optimality conditions. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Operations Research An Introduction, Eight Edition, Hamdy A .TAHA, Pearson Prentice Hall 2016, New Delhi.*
2. *Resource management techniques by V.Sundaresan, Tenth Edition, 2016, A.R Publications, Chennai.*

REFERENCES

1. *Kanti Swarup, P.K. Gupta and Man Mohan, " Operations Research", Sultan Chand & Sons, Educational publishers, New Delhi. 20th Edition, 2019.*
2. *Frederick S. Hillier, Gerald J. Lieberman, "Introduction to Operations Research", Mc Graw Hill, (India) Private Limited, India, 11th Edition, 2021.*

19MOE04 - PROBABILITY AND RANDOM PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : The students will be able to understand the basic probability problems and to solve the real time problems.

CO2 : To familiarize the students with basic concept of probability distributions and solve problems associated with engineering applications.

CO3 : To achieve an understanding of the basic concepts of Correlation and regression and method of solving them.

CO4 : Able to solve a signal processing problems by using random process concepts.

CO5 : Able to use the concepts of Correlation functions and Power spectral densities for solving Electrical and electronics problem.

THEORY OF PROBABILITY

Sample Space, Events, Axioms of probability, Conditional probability, Independent events, Theorem of total probability, Baye's Theorem. **(9)**

PROBABILITY DISTRIBUTIONS

Definition of Discrete and Continuous random Variables

Discrete distributions : Binomial, Poisson and Geometric - Properties and Simple problems

Continuous distributions : Normal, Uniform Exponential - Properties and Simple problems. **(9)**

CORRELATION AND REGRESSION

Correlation -Meaning and scope of Correlation - Scatter diagram, Karl Pearson's co-efficient of Correlation, Spearman's Rank Correlation, Multiple Correlation and partial correlation - simple problems.

Regression Analysis - Meaning and Scope of regression - Regression in two variables - Uses of Regression. **(9)**

RANDOM PROCESSES

Classification - Stationary process - Markov process - Poisson process - Random telegraph process. **(9)**

CORRELATION FUNCTIONS AND POWER SPECTRAL DENSITIES

Auto Correlation functions - Cross Correlation functions - Properties - Power spectral density - Cross spectral density - Properties. **(9)**

TOTAL : 45

TEXT BOOKS

1. *S.C. Gupta and V.K. Kapoor, Fundamental of Mathematical Statistics, Tenth Revised Edition, 2020.*
2. *T. Veerarajan, Probability, Statistics and Random Processes, Second Edition, Tata Mc Graw - Hill 2017.*

REFERENCS

1. *Robert Hogg & Joseph McKean: Introduction to Mathematical Statistics, Pearson 8th Edition 2018.*
2. *Bhat, B. R.: Modern Probability Theory - An Introductory Text Book, Third Edition, New Age International 2015.*

3. *Cochran,W.G: Sampling Techniques, Wiley Eastern Private Limited, 2007.*
4. *Sukhatme, P.V. and Sukhatme, B.V.(1977) : Sampling Theory of Survey with Applications, Asia publishing House.*
5. *Rakesh Dube, "Higher mathematics for Engineering and Science" Manakin Press, 2018.*
6. *Ibe,O.C.,"Fundamentals of Applied Probability and Random processes", 2nd Edition, Elsevier, 2019.*
7. *Peyton Peebles, "Probability Random Variables and Random Signal Principles", Tata Mc Graw Hill, 4th Edition, NewDelhi, 2017.*

19POE01 - INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Demonstrate the understanding of length scales concepts, nanostructures and nanotechnology.

CO2 : Understand the different classes of nanomaterials.

CO3 : Identify the principles of processing, manufacturing and characterization of nanomaterials and nanostructures.

CO4 : Outline the applications of nanotechnology and develop an ability to critically evaluate the promise of a nanotechnology device.

BASICS OF NANOTECHNOLOGY

Introduction - Time and length scale in structures - Definition of a nanosystem - Dimensionality and size dependent phenomena - Surface to volume ratio - Fraction of surface atoms - Surface energy and surface stress- surface defects - Effect of nanoscale on various properties - Structual, thermal, mechanical, magnetic, optical and electronic properties. **(9)**

DIFFERENT CLASSES OF NANOMATERIALS

Classification based on dimensionality - Quantum Dots, Wells and Wires - Carbon based nano materials (buckyballs, nanotubes, graphene) - Metal based nanomaterials (nanogold, nanosilver and metal oxides) - Nanocomposites - Nanopolymers - Nano ceramics - Biological nanomaterials. **(9)**

SYNTHESIS OF NANOMATERIALS

Chemical Methods: Metal Nanocrystals by Reduction - Sol - gel processing - Solvothermal Synthesis - Photochemical Synthesis - Chemical Vapor Deposition (CVD) - Metal Oxide - Chemical Vapor Deposition (MOCVD). Physical Methods: Ball Milling - Electrodeposition - Spray Pyrolysis - DC/RF Magnetron Sputtering - Molecular Beam Epitaxy (MBE). **(9)**

