COIMBATORE INSTITUTE OF TECHNOLOGY

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

COIMBATORE - 641 014, TAMILNADU, INDIA

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 the academic year 2015 - 2016 and onwards)

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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.

DEPARTMENT OF CHEMICAL ENGINEERING

COIMBATORE INSTITUTE OF TECHNOLOGY

VISION AND MISSION OF THE DEPARTMENT

VISION

The Department of Chemical Engineering strives for excellence in all aspects of teaching and research, to produce Chemical Engineers of quality required in Industries / academic / research organizations and serves the society at national and international standards.

MISSION

1. To educate the young minds by providing academic and research proficiency to pursue their successful career in industry, academic and research organization.

2. To evolve innovative technologies in the field of chemical engineering towards serving the profession and the community.

3. Nurture students to be dynamic, versatile in their profession and also in the humanism.

DEPARTMENT OF CHEMICAL ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1 : Students will exhibit professional knowledge in understanding of chemical processes, design and development of chemical equipments in chemical industries.

PEO2 : Students will be able to perform research and development work by utilizing the experimental skills, mathematical tools and specialized software.

PEO3 : 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.

DEPARTMENT OF CHEMICAL ENGINEERING

B. Tech. CHEMICAL ENGINEERING

PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES
(POs & PSOs)

Chemical Engineering Graduates will be able to :

PO1 : Apply the knowledge of mathematics, physical sciences and engineering fundamentals to practical problems in their respective professions

PO2 : Identify and analyze chemical engineering problems to improve the efficiency of processes and quality of products in chemical industry.

PO3 : Design innovative processes suitable to the contemporary needs of the chemical industry.

PO4 : Conduct work in multidisciplinary teams to solve complex engineering problems.

PO5 : Create work in ICT (information & communication tools) related to chemical engineering processes.

PO6 : Apply contextual knowledge in designing systems, components or processes to meet societal needs in the field of chemical engineering.

PO7 : Understand specified objectives within realistic benefits of environment and sustainability in the field of chemical engineering.

PO8 : Apply ethical principles and commit the norms of the chemical engineering practices.

PO9 : Work effectively as on individual, and as a member or leader in diverse teams, and in multidisciplinary environments.

PO10 : Communicate information and produce effective technical reports and oral presentations.

PO11 : Express knowledge and understanding of the chemical engineering and management principles as a member and leader in a team to manage projects.

PO12 : Recognize lifeling learning and to update technical know-how by self-learning besides learning a great deal by associating with professional bodies and alumni.

PSO1 : Understand and apply working knowledge of chemical engineering principles and applications.

PSO2 : Implement the inter-perceptional skills of individuals in technical profession.

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B.Tech. CHEMICAL ENGINEERING

CHOICE BASED CREDIT SYSTEM

Curriculum from the Academic Year 2015 - 2016 and onwards

Semester III

S. No.	Course Code	Course Name	Contact Hours	L	T	P	C	Category
		THEORY						
1	15CEM31	Complex Variables, Fourier Transforms and Partial Differential Equations	4	2	2	0	3	BS
2	15CH31	Organic Chemistry	3	3	0	0	3	BS
3	15CH32	Mechanics of Solids	3	3	0	0	3	PC
4	15CH33	Fluid Mechanics	4	2	2	0	3	PC
5	15CH34	Electrical Machines and Drives	3	3	0	0	3	ES
6	15CH35	Chemical Process Calculations	4	2	2	0	3	PC
7	15HSS01	Science of Creativity and Professional Ethics	2	1	1	0	1	EEC
		PRACTICALS						
8	15CH36	Organic Chemistry Laboratory	4	0	0	4	2	BS
9	15CH37	Electrical Engineering Laboratory	2	0	0	2	1	ES
		TOTAL					**22**	

Semester IV

S. No.	Course Code	Course Name	Contact Hours	L	T	P	C	Category
		THEORY						
1	15CMM41	Numerical Methods, Random Variables, Sampling Theory and Z-Transforms	4	2	2	0	3	BS
2	15CH41	Physical Chemistry	3	3	0	0	3	BS
3	15CH42	Chemical Process Industries	3	3	0	0	3	PC
4	15CH43	Chemical Engineering Thermodynamics	4	2	2	0	3	PC
5	15CH44	Mechanical Operations	4	2	2	0	3	PC
6	15CH45	Process Instrumentation	3	3	0	0	3	PC
		PRACTICALS						
7	15CH46	Technical Seminar and Report Writing	2	0	2	0	1	EEC
8	15CH47	Physical Chemistry Laboratory	4	0	0	4	2	ES
9	15CH48	Fluid Mechanics Laboratory	4	0	0	4	2	PC
		TOTAL					**23**	

Semester V

S. No.	Course Code	Course Name	Contact Hours	L	T	P	C	Category
		THEORY						
1	15CH51	Instrumental Methods of Chemical Analysis	3	3	0	0	3	PC
2	15CH52	Chemical Reaction Engineering	3	2	2	0	3	PC
3	15CH53	Heat Transfer	4	2	2	0	3	PC
4	15CH54	Mass Transfer - I	4	2	2	0	3	PC
5		Elective - I	3	3	0	0	3	
6		Elective - II	3	3	0	0	3	
		PRACTICALS						
7	15CH55	Technical and Instrumental Analysis Laboratory	4	0	0	4	2	PC
8	15CH56	Mechanical Operations Laboratory	4	0	0	4	2	PC
9	15CH67	Mini Project	4	0	0	4	-	EEC
		TOTAL					**22**	

Semester VI

S. No.	Course Code	Course Name	Contact Hours	L	T	P	C	Category
		THEORY						
1	15CH61	Process Dynamics and Control	4	2	2	0	3	PC
2	15CH62	Process Plant Utilities	4	3	0	0	3	PC
3	15CH63	Mass Transfer - II	4	2	2	0	3	PC
4	15CH64	Process Equipment Design and Drawing	5	1	0	4	3	ES
5		Elective - III	3	3	0	0	3	
6		Elective - IV	3	3	0	0	3	
		PRACTICALS						
7	15CH65	Reaction Engineering Laboratory	4	0	0	4	2	PC
8	15CH66	Heat Transfer Laboratory	4	0	0	4	2	PC
9	15CH67	Mini Project	4	0	0	4	2	EEC
		TOTAL					**24**	

Semester VII

S. No.	Course Code	Course Name	Contact Hours	L	T	P	C	Category
		THEORY						
1	15CH71	Transport Phenomena	4	2	2	0	3	PC
2	15CH72	Process Economics and Industrial Management	3	3	0	0	3	PC
3	15CH73	Process Modeling & Simulation	4	2	2	0	3	PC
4	15CH74	Chemical Process Plant Safety	3	3	0	0	3	PC
5	15CH75	Total Quality Management	3	3	0	0	3	PC
		PRACTICALS						
6	15CH76	Mass Transfer Laboratory	4	0	0	4	2	PC
7	15CH77	Process Control & Simulation Laboratory	4	0	0	4	2	PC
8	15CH78	In-plant Training Presentation	2	0	0	2	1	EEC
9	15CH81	Project Work and Viva-Voce	6	0	0	6	-	EEC
		TOTAL					**20**	

Semester VIII

S. No.	Course Code	Course Name	Contact Hours	L	T	P	C	Category
		THEORY						
1		Elective - V	3	3	0	0	3	
2		Elective - VI	3	3	0	0	3	
3		Elective - VII	3	3	0	0	3	
4		Elective - VIII	3	3	0	0	3	
5		Elective - IX	3	3	0	0	3	
		PRACTICALS						
6	15CH81	Project Work and Viva-Voce	6	0	0	6	6	EEC
		TOTAL					**21**	

LIST OF PROFESSIONAL ELECTIVES

S. No.	Course Code	Course Name	Contact Hours	L	T	P	C	Category
1	15CHE01	Sugar Technology	3	3	0	0	3	PE
2	15CHE02	Biochemical Engineering	3	3	0	0	3	PE
3	15CHE03	Electrochemical Engineering	3	3	0	0	3	PE
4	15CHE04	Drugs and Pharmaceuticals Technology	3	3	0	0	3	PE
5	15CHE05	Food Technology	3	3	0	0	3	PE
6	15CHE06	Environmental Engineering	3	3	0	0	3	PE
7	15CHE07	Energy Technology	3	3	0	0	3	PE
8	15CHE08	Polymer Science and Technology	3	3	0	0	3	PE
9	15CHE09	Modern Separation Techniques	3	3	0	0	3	PE
10	15CHE10	Energy Management in Chemical Industries	3	3	0	0	3	PE
11	15CHE11	Integrated Design of Chemical Processes	3	3	0	0	3	PE
12	15CHE12	Petrochemicals Technology	3	3	0	0	3	PE
13	15CHE13	Fertilizer Technology	3	3	0	0	3	PE
14	15CHE14	Optimization of Chemical Processes	3	3	0	0	3	PE
15	15CHE15	Computer Aided Design	3	2	2	0	3	PE
16	15CHE16	Piping and Instrumentation	3	3	0	0	3	PE
17	15CHE17	Mineral Processing Technology	3	3	0	0	3	PE
18	15CHE18	Fluidization Engineering	3	3	0	0	3	PE
19	15CHE19	Pulp and Paper Technology	3	3	0	0	3	PE
20	15CHE20	Industrial Waste Water Treatment	3	3	0	0	3	PE
21	15CHE21	Surface Coating Technology	3	3	0	0	3	PE
22	15CHE22	Petroleum Refinery Engineering	3	3	0	0	3	PE
23	15CHE23	Environmental Impact Assessment and Clean Technology	3	3	0	0	3	PE
24	15CHE24	Process Automation	3	3	0	0	3	PE
25	15CHE25	Heat Power Engineering	3	3	0	0	3	PE
26	15CHE26	Synthesis and Applications of Nanomaterials	3	3	0	0	3	PE

HUMANITIES AND SOCIAL SCIENCES (HS)

S. No.	Course Code	Course Name	L	T	P	C	Semester
1	15 FY 12	Technical English	3	0	0	3	I
2	15 FY 18	English Language Laboratory	0	0	2	1	I
3	15 FY 22	Language Elective	3	0	0	3	II
4	15 FY 24	Principles of Environmental Science and Engineering	3	0	0	3	II
		TOTAL CREDITS				**10**	

BS - Basic Sciences, HS - Humanities and Social Sciences, ES - Engineering Sciences,

PC - Professional Core, PE - Professional Elective, OE - Open Elective,

EEC - Employability Enhancement Course

BASIC SCIENCES (BS)