CHARACTERIZATION OF NANOSTRUCTURES

Introduction, structural characterization, X-ray diffraction (XRD-Powder/Single crystal), Small angle X-ray scattering (SAXS), Scanning Electron Microscopy (SEM) - Energy Dispersive X-ray analysis (EDAX) - Transmission Electron Microscope (TEM) - Scanning Tunneling Microscope (STM) - Atomic force microscopy (AFM), UV-vis spectroscopy (liquid and solid state) - Raman spectroscopy - X-ray Photoelectron Spectroscopy (XPS) - Auger electron spectroscopy(AES). **(9)**

APPLICATIONS

Solar energy conversion and catalysis - Molecular electronics and printed electronics -Nanoelectronics - Polymers with a special architecture - Liquid crystalline systems - Applications in displays and other devices - Nanomaterials for data storage - Photonics, Plasmonics - Chemical and biosensors - Nanomedicine and Nanobiotechnology. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Nano technology: Basic Science and Emerging technologies, Mick Wilson, Kamali Kannargare., Geoff Smith Overseas Press (2005)*
2. *A Text book of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw Hill Education Pvt. Ltd., 2012.*
3. *Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, 2002.*
4. *Introduction to Nanotechnology, Charles P.Poole,Frank J.Owens, Wiley Interscience (2003)*

5. *Textbook of Nanoscience and Nanotechnology, B.S. Murty, P. Shankar, Baldev Raj, B B Rath, James Murday, Springer Science & Business Media, 2013.*

REFERENCES

1. *Nanotechnology: A gentle introduction to the next Big idea, Mark A.Ratner, Daniel Ratner, Mark Ratne, Prentice Hall P7R:1st Edition (2002)*
2. *Fundamental properties of nanostructed materials Ed D. Fioran, G.Sberveglier, World Scientific 1994*
3. *Dupas C., Houdy P., Lahmani M.,Nanoscience: Nanotechnologies and Nanophysics, Springer-Verlag Berlin Heidelberg, 2007*

19POE02 - PHYSICS AND TECHNOLOGY OF THIN FILMS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Recognize the fundamental growth and material parameters of thin films.

CO2 : Evaluate and use models for nucleation and growth of thin films.

CO3 : Asses the relation between deposition technique, film structure and film properties.

CO4 : Identify modern techniques for the characterization of thin films

CO5 : Demonstrate the applications of thin films

Preparation of thin films : Preparation methods: electrolytic deposition, cathodic and anodic films, thermal evaporation, cathodic sputtering, chemical vapour deposition. Molecular beam epitaxy and laser abalation methods. Thickness measurement and monitoring: electrical, mechanical, optical interference, microbalance, quartz crystal methods. **(9)**

Growth Kinetics of Thin Films : General features.- nucleation theories - energy formation of a nucleus - critical nucleation parameters; spherical and non spherical (cap, disc and cubic shaped) Effect of electron bombardment on film structure. Post-nucleation growth, epitaxial films and growth. **(9)**

Analytical techniques of characterization : X-ray diffraction - Photoluminescence - UV-Vis-IR spectrophotometer - Atomic Force Microscope - Scanning Electron Microscope - Hall effect - Vibrational Sample Magnetometer - Secondary Ion Mass Spectrometry - X-ray Photoemission Spectroscopy - Auger emission spectroscopy. **(9)**

Properties of Thin films : Dielectric properties - experimental technique for the determination of dielectric properties - optical properties - experimental technique for the determination of optical constants - mechanical properties - experimental technique for the determination of mechanical properties of thin films - magnetic and superconducting properties. **(9)**

Applications : Optoelectronic devices : LED, LASER and Solar cell - Micro Electromechanical Systems (MEMS) - Fabrication of thin film capacitor - application of ferromagnetic thin films; data storage, Giant Magnetoresistance (GMR) - sensors - fabrication and characterization of thin film transistor and FET. **(9)**

TOTAL : 45

TEXT BOOKS

1. *A. Goswami, Thin Film Fundamentals, New Age international (P) Ltd. Publishers, New Delhi, 2006.*
2. *L.I. Maissel and Glang (Eds.), Handbook of Thin film Technology, McGraw-Hill, 1970.*
3. *K.L. Chopra, Thin Film Phenomena, McGraw-Hill (1983)*

REFERENCES

1. *Thin-Film Deposition : Principles and Practice, Smith Donald Donald L Smith Smith, McGraw-Hill Professional Pub, 1995*
2. *J.C. Anderson, The Use of Thin Films in Physical Investigation, Academic Press 1966.*
3. *J.J. Coutts, Active and Passive Thin Film Devices, Academic Press 1978.*
4. *George Hass, Physics of Thin Films: Volumes 1.:12, Academic Press 1963.*
5. *Kiyotaka Wasa, Makoto Kitabatake, Hideaki Adachi, Thin Films Material Technology, Springer-Verlag Berlin Heidelberg, 2004.*

19POE03 - SOLAR CELL FUNDAMENTALS AND MATERIALS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Demonstrate the knowledge about photovoltaics.

CO2 : Gain knowledge about principle of operation of solar cells

CO3 : Realization about semiconducting materials used in the manufacture of PV cells

CO4 : Outline the various advanced solar cell technologies, their current status and future technological challenges

EVOLUTION OF SOLAR CELLS

Historical development; present and future global issues- commercialization/economic factors- basic components of PV systems - The solar spectrum - terrestrial and space spectra; air mass (AM0, AM1.5) - Introduction to 1st, 2nd and 3rd generation photovoltaics. **(9)**

SOLAR CELL FUNDAMENTALS

Photovoltaic effect - Principle of direct solar energy conversion into electricity in a solar cell - light absorption- creating charge carriers forming the electric field - driving the charge carriers - solar cell parameters- electrical characteristics - the ideal solar cell, solar cell in practice, the quantum efficiency and spectral response, optical properties - basics of solar cell device design. **(9)**

SEMICONDUCTOR PROPERTIES

Overview of semiconductor properties relevant to solar cell operations- semiconductor band structure, carrier statistics in semiconductors, the transport equations, carrier mobility, carrier generation by optical absorption - band to band transitions, free-carrier absorption, recombination- bulk recombination processes, surface recombination, minority carrier life time. **(9)**

SILICON AND THIN FILM SOLAR CELLS

Si photovoltaics - single crystal silicon cells - semicrystalline and polycrystalline silicon cells - overview of various thin film solar cells: gallium arsenide solar cells - fabrication techniques, InP & cadmium telluride based solar cells - copper indium diselenide solar cells - multijunction cells - environmental and health aspects. **(9)**

ADVANCED SOLAR CELLS

Advanced solar cell concepts - organic (polymer) photovoltaics - new concepts - quantum dots, wires, intermediate band, multiple exciton generation - Dye sensitized solar cells - perovskite solar cells - challenges in materials and device design - current and future research trends in PV. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Fonash S. J., "Solar Cell Device Physics", Academic, 2010.*
2. *Goetzberger, J. Knobloch, and B. Voss "Crystalline Silicon Solar Cells" Wiley, 1998.*
3. *Green M. A. "Third Generation Photovoltaics: Advanced Solar Energy Conversion" Springer, 2006 .*

REFERENCES

1. *Chetan Singh Solanki., Solar Photovoltaic: "Fundamentals, Technologies and Application", PHI Learning Pvt. Ltd., 2009.*
2. *Jha A.R., "Solar Cell Technology and Applications", CRC Press, 2010.*

19POE04 - ADVANCED MATERIAL PROCESSING TECHNOLOGIES

L	T	P	C
3	0	0	3

COURSE OUTCOMES

After completing the course successfully, the students will be able to,

CO1 : Recognize the criteria for material selection based on properties of materials and to choose the required material for a specified application.

CO2 : Understand various metallurgical forming processes such as casting, rolling extrusion, drawing, development of grain structure and processing of different composite types.

CO3 : Demonstrate knowledge about powder metallurgy, ceramic and polymer processing methods.

CO4 : Identify and choose the required surface treatment technique for coating formation on account of enhancing the surface properties of the mechanical components for engineering applications.

CO5 : Understand the applicable joining and machining techniques and their limitations

INTRODUCTION AND SELECTION OF MATERIALS

Motivation for selection - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability, corrosion and wear resistance - Relationship between materials selection and processing - Case studies - aero, auto, marine, machinery and nuclear applications. High and low temperature materials, superconductors, supramagnetic materials, high entropy alloys, nanomaterials and biomaterials. **(9)**

METALLURGICAL FORMING AND PROCESSING OF COMPOSITES

Metallurgical forming: Casting, rolling extrusion, drawing, development of grain structure for specific properties. Processing of composites: lay up methods, press/ autoclave / resin transfer moulding, Reinforced Reaction Injection Molding (RRIM), obtrusion and filament winding. **(9)**

POWDER METALLURGY, CERAMIC AND POLYMER PROCESSING

Powder metallurgy and ceramic processing: green fabrication methods, sintering, hot pressing, Hot Isostatic Pressing (HIP), spark plasma sintering, development of microstructure in powder processed materials. Polymer processing: extrusion, injection moulding, blow moulding, rotational moulding, vacuum forming and related processes processing of cellular polymers. **(9)**

COATING METHODS

Introduction to surface Engineering, Differences between surface and bulk properties, Properties of surfaces-wear, wettability. Chemical vapour deposition, physical vapour deposition, electro deposition, electroless deposition, thermal spray processes. Principle of various coating processes, process parameters, controlling the yield of coating and various surface properties of the coating. Criteria for selection of a surface coating technology. Product oriented surface coating technology. **(10)**