S. No.	Course Code	Course Name	L	T	P	C	Semester
1	15FY11	Mathematics-I	3	2	0	4	I
2	15FY13	Engineering Physics	3	0	0	3	I
3	15FY14	Engineering Chemistry	3	0	0	3	I
4	15FY16	Physics Laboratory - I	0	0	2	1	I
5	15FY17	Chemistry Laboratory - I	0	0	2	1	I
6	15FY21	Mathematics - II	3	2	0	4	II
7	15FY23	Material Science	3	0	0	3	II
8	15FY26	Physics Laboratory - II	0	0	2	1	II
9	15FY27	Chemistry Laboratory - II	0	0	2	1	II
10	15CEM31	Complex Variables, Fourier Transforms and Partial Differential Equations	2	2	0	3	III
11	15CH31	Organic Chemistry	3	0	0	3	III
12	15CH36	Organic Chemistry Laboratory	0	0	4	2	III
13	15CMM41	Numerical Methods, Random Variables, Sampling Theory and Z- Transforms	2	2	0	3	IV
14	15CH41	Physical Chemistry	3	0	0	3	IV
		TOTAL CREDITS				**35**	

ENGINEERING SCIENCES (ES)

S. No.	Course Code	Course Name	L	T	P	C	Semester
1	15 EE 01	Basic Electrical & Electronics Engineering	3	0	0	3	I
2	15 CS 01	C Programming	3	0	0	3	I
3	15 FY 15	Engineering Graphics - I	1	0	4	3	I
4	15 CS 02	C Programming Laboratory	0	0	2	1	I
5	15 ME 01	Carpentry and Fitting Laboratory	0	0	2	1	I
6	15 CM 01	Basic Civil and Mechanical Engineering	4	0	0	4	II
7	15 CH 01	Chemistry for Chemical Engineers	3	0	0	3	II
8	15 FY 25	Engineering Graphics - II	1	0	4	3	II
9	15 ME 02	Home Appliances Laboratory	0	0	2	1	II
10	15 CH 34	Electrical Machines and Drives	3	0	0	3	III
11	15 CH 37	Electrical Engineering Laboratory	0	0	2	1	III
12	15 CH 47	Physical Chemistry Laboratory	0	0	4	2	IV
13	15 CH 64	Process Equipment Design and Drawing	1	0	4	3	VI
		TOTAL CREDITS				**31**	

PROFESSIONAL CORE (PC)

S. No.	Course Code	Course Name	L	T	P	C	Semester
1	15 CH 32	Mechanics of Solids	3	0	0	3	III
2	15 CH 33	Fluid Mechanics	2	2	0	3	III
3	15 CH 35	Chemical Process Calculations	2	2	0	3	III
4	15 CH 42	Chemical Process Industries	3	0	0	3	IV
5	15 CH 43	Chemical Engineering Thermodynamics	2	2	0	3	IV
6	15 CH 44	Mechanical Operations	2	2	0	3	IV
7	15 CH 45	Process Instrumentation	3	0	0	3	IV
8	15 CH 48	Fluid Mechanics Laboratory	0	0	4	2	IV
9	15 CH 51	Instrumental Methods of Chemical Analysis	3	0	0	3	V
10	15 CH 52	Chemical Reaction Engineering	2	2	0	3	V
11	15 CH 53	Heat Transfer	2	2	0	3	V
12	15 CH 54	Mass Transfer - I	2	2	0	3	V
13	15 CH 55	Technical and Instrumental Analysis Laboratory	0	0	4	2	V
14	15 CH 56	Mechanical Operations Laboratory	0	0	4	2	V
15	15 CH 61	Process Dynamics and Control	2	2	0	3	VI
16	15 CH 62	Process Plant Utilities	3	0	0	3	VI
17	15 CH 63	Mass Transfer - II	2	2	0	3	VI
18	15 CH 65	Reaction Engineering Laboratory	0	0	4	2	VI
19	15 CH 66	Heat Transfer Laboratory	0	0	4	2	VI
20	15 CH 71	Transport Phenomena	2	2	0	3	VII
21	15 CH 72	Process Economics and Industrial Management	3	0	0	3	VII
22	15 CH 73	Process Modeling & Simulation	2	2	0	3	VII
23	15 CH 74	Chemical Process Plant Safety	3	0	0	3	VII
24	15 CH 75	Total Quality Management	3	0	0	3	VII
25	15 CH 76	Mass Transfer Laboratory	0	0	4	2	VII
26	15 CH 77	Process Control and Simulation laboratory	0	0	4	2	VII
		TOTAL CREDITS				**71**	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No.	Course Code	Course Name	L	T	P	C	Semester
1	15 HSS 01	Science of Creativity and Professional Ethics	1	0	0	1	III
2	15 CH 46	Technical Seminar and Report Writing	0	2	0	1	IV
3	15 CH 67	Mini Project	0	0	4	2	V&VI
4	15 CH 78	In-plant Training Presentation	0	0	2	1	VII
5	15 CH 81	Project Work and Viva-Voce	0	0	6	6	VII&VIII
		TOTAL CREDITS				**11**	