JOINING AND MACHINING

Joining: fusion welding, solid state welding, adhesive bonding, mechanical joining and recent advancements in welding. machining: Electromachining (electrochemical and electro-discharge), mechanical machining and recent advancements. **(8)**

TOTAL : 45

TEXT BOOKS

1. *Charles J.A., Crane, F.A.A and Furness, J.A.G., "Selection and use of Engineering Materials", 3rd Edition, Butterworth-Heinemann, 1977.*
2. *Betzalel Avitzu, "Metal Forming- Processes and Analysis", Tata McGraw Hill, 1977.*

3. *William F Hasford, Robert M Caddell "Metal Forming: Mechanics and Metallurgy" Cambridge University Press P. ltd, 2007.*
4. *Angelo P C and Subramanian R" Powder Metallurgy Science, Technology and Applications", Prentice Hall of India, New Delhi, 2012.*

REFERENCES

1. *Michael Barsoum, "Fundamentals of Ceramics", Mc Graw Hill Publishing Co., INC, 1997*
2. *Gowariker V R, Viswanathan N V, Jayadev Sreedhar, "Polymer Science", New Age International P Ltd., 2005.*
3. *David S. Rickerby, Allan Matthews "Advanced surface coatings: a handbook of surface engineering", Blackie, 1991.*
4. *Parmar, R.S, "Welding Engineering and Technology", Khanna Publishers, 2003.*

19COE01 - MEDICAL NANO TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

The students will be able to

CO1 : Understand the essential features of nanomedicine

CO2 : Identify the medical based nanotools

CO3 : Assess health effects due to nanoparticle exposure

ASSESSING NANOTECHNOLOGY HEALTH

Nanomaterials : The Current State of Nanotechnology Application - Nanotechnology Risks - Risk Analysis - Hazard Identification - Exposure Assessment for Nanomaterials - Risk Characterization - Risk Management - Best Practices for Nanomaterials in the Workplace - Safety Research - Needs for Engineered Nanoscale Materials **(9)**

RISK ASSESSMENT AND ENVIRONMENTAL PROTECTION

Context for Technological Risk - Need for Risk Assessment for Nanotechnology - Adaptive Risk Assessment for Nanomaterials - Origins and Development of Risk Assessment - Risk Assessment Used in Environmental Decision Making - Issues in Applying the Four Steps of Risk Assessment to Nanotechnology - Hazard Assessment - Exposure Assessment - Dose - Response Evaluation **(9)**

SUSTAINABLE NANOTECHNOLOGY DEVELOPMENT

Necessity of Risk Assessment in Nanotechnology - The Pace of Nanotechnology Development and the Paucity of Information - Potential for Wide Dispersion in the Environment Amid Uncertainty - Few Standards or Guidelines - Environmental Risk Issues - Carbon Nanotubes - Defining the Toxic Dose - Environmentally Friendly Nanotechnology - Life Cycle Analysis for Sustainable Nanotechnology **(9)**

HUMAN HEALTH, TOXICOLOGY, AND NANOTECHNOLOGY RISK

Mechanisms of Toxicity - Types of Toxicological Studies - Pulmonary Toxicity Studies - Gastro intestinal Toxicity - In Vitro Studies - Dermal - In Vitro Toxicity Studies **(4)**

ENVIRONMENTAL RISKS

Antimicrobial Properties of Nanoscale Silver - Buckyballs, Titanium Dioxide - Short-term Toxicity Tests - Daphnia LC50 Assays - Studies of Nanomaterial Toxicity to Fish - Buckyballs and Bass-TiO_2 in Arsenic - Field Studies - Environmental Exposures - Nanoscale Zerovalent Iron **(9)**

NANOELECTRONIC DEVICES

Resonant tunneling diodes - Field effect transistors - Single electron transfer devices - Potential effect transistors - Light emitting diodes and lasers - Nanoelectromechanical system devices - Quantum dot cellular automata **(5)**

TOTAL : 45

TEXT BOOKS

1. *George W. Hanson, "Fundamentals of Nanoelectronics", Prentice Hall, 2007*
2. *Vladimir V. Mithin et.al, "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications" Cambridge University Press, 2012*

REFERENCES

1. *Mithin.V, Kochelap.V and Stroscio.M, "Introduction to Nanoelectronics", Cambridge University Press, 2008*
2. *Karl Gosar et.al, "Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum devices", Springer, 2005.*

19COE02 - ADVANCED DRUG DELIVERY SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : The students will be able to know the fundamentals of Nanoscience and their applications in pharamacological industries

CO2 : The students will able to describe polymeric drug delivery systems and their encapsulation methodology to study targeted drug delivery with different polymeric systems

CO3 : The students will able to identify lipids-nanocarriers and their application in biological system

CO4 : The students will able to study site specific drug delivery for gene therapy

THEORY OF ADVANCED DRUG DELIVERY

Fundamentals of Nanocarriers - Size, Surface, Magnetic and Optical Properties, Pharmacokinetics and Pharmacodynamics of Nano drug carriers. Critical Factors in drug delivery. Transport of Nanoparticles - In Vitro and Ex Vivo Models. **(10)**