SUMMARY OF TOTAL CREDIT PERCENTAGE

Sl. No.	Category	Credits as per Semester								Credits Total
		I	II	III	IV	V	VI	VII	VIII	
1.	HS	4	6							10
2.	BS	12	9	8	6					35
3.	ES	11	11	4	2		3			31
4.	PC			9	14	16	13	19		71
5.	PE/OE					6	6		15	27
6.	EEC			1	1		2	1	6	11
	TOTAL	**27**	**26**	**22**	**23**	**22**	**24**	**20**	**21**	**185**

Sl. No.	Category	Range of Total Credits		
		% Contribution	Total Credits = 185	Number of 3 Credit Subjects
1.	HS	5.41	10	3
2.	BS	18.92	35	7
3.	ES	16.76	31	7
4.	PC	38.37	71	19
5.	PE/OE	14.59	27	9
6.	EEC	5.95	11	-

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LIST OF OPEN ELECTIVES

DEPARTMENT OF CIVIL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
15CEE35	Disaster Management	3	0	0	3	All Branches
15CEE36	Renewable Energy Resources	3	0	0	3	All Branches
15CEE38	Environmental Impact Assessment	3	0	0	3	All Branches
15CEE39	Solid and Hazardous Waste Management	3	0	0	3	All Branches
15CEE40	Principles of Sustainable Development	3	0	0	3	All Branches
15CEE41	Safety Engineering in Building	3	0	0	3	All Branches

DEPARTMENT OF MECHANICAL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
15MEOE01	Robotics	3	0	0	3	All Branches
15MEOE02	Low Cost Automation	3	0	0	3	All Branches
15MEOE03	Adaptive Control and Process Dynamics	3	0	0	3	All Branches
15MEOE04	Project Planning and Management	3	0	0	3	All Branches
15MEOE05	Supply Chain Management	3	0	0	3	All Branches
15MEOE06	Resource Management Techniques	2	2	0	3	All Branches
15MEOE07	Sustainable Development	3	0	0	3	All Branches
15MEOE08	Processing and Applications of Biomaterials	3	0	0	3	All except CSE & IT
15MEOE09	Numerical Simulation of Fluid Flow	3	0	0	3	All Circuit Branches
15MEOE10	Solar Energy Utilisation	3	0	0	3	Civil & Chemical

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
15EEOE01	Energy Auditing	3	0	0	3	ECE, Mech, Chemical, Civil
15EEOE02	Solar and Wind Energy Systems	3	0	0	3	ECE, Mech, Chemical
15EEOE03	Hybrid Smart Vehicles	3	0	0	3	All Branches except Civil, Chemical
15EEE07	Electrical Safety	3	0	0	3	All Branches
15EEE14	Energy Efficient Lighting System	3	0	0	3	All Branches

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
15ECOE01	Consumer Electronics	3	0	0	3	Civil & Mech
15ECOE02	ARM System Architecture	3	0	0	3	CSE & IT
15ECOE03	Broadband Communication	3	0	0	3	Mech, EEE, CSE & IT
15ECOE04	Robotics for Industrial Applications	3	0	0	3	Mech, CSE & IT
15ECOE05	Signal Processing and its Applications	3	0	0	3	Chemical, Mech & CSE

DEPARTMENT OF CSE

Course Code	Course Name	L	T	P	C	Eligible Branches
15CSOE01	Fundamentals of Software Engineering	3	0	0	3	EEE, ECE, Mech, Chemical & Civil
15CSOE02	Introduction to Data Warehousing and Data Mining	3	0	0	3	EEE, ECE, Mech, Chemical & Civil
15CSOE03	Introduction to Embedded Systems	3	0	0	3	Mech, Chemical & Civil
15CSOE04	Internet Programming	3	0	0	3	EEE, ECE, Mech, Chemical & Civil
15CSOE05	Customer Relationship Management Essentials	3	0	0	3	IT, EEE, ECE, Mech, Chemical & Civil
15CSOE06	E-commerce	3	0	0	3	IT, EEE, ECE, Mech, Chemical & Civil

DEPARTMENT OF IT

Course Code	Course Name	L	T	P	C	Eligible Branches
15ITOE01	Digital Computer Basics	3	0	0	3	Mech, Civil & Chem
15ITOE02	Programming in Java	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
15ITOE03	Fundamentals of Database Systems	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
15ITOE04	Cloud Computing Fundamentals	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
15ITOE05	Information Security Fundamentals	3	0	0	3	EEE, ECE, Mech, Civil & Chemical
15ITOE06	Introduction to Human Computer Interaction	3	0	0	3	CSE, EEE, ECE, Mech, Civil & Chemical
15ITOE07	Enterprise Resource Planning Concepts	3	0	0	3	CSE, EEE, ECE, Mech, Civil & Chemical

DEPARTMENT OF CHEMICAL ENGINEERING

Course Code	Course Name	L	T	P	C	Eligible Branches
15CHOE01	Industrial Safety Engineering	3	0	0	3	All Branches
15CHOE02	Risk Analysis and Hazop	3	0	0	3	All Branches
15CHOE03	Green Technology	3	0	0	3	All Branches
15CHOE04	Corrosion Science and Engineering	3	0	0	3	All Branches
15CHOE05	Introduction to Chemical Engineering	3	0	0	3	All Branches

DEPARTMENT OF MATHEMATICS

Course Code	Course Name	L	T	P	C	Eligible Branches
15MOE01	Graph Theory and Its Applications	3	0	0	3	All Branches
15MOE02	Methods of Applied Mathematics	3	0	0	3	All Branches
15MOE03	Linear and Non-Linear Programming	3	0	0	3	All Branches
15MOE04	Probability and Random Processes	3	0	0	3	All Branches

DEPARTMENT OF PHYSICS

Course Code	Course Name	L	T	P	C	Eligible Branches
15POE01	Introduction to Nanoscience and Nanotechnology	3	0	0	3	All Branches except IT
15POE02	Physics and Technology of Thin Films	3	0	0	3	Mech, EEE, ECE & Chemical
15POE03	Solar Cell Fundamentals and Materials	3	0	0	3	EEE, ECE & Chemical
15POE04	Advanced Material Processing Technologies	3	0	0	3	Mech & Chemical

DEPARTMENT OF CHEMISTRY

Course Code	Course Name	L	T	P	C	Eligible Branches
15COE01	Medical Nano Technology	3	0	0	3	Chemical
15COE02	Advanced Drug Delivery System	3	0	0	3	Chemical
15COE03	Biosensors	3	0	0	3	Chemical, ECE & EEE
15COE04	Nanocomposites	3	0	0	3	Mech, Chemical & Civil
15COE05	Biorefinery	3	0	0	3	Mech & Chemical

DEPARTMENT OF HUMANITIES

Course Code	Course Name	L	T	P	C	Eligible Branches
15HOE01	Principles of Management	3	0	0	3	All Branches
15HOE02	Current Trends in Indian Economy	3	0	0	3	All Branches
15HOE03	Monetary Economics	3	0	0	3	All Branches
15HOE04	Accounting for Managerial Decisions	3	0	0	3	All Branches
15HOE05	Entrepreneurship Development	3	0	0	3	All Branches
15HOE06	Employability Skills	3	0	0	3	All Branches
15HOE07	English for Academic Purposes	3	0	0	3	All Branches
15HOE08	English for Competitive Exams	3	0	0	3	All Branches
15HOE09	Life and Literature	3	0	0	3	All Branches

15CEM31 - COMPLEX VARIABLES, FOURIER TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : *Analyze the complex differentiation and to study the conformal mappings.*

CO2 : *Apply the Cauchy's theorems to evaluate the integrate in complex domain and expanding complex function usig Taylor / Laurent's series and also tostudy the method of calculus of residues.*

CO3 : *Formulate and solve the partial differential equations of linear and non-linear with standard techniques of higher order.*

CO4 : *Find the infinite and finite Fourier transform of standard functions and also to study the properties.*

CO5 : *Solve the one dimensional wave equation, one dimensional and two dimensional heat equations using Fourier series solution.*

COMPLEX DIFFERENTIATION

Analytic functions-Definitions and properties-Cauchy Riemann equations in Cartesian and polar coordinates-construction of analytic functions-Conformal mappings-Bilinear Transformation -the mappings of the form w= z+a, az, 1/z, z^2, ez, sinz, cosz, -Simple problems. **(12)**

COMPLEX INTEGRATION

Cauchy's integral theorem-Integral formula-Taylor's and Laurent's series (without proof)-Types of singularities, Poles and residues-Cauchy's residue theorem-Applications-Contour integration using circular and semicircular contours. **(12)**

PARTIAL DIFFERENTIAL EQUATIONS

Formation by elimination of arbitrary constants and functions-Solution by direct method-Solution of first order non-linear PDE-standard types-Lagrange's linear equation-Linear higher order homogeneous PDE with constant coefficients. **(12)**

FOURIER TRANSFORMS

Fourier integral theorem (without proof)-Infinite Fourier transform-Infinite Fourier sine and cosine transforms, properties and problems-Convolution theorem-Parseval's identity-Finite Fourier sine and cosine transforms, properties and problems. **(12)**

BOUNDARY VALUE PROBLEMS

Vibration of strings- One dimensional wave equations, one dimensional heat flow- Unsteady state and steady state -Two dimensional heat flow steady state in Cartesian coordinates-Separation of variables-Fourier series solution. **(12)**

TOTAL : 60

TEXT BOOKS

1. *Srimanta pal and Subodh C. Bhunia, " Engineering Mathematics", Oxford University Press India, 1stEdition, 2015.*

2. *E.Rukmangadachari, "Engineering Mathematics Vol II & Vol III", Pearson Education, 1st Edition.*

3. *VeerarajanT.,"EngineeringMathematics",ForSemesterI&II,ThirdEdition,Tata McGraw-HillPublishingcompanyLtd.,-2012.*

4. *Veerarajan .T, "Engineering Mathematics", (for Semester III), 3rd Edition, 4th Reprint, Tata McGraw-Hill publishing company Ltd ,2008.*

REFERENCE BOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, John Wiley & Sons (Asia) Private Limited., 2008.