POLYMERS Dendrimers- Synthesis -Nanoscale containers- Dendritic Nanoscafold systems Biocompatibility of Dendrimers, Gene transfection. pH based targeted delivery- chitosan and alginate. Copolymers in targeted drug delivery- PCL,PLA, PLGA. **(8)**

LIPID BASED NANOCARRIERS

Liposomes, niosomes and solid lipid nanoparticles. Ligand based delivery by liposomes. Cubosomes. **(9)**

MICROBES AND ANTIBODY BASED NANOCARRIERS

Bacterial dependent delivery of vaccines. Drug delivery and subcellular targeting by virus, Drug packaging and drug loading. Delivery of therapeutics by antibodies and antibodybioconjugates. **(9)**

SITE SPECIFIC DRUG DELIVERY

Concepts and mechanism of Site specific drug delivery- Microneedles, Micropumps, microvalves. Implantable microchips. **(9)**

TOTAL : 45

REFERENCES

1. *Drug Delivery: Engineering Principles for Drug Therapy, M. Salzman, Oxford University Press, 2001.*
2. *Drug Delivery and Targeting, A.M. Hillery, CRC Press, 2002.*
3. *Drug Delivery: Principles and Applications, B. Wang, Wiley Intersceince, 2005.*
4. *Nanoparticle Technology for Drug Delivery, Ram B. Gupta, Uday B. Kompella Taylor & Francis, 2006.*

19COE03 - BIOSENSORS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : The students will able to understand protein based biosensors and their enzyme reactivity, stability and their application in protein based nano crystalline thin film processing

CO2 : The students will able to describe DNA based biosensors to study the presence of heavy metals in the food products

CO3 : The students will able to understand fluorescence, UV-Vis and electrochemical applications of biosensors

CO4 : The students will able to study about the fabrication of biosensors and its application as nanochip analyzer

PROTEIN BASED BIOSENSORS

Nano structure for enzyme stabilization - Single enzyme nano particles - Nanotubes microporous silica - Protein based nano crystalline Diamond thin film for processing **(9)**

DNA BASED BIOSENSOR

Heavy metal complexing with DNA and its determination, water and food samples - DNA zymo biosensors **(9)**

ELECTRO CHEMICAL APPLICATION

Detection in biosensors - Flurorescence - Absorption - Electrochemical. Integration of various techniques - Fibre optic biosensors **(9)**

FABRICATION OF BIOSENSORS

Techniques used for microfabrication - Microfabrication of electrodes - On chip analysis **(9)**

BIOSENSORS IN RESEARCH

Future direction in biosensor research - Designed protein pores-as components of biosensors - Molecular design - Bionanotechnology for cellular biosensing - Biosensors for drug discovery - Nanoscale biosensors **(9)**

TOTAL : 45

REFERENCES

1. *Biosensors: A Practical Approach, J. Cooper & C. Tass, Oxford University Press, 2004*
2. *Nanomaterials for Biosensors, Cs. Kumar, Willey - VCH, 2007*
3. *Smart Biosensor Technology, G.K. Knoff, A.S. Bassi, CRC Press, 2006.*

19COE04 - NANOCOMPOSITES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

The students will be able to

CO1 : Study the different synthesis techniques of metal ceramic nanocomposites and their functionality

CO2 : Describe the processing techniques for heterometallic nanocomposites and to study their electromagnetical property

CO3 : Understand the design of super hard nanocomposites with improved mechanical properties

CO4 : Study the polymer based carbon nanotube composites, to study their mechanical properties and their industrial applications

NANO CERAMICS

Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. **(9)**

METAL BASED NANOCOMPOSITES

Metal-metal nanocomposites, some simple preparation techniques and their new electrical and magnetic properties. **(9)**

DESIGN OF SUPER HARD MATERIALS

Super hard nanocomposites, its designing and improvements of mechanical properties. **(9)**

NEW KIND OF NANOCOMPOSITES

Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Electrical property of fractal based nanocomposites. Core-Shell structured nanocomposites. **(9)**

POLYMER BASED NANOCOMPOSITES

Preparation and characterization of diblock Copolymer based nanocomposites; Polymercarbon nanotubes based composites, their mechanical properties, and industrial possibilities. **(9)**

TOTAL : 45

REFERENCES

1. *Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun 2006.*
2. *Physical Properties of Carbon Nanotubes- R. Saito 1998.*
3. *Carbon Nanotubes (Carbon, Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.*
4. *The search for novel, superhard materials- Stan Veprek (Review Article) JVST A, 1999*
5. *Electromagnetic and magnetic properties of multi component metal oxides, hetero*
6. *Nanometer versus micrometer-sized particles-Christian Brosseau,Jamal Ben, Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003*
7. *Diblock Copolymer, - Aviram (Review Article), Nature, 2002*

19COE05 - BIOREFINERY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

The students will be able to

CO1 : Understand various renewable feedstocks for biofuels production

CO2 : Understand the broad concept of second and third generation biofuel products from biomass and other low-cost agri-residues and biowastes.