2. Grewal, B.S., "Higher Engineering Mathematics", 40th Edition, Khanna Publishers - 2007.

3. Free ebook : Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, John Wiley& Sons (Asia), Private Limited., 2008- http://www-elec.inaoep.mx/~jmram/Kreyzig-ECS-DIF1.pdf

4. http://nptel.ac.in/courses/111105035/

15CH31 - ORGANIC CHEMISTRY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : *Predict the electron displacement effects, stability, optical activity and aromaticity of organic compounds.*

CO2 : *Develop the hybridization structures of hydrocarbons, conformational structures of alkanes, open chain and ring structures of carbohydrates.*

CO3 : *Analyze the electrophilic substitution reactions in aromatic hydrocarbons and heterrocyclic compounds.*

CO4 : *Prepare cycloalkanes, heterocyclic compounds, synthetic reagents and commercially valuable dyes.*

CO5 : *Discuss Bayer's strain theory, theory of orentation effects, applications of synthetic reagents, physiologial activities of alkaloids and industrial uses of dyes.*

NOMENCLATURE AND HYDROCARBONS

Nature and structure of organic molecules-Homologous series-functional groups-IUPAC nomenclature. Electron Displacement Effects-Inductive, Electromeric, Mesomeric and Hyperconjugative effects and their applications. Cycloalkanes: preparation, properties and stability of cycloalkanes - Baeyer's strain theory- Sachse - Mohr concept of strainless ring systems. Recovery of benzene and their homologues from coal tar and petroleum. Aromaticity - electrophilic substitution reactions of benzene and toluene. Orientation and reactivity - Disubstituion in benzene - theories of orientation. **(9)**

STREOCHEMISTRY

Geometrical isomerism - Beckmann rearrangement- optical isomerism - configurational isomerism - D and L and R-S Systems - Racemization- Resolution _ Asymmetric synthesis _ Walden inversion. Conformational isomerism -Conformers of ethane, propane, butane and cycloalkanes. **(9)**

CARBOHYDRATES

Classification- Conversions of monosaccharides - chemical properties of glucose and fructose- open chain and ring structures of glucose and fructose. Disaccharides: Sources, structure (no elucidation) and uses. Polysaccharies: sources and structures (no elucidation) of starch and cellulose- Applications of cellulose derivatives. **(9)**

HETEROCYCLICS AND ALKALOIDS

Five-membered and six-membered ring compounds - sources, isolation, preparation, structure (no elucidation) and properties of Furan, Pyrrole, Thiopene and Pyridine condensed ring compounds-source, proportion, structure (no elucidation) and chemical properties of Indole, Quinoline and Isoquinoline. Alkaloids: Sources, isolation, structures (no elucidation) and uses of Coniine, Nicotine, Quinine, Cocaine and Atopine. **(9)**

SYNTHETIC APPLICATIONS OF ORGANIC COMPOUNDS AND DYES

Synthetic applications of Grignard reagents, Organolithium, Organolead and Organozine- syntheitic applications of active methylene compounds like malonic ester and acetoacetic ester.

Dyes : Colour and constitution - classification of dyes based on their chemical structure and their applications. Important dyes like Maritus yellow, Congo red, Bismarck brown, Auramine - O, Crystal violet, Magenta, Uranine, Indigo, Thioindigo and Alizarin (preparation and uses only). **(9)**

TOTAL : 45

TEXT BOOKS

1. Bhupinder Mehta &Manju Mehta, "Organic Chemistry" Prentice- Hall of India (P) Ltd, Delhi, 2009.

2. Thomas N.Sorrel, "Organic Chemistry", Second edition, Viva Books Private Limited, New Delhi, 2010.

3. Robert Thornton Morrison and Robert Neilson Boyd, " Organic Chemistry", 6th Edition, Prentice- Hall of India (P) Ltd New Delhi (2002)

REFERENCE BOOKS

1. Jerry March, Advanced Organic Chemistry - Reactions, Mechanisms and Structure 7th Edition, John Wiley & Sons, New York, 2015.

2. I.L.Finar, "Organic Chemistry Vol1. The Fundamental Principles" 8th Edition ELBS Edition, UK, 2009.

15CH32 - MECHANICS OF SOLIDS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are 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.*

REFERENCE BOOKS

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.*

15CH33 - FLUID MECHANICS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

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

CO3 : *Ability to demonstrate the applications of flow statics, fluid flow phenomena.*

CO4 : *Ability to design fluid flow reactors and solve problems on fluid flow measurements.*

CO5 : *Ability to 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. **(14)**

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 **(12)**

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. **(12)**

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. **(10)**

HYDRAULIC PUMPS AND PIPE FITTINGS

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. **(12)**

TOTAL : 30+30 = 60

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.*

REFERENCE BOOKS

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.*

15CH34 - ELECTRICAL MACHINES AND DRIVES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : *Explain the basic concepts and working principles of DC machines and transformer.*

CO2 : *Describe the construction, working principle and applications of AC machines.*

CO3 : *List the various characteristics of AC/DC drives and identify the suitable drives needed for chemical industries.*

CO4 : *Understand the concepts of carious transducers.*

CO5 : *Interface external devices with ARM processor.*

DC MACHINES AND TRANSFORMERS

DC Generator: Constructional details-EMF equations-types and characteristics-D.C motors: Principle of operation- torque equation-types and characteristics -speed control-applications. Transformers: Construction and principle of operation -EMF equation - equivalent circuit -OC and SC test-regulation and efficiency-auto transformer. **(9)**

AC MACHINES

Alternator: types of construction-operation-EMF equation-regulation by load test-synchronous motor: Principles of operation-starting -applications. Three phase induction motor: types of construction -principle of operation-torque-slip characteristics-speed control-applications. Single phase induction motor: Capacitor start and run, shaded pole induction motor-universal motor. **(9)**

INDUSTRIAL DRIVES AND CONTROL (Qualitative Treatment)