CO3 : Analyze the design processes for biofuel production

CHEMISTRY & BIOCHEMISTRY OF BIOMASS

Types of biomass (e.g. wood waste, forestry residues, agricultural residues, perennial annual crops, organic municipal solid waste). Composition of lignocellulose (lignin, hemicellulose, cellulose); energy crops; chemical pretreatment; enzymatic pretreatment; degradation of cellulose; trichoderma cellulases; bacterial cellulases; and comparison with degradation of high starch. **(9)**

BIODIESEL

Sources and processing of biodiesel, nature of lipids, fatty acids and triglycerides.Sources and characteristics of lipids for use as biodiesel feedstock; and conversion of feedstock into biodiesel, (transesterification). Use of vegetable oil (SVO) and waste vegetable oil (WVO). Environmental issues of biodiesel; major policies and regulations pertaining to the production, distribution, and use of biodiesel. **(9)**

BIOMETHANE OR BIOGAS

Hydrolysis; anaerobic digestion; methanogenesis (acetoclastic, hydrogenotrophic), rates of methane formation; and one and two stage fermentation.Thermal depolymerization.Use of exhaust gases (e.g. CO_2, H_2S and H_2) from geothermal power plants and industrial operations (e.g. coal and oil refineries) as an energy sources (methane and hydrogen) **(9)**

GASIFICATION & PYROLYSIS TECHNOLOGIES

Gasification processes and the main types of gasifier designs; production of electricity by combining a gasifier with a gas turbine or fuel cell.Combined- cycle electricity generation with gas and steam turbines, and generation of heat and steam for district heating systems or CHP, including kalina Cycle. Production of synthesis gas (i.e. CO, H_2, H_2O, CO_2) tar vapor and ash particles) for subsequent conversion to hydrogen and transport fuels; advanced gas cleaning technologies for biomass. Biological conversion of syngas into liquid biofuels. Fast pyrolysis technology to produce a range of fuels, chemicals, and fertilizers; biorefineries, and new uses for glycerine in biorefineries. **(9)**

POLICIES AND FUTURE R&D OF BIOFUELS & BIOENERGY

Analysis of both current and future EU regulations and directives on biofuels and bioenergy.Tax regulations. Evaluation of different production alternatives to produce bioenergy; competitiveness of bioenergy alternatives in agriculture compared to other energy sources. Evaluation of current and future R&D needs; legal framework to support sustainable development and increased use of biofuels; government policies and programs with regard to biofuels and investment opportunities worldwide. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Robert C.Brown, "Biorenewable Resourses: Engineering", New Products from Agriculture, Wiley- Blackwell Publishing, 2003.*
2. *Samir K.Khanal, "Anaerobic Biotechnology for Bioenergy Production: Principles and Application", Wiley- Blackwell Publishing 2008.*

REFERENCES

1. *Martin Kaltschmitt; Hermann Hofbauer. "Biomass Conversion and Biorefinery", Springer Publishing, 2008.*

19HOE01 - PRINCIPLES OF MANAGEMENT

COURSE OUTCOMES

CO1 : Design the Management function for a given organization

CO2 : Design and develop a strategic approach for the completion of the project

CO3 : Analyze the behavior of individuals and groups in organizations in terms of the key factors

CO4 : Formulate the procedure for recruitment, selection, training of staff to establish an organization

Unit I - Introduction to Management: Meaning, Definition and Significance of Management-Basic functions of Management-Development of Management Thought **(9)**

Unit II - Management Concepts: Planning, Organizing, Staffing, Directing and Controlling- MBO-Six sigma **(9)**

Unit III - Organizational Behavior: Significance of OB, Role of Leadership, Personality and Motivation, Stress, Attitudes, Values and Perceptions at work **(9)**

Unit IV - Business Process Reengineering: Need for BPR, Various phases of BPR, Production and Productivity-Factors influencing Productivity **(8)**

Unit V - Human Resource Management: Evolution of Management- Development of Managerial skills-Human Resource Management - Objectives -Job analysis -Recruitment -Selection and Placement and Training Development **(10)**

TOTAL : 45

TEXT BOOKS

1. *Harold Koontz, Heinz Weihrich and Ramachandra Aryasri, "Principles of Management" Tata Mcgraw Hill, New Delhi, 2013.*
2. *Mamoria, CB, "Personnel Management", Sultan Chand and Sons, New Delhi, 2013.*

REFERENCES

1. *Robbin Finchanm and Peter Rhodes, "Principles of Organizational Behavior" Oxford University Press, 2010.*
2. *CB Gupta "Management Theory and Practice" Sultan Chand and Sons, New Delhi, 2009.*
3. *VSP Rao "Management Text and Cases" Excel Books, New Delhi, 2009.*
4. *Fred Luthans "Organizational Behavior" Mc-Graw hill, New York, 2005.*
5. *Knanna OP "Industrial Engineering and Management", Dhanpat Rai publications, New Delhi, 2003.*