Characteristics of electric drives and loads-selection of motor rating-solid state DC drive-solid state AC drive (Qualitative treatment)-V/F control. Selection of drives for chemical industries: paper mills, process control industries, cement mills, printing press. **(9)**

NSTRUMENTATION

Strain gauges, linear variable differential transformers, piezo-electric transducers, digital displacement transducers, sound level meter, electromagnetic flow meters, thermocouples, thermistors, resistance potentiometers, capacitive transducers,speed measurement. **(9)**

MICRO CONTROLLERS

ARM: General block diagram- mbednxp lpc1768-simple programs-Interfacing: Two segment LED, seven segment LED, LCD, stepper motor, push button operations-switching, swapping, rotating operations. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Arvind Mittal, Mittle, V.N., Basic Electrical Engineering, Second Edition, Tata McGraw Hill, New Delhi, 2005.*

2. *Dubey, G.K , Fundamentals of Electrical Drives, Second Edition, Narosa Publishing House, New Delhi, 2002.*

3. *Sawhney A.K, PuneetSawhney, A Course in Electrical and Electronics Measurements, Twentieth Edition, DhanpatRai and Sons, New Delhi, 2012.*

4. *Steve B. Furber, Stephen B. Furber, ARM System-on-Chip Architecture, Second Edition, Addison Wesley Longman Limited, 2000.*

REFERENCE BOOKS

1. *Robert L. Boylsteadd and Louis Nashelsky, Electronic Devices and Circuit Theory, Eleventh Edition, Pearson Education Asia, United States, 2012.*

2. *Ian G.Warnock, Programmable Controllers Operation and Application, Prentice Hall International, UK, 1992.*

3. *Singh, S.K, Industrial Instrumentation and Control, Third Edition, Tata McGraw Hill Publishers, New Delhi, 2009.*

15CH35 - CHEMICAL PROCESS CALCULATIONS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : Apply the principles of dimesnional 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 compostion 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 - Ideal gas laws. Mole fractions and partial pressures - Application of Dalton's and Amagat's law. **(12)**

HUMIDITY AND SATURATION

Definition of dry, wet bulb temperature - relative and percentage saturation, Dew point - humid heat, adiabatic saturation curve - Humidity Charts. Solubility and Crystallization - Recovery of crystals from solutions by crystallization - Calculations based on material balance. Henry's laws.Concept of Vapour pressure, Raoult's law and its applications, vapour pressure plots and effect of temperature on vapour pressure. **(12)**

MATERIAL BALANCE WITH CHEMICAL REACTIONS

Concept of limiting and excess reactants, Concepts of tie elements, recycle, by-pass and purge. Batch, stage wise and continuous operations. **(12)**

MATERIAL BALANCE WITHOUT CHEMICAL REACTIONS

Material balance in systems without chemical reactions, Material balance in systems with Recycle, Byepass and Purge. **(12)**

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 and Trouton'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. **(12)**

TOTAL : 30+30= 60

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.

REFERENCE BOOKS

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.*

15HSS01 - SCIENCE OF CREATIVITY AND PROFESSIONAL ETHICS

L	T	P	C
1	1	0	1

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Explain the principles of karma yoga and biomagnetism.*

CO2 : *Point out the various theories - creation, evolution, permanence, mithya for the evolution of universe   and living beings.*

CO3 : *Analyze the benefits of yoga and meditation.*

CO4 : *Demonstrate good thought for better living.*

CO5 : *Examine the human values for Sustained growth in career and life.*

LIFE FORCE, MIND AND CONCIOUSNESS

Science of Creativity and Personality Development - Objectives - Principles of Karma Yoga - Duty Consciousness - Communism and Capitalism - Law of Nature - Life Force - Origin - Potentiality of the Life Force - Premordial State - Wave Theory - Consciousness - Pancha Thanmatras - Secret of Revelations - Mind - Biomagnetism - Physical Transformation of Biomagnetism.   **(7)**

EVOLUTION OF THE UNIVERSE AND LIVING BEINGS

Evolution of the Universe: Creation Theory - Evolution Theory - Theory of Permanence - Theory of Mithya - Evolution of Living Beings: Absolute Space and Force - Plants Experience Pain - Two Eyes and Two Ears - Seven ConstituentLayers in the Body.

(5)

YOGA AND ITS BENEFITS

Simple and Safe Yoga - Upa Yoga Practices: Yoga for Peace - Yoga for Health - Yoga for Joy - Yoga for Love - Yoga for Well-being - Yoga for Success. Physical Exercise - Meditation - Seven Centers of Meditation - Benefits - Effect of Good Vibrations - Cause and Effect System - Food and health.   **(6)**

INTROSPECTION

Attachment, Detachment and Moderation in Enjoyment - Imaginary Expectations - Harmony in Life: Self, Family, Society and Nature - Introspection: Analysis of Thought, Moralization of Desire, Neutralization of Anger, Eradication of Worries and Self Realization.   **(6)**

HUMAN VALUES

Morals, Values and Ethics - Integrity - Work Ethics - Service Learning - Virtues - Respect for Others - Living Peacefully - Caring - Sharing - Honesty - Courage - Valuing Time - Co-operation - Commitment - Empathy - Self Confidence - Challenges in Work Place - Impact of cyberspace on individuals.   **(6)**

TOTAL : 15+15=30

TEXT BOOKS

1. *YogirajVethathri 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. *Henry Dreyfuss, "The Measure of Man and Woman: Human Factors in Design", John Wiley and ons Publications, 2012.*