19HOE02 : CURRENT TRENDS IN INDIAN ECONOMY

L	T	P	C
3	0	0	3

COURSE OUTCOMES

CO1 : Outline the structure of our Indian Economic System

CO2 : Access the role of industrial sector in Indian economy

CO3 : Interpret the demographic trends for the current scenario

CO4 : Analyze the role of two tier for the achievement of common national goals

Unit - 1 National Income and Agriculture Sector: Economics Development-Meaning-National Income and Per capita Income in India- Indian Planning-Agricultural Development of India: Major crops- Production-Productivity-Contribution to GDP and Exports **(8)**

Unit - II Industrial Sector: India's industrial development-Industrial policies of 1948, 1956 and 1991-Liberalisation-Public sector-Privatization-Disinvestment policy-Role and importance of large scale industries and small scale industries-Special economic zones-Contribution to GDP-Growth rate **(8)**

Unit - III Population: Growth and policy issues-Demographic trends-Vital statistics-India's population: size and growth rate-Demographic dividend-HDI-Population policy-Issues of Unemployment, Poverty and inequality in India **(10)**

Unit - IV Service sector: Service sector in India-Banking-Insurance-Telecommunication-IT sector-Software exports-BPO-Contribution to GDP **(9)**

Unit - V Federal System and Foreign Trade: Federal setup in India-Taxes: Direct and Indirect Tax-Value added Tax-Foreign direct investment-Merits and Demerits-India's imports and exports: Composition and direction-Foreign exchange reserve position-MNC's in India **(10)**

TOTAL : 45

TEXT BOOKS

1. *Ruddar Datt and Sundaram, KPM, Indian Economy, S.Chand and company, New Delhi-2015*
2. *Ramesh Singh Indian Economy, McGraw hill Education 7th edition, 2015*

References: www.jagranjosh.com

19H0E03 - MONETARY ECONOMICS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

CO1 : Evaluate the monetary measures formulated through static and dynamic role of money

CO2 : Design the driving force of circular flow of money

CO3 : Analyse how quantity theory of money fluctuate the price level

CO4 : Estimate the demand and supply of money based on the Interest rate

Unit I Nature and significance of Money: Definition of Money-Functions of Money-Static and Dynamic role of Money-Circular flow of Money-Monetary standards-Gold standard-Paper currency standard-Principles of Note issue-Measures of Money supply **(9)**

Unit II Quantity Theory of Money: Fisher's quantity theory of Money-Assumptions-Cash Balance Approach (Cambridge Equations)- Equation of Marshall, Pigou and Keynes-Similarities and dissimilarities of cash balance and cash transaction approaches-Income and expenditure theory-Superiority of Income and expenditure theory-Demand for Money: Classical and Keynesian liquidity preference theory approach **(9)**

Unit III Inflation and Deflation: Meaning-Types-Causes of Inflation-Demand Pull and Cost push inflation -Inflationary Gap-Phillips Curve-Effects of Inflation-Deflation-Causes-Measures to control Inflation and Deflation-Stagflation **(9)**

Unit IV Commercial Banking and Financial Markets: Functions of Commercial Banks-Credit Creation-Meaning and constitute of Money Markets-Capital Market-Institutional structure of Capital Market-Primary Market-Secondary Market-Indian capital Market-Non-Banking financial intermediaries **(9)**

Unit V Central Banking and Monetary Policy: Central Banking-Functions-Organization-Instruments of Credit control-Monetary Policy: Meaning, Objectives, and Recent policy changes in RBI-Monetary Policy in a developing economy **(9)**

TOTAL : 45

TEXT BOOK

1. *Jhinghan ML "Monetary Economics:" Vrinda Publications, New Delhi, 2013.*

REFERENCES

1. *Sethi TT, "Monetary Economic Theory", S Chand & Co, New Delhi, 1996.*
2. *Mithani DN, "Money Banking and International Trade", Himalaya, Mumbai, 2013.*

19HOE04 - ENGLISH FOR ACADEMIC PURPOSE

L	T	P	C
3	0	0	3

COURSE OUTCOMES

CO1 : Write a description and apply grammatical rules.

CO2 : Analyse a passage and enhance vocabulary.

CO3 : Formulate a research paper

CO4 : Listen to a lecture and prepare a summary.

CO5 : Construct dialogues using appropriate expressions.

FOCUS ON LANGUAGE

Sentence construction- types of clauses- sequence- co ordination- subordination- paragraphing information - describing a system & procedure **(9)**

READING

Understand a writer's purpose - Use strategies to ascertain meaning from unfamiliar vocabulary encountered in context - Recall and use vocabulary regarding urbanization and megacities - To identify and outline main ideas in a passage - Skim a reading passage for main ideas - Summarize texts and images - Using a dictionary to obtain lexical, phonological and orthographical information - Identify and use target vocabulary words - Highlight important parts and texts. **(13)**

WRITING

Achieving appropriate tone and style in academic writing - writing a Research article - Types of Research Designs - Choosing a Research Problem- The Abstract - The Introduction - The Literature Review - 6. The Methodology - The Results - The Discussion - The Conclusion - Citing Sources - Proofreading.