4. *Mike W. Martin and Roland Schinzinger,"Ethics in Engineering", 4th Edition McGraw Hill, NewYork, 2005.*

5. *M. Govindarajan, S. Natarajan, V.S. Senthilkumar, "Engineering Ethics", 1st Edition, Prentice Hall of India, 2009.*

15CH36 - ORGANIC CHEMISTRY LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOME

After completion of the course, students are able to

CO1 : *Choose the basic experiment set up and suitable reaction conditions for the preparation of organic compounds.*

CO2 : *Synthesize different organic compounds like Acetanilide, Benzoic acid, salicylic acid, Dinitrobenzene and Aspirin.*

CO3 : *Determine the type of functional groups like carboxylic acids, amides, amines, aldehydes, ketones, reducing sugars and phenols in organic compounds.*

CO4 : *Predict the sepcial elements like nitrogen, sulphur and halogens present in the various organic compounds.*

CO5 : *Identify the arematic / aliphatic, saturated / unsaturated characteristics of organic compounds.*

EXPERIMENTS

Preparation of Organic Compounds

- Preparation of Acetanilide from Aniline

- Preparation of Benzoic acid from Ethyl benzoate

- Preparation of Salicylic acid from Methyl salicylate

- Preparation of Sym. Tribromoaniline from Aniline

- Preparation of Nitrobenzene from Benzene

- Preparation of m - Dinitrobenzene from Nitrobenzene

- Preparation of Benzoic acid from Benzaldehyde

- Preparation of Benzanilide from Aniline

- Preparation of Phthalimide from Phthalic acid

- Preparation of Aspirin from Salicyclic acid.

Qualitative analysis of simple organic substances with one and two functional groups only

- Aldehydes and Ketones

- Amides and Imides

- Amines

- Carbohydrates

- Carboxylic acids

- Esters

- Nitrocompounds

- Phenols.

TEXT BOOKS

1. *Venkateshwaran.V.,Veeraswamy.R., Kulandaivelu.A.R., Basic Principles of Practical Chemistry, Second Edition, S. Chand and Sons, New Delhi. 2004.*

REFERENCE BOOKS

1. *Dey.B.B.,Sitaraman.M.V., Govindachari.T.R., Laboratory Manual of Organic Chemistry, Fourth Edition, Allied Publishers, New Delhi, 1992.*

15CH37- ELECTRICAL ENGINEERING LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOME

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

- Calibration of Ammeter, Voltmeter and Wattmeter
- Calibration of Single Phase Energy meter
- Swinburne's Test
- No load Speed Control of DC Shunt Motor
- Open Circuit Characteristics of a separately excited DC generator
- Critical speed of DC shunt generator
- Load Test on DC shunt Motor
- Load Test on DC shunt Generator
- Open circuit and short circuit test on single phase Transformer
- Predetermination of efficiency and regulation characteristics of single phase transformer
- Load test on single phase transformer
- Load test on three phase squirrel cage induction motor
- Load test on slip ring induction motor
- Load test on single phase capacitor start induction motor
- Load test on single phase Alternator
- Study of capacitive transducers
- Study of inductive transducers
- Speed torque characteristics of single phase Fan motor
- Simple programs in ARM
- Interfacing programs in ARM.

15CMM41 - NUMERICAL METHODS, RANDOM VARIABLES,SAMPLING THEORY AND Z-TRANSFORMS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : *Summarize the concepts of numerical methods in solving linear system of equations using Gaussian methods. Also to discuss standard methods to solve ordinary differential equations.*

CO2 : *Analyze and study various methods to solve partial differential equations numerically.*

CO3 : *Discuss two-dimensional random variables and their properties. Also to discuss curve fitting with least square technique.*

CO4 : *Demonstrate the concepts of sampling theory with various hypthetical testing.*

CO5 : *Discuss z-transofrms with their properties and also to solve the difference equations with constant coefficients.*

NUMERICALMETHODS

Linear simultaneous equations: Gauss elimination method -Gauss Jordan method- Crout's method - Gauss Seidal method - relaxation method. Ordinary differential equations: Taylor's series - modified Euler's - Runge-Kutta fourth order methods-Milne's predictor-corrector method. **(12)**

Finite difference approximations - solution of PDE - Laplace equation-Liebmann's iteration process - Poisson equation - parabolic equations - Bender Schmidt and Crank-Nicholson methods - Hyperbolic equation. **(12)**

TWODIMENSIONAL RANDOM VARIABLES

Probability mass function - probability distribution function - cumulative distribution function-marginal probability functions - conditional distribution-expectation of two dimensional random variables - covariance correlation - regression - curve fitting - least square technique - only curve of the form or reducible to the form. **(12)**

SAMPLINGTHEORY

Elements of sampling - large sample - test for mean - proportion-standard deviation. Small sample test t, F and Chi-square tests - contingency table -test for independence. **(12)**

Z-TRANSFORMS

Definition and properties - inverse Z transforms - initial and final value theorems - convolution-solution of difference equations with constant coefficients. **(12)**

TOTAL : 30+30 = 60

TEXT BOOKS

1. *Kandasamy,P, Thilagavthy P, Gunavathy , P, "Numerical methods", S Chandand Company, 2013.*

2. *Kandasamy,P, Thilagavthy P, Gunavathy , P, Probability Statistics