LISTENING

Listening to conversation - lectures - topics - discussions - listening comprehension on specific topics - listening to recognize formal and informal spoken English **(11)**

SPEAKING

Seminar skills - Engage in verbal role playing in Formal and Informal situation. - Express advice and personal opinions with supporting information - Paraphrase stories and information - Expressing requests - Suggestions - Complaints - Apology - Giving and Accepting compliments - Making invitations - Refusing invitations **(12)**

TOTAL : 45

REFERENCES

1. *Wisniewska, I., Riggenbach, H.,& Samuda, V. (2007). Grammar dimensions*
2. *Form, meaning, and use (4th Ed.). Boston, MA: Heinele Cengage Learning Longman Introductory Course for the TOFEL Test*
3. *Original publications and web- based resources will be reviewed as necessary.*

19HOE05 - ENGLISH FOR COMPETITIVE EXAMS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

CO1 : Listen to TOEFL exercises and formulate appropriate answers.

CO2 : Speak using right grammar and appropriate pronunciation on general and academic topics.

CO3 : Analyze the passage and answer the question.

CO4 : Generate and organize ideas on a given topic

LISTENING

Listening to conversation - Narration - Suggestion - Assumptions - Predictions - Implications - Problems - Academic conversations - Discussions - Lectures **(11)**

SPEAKING

Independent speaking - Integrated speaking - Speaking about a personal experience - Preferences - Report the speakers opinion - Explain a problem and solution - Give a summary of a academic lecture. **(13)**

READING

Read and understand short passages - Integrated reading tasks - Read the passage and choose the right summary of the passage - Reading for main ideas - Scanning the passage for synonyms - Making inferences - Identifying exceptions - Locating references. **(12)**

WRITING

Independent writing - Integrated writing - Writing short essays - Writing dialogues - Articles - Sentence construction **(9)**

TOTAL : 45

REFERENCES

1. *Sharpe J.Pamela. Barron's How to prepare for the TOEFL Test of English as a foreign Language. 11th Edition, Galgotia Publications Pvt. Ltd: New Delhi, 2004.*
2. *Sharpe J.Pamela. Barron's TOEFL iBT Internet- Based Test. 12th Edition, Galgotia publications Pvt.Ltd: New Delhi, 2009.*

19HOE06 - LIFE AND LITERATURE

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COURSE OUTCOMES

CO1 : Compose an essay on the prose piece

CO2 : Analyse the poem and write a critical appreciation of it

CO3 : Read the story and find the moral values implied in the stories

CO4 : Write a review the fiction

Unit - 1 : Prose

The Postmaster by Rabindranath Tagore

Snapshot of a Dog by J G Thurber

On the Rule of the Road by A.G. Gardiner

The Village Schoolmaster by Oliver Goldsmith

Incident of the French Camp by Robert Browning **(13)**

Unit - 2 : Poems

Stopping By Woods on a Snowy Evening by Robert Frost

The Ballad of Father Gilligan by W.B. Yeats **(9)**

Unit - 3 : Short stories

The Model Millionaire by Oscar Wilde

The Ant and the Grasshopper by W. Somerset Maugham

The Doll's House by Katherine Mansfield, Biography

Albert Einstein and Steve Jobs **(11)**

Unit - 4 : Fiction

The Old Man and the Sea by Ernest Hemmingway

The Scarlet Pimpernel by Baroness Emma Orczy

Practice in creative writing, review writing **(13)**

TOTAL : 45

REFERENCES

1. *Xavier. ed. An Anthology of Popular Essays and Poems. Macmillan: New Delhi, 2009.*
2. *Kumara Pillai. ed. A Book of Modern Short Stories. Macmillan: New Delhi, 2009.*
3. *Colleen and Darius Krishnaraj. ed. Convergence , A Book of Short Stories. Macmillan: New Delhi, 2009.*
4. *Ernest Hemmingway. The Old Man and the Sea. Arrow: Warwickshire, 2000.*
5. *Baroness Emma Orczy, The Scarlet Pimpernel. Hutchinson : 1995.*

COIMBATORE INSTITUTE OF TECHNOLOGY

(Autonomous Institution affiliated to Anna University Chennai)

COIMBATORE - 641 014

DIAMOND JUBILEE
(1956 - 2016)

DEPARTMENT OF CHEMICAL ENGINEERING

B.Tech. CHEMICAL ENGINEERING

Curriculum and Syllabi

THIRD TO EIGHTH SEMESTER

Under Choice Based Credit System

(For the students admitted during 2019 - 2020 and onwards)

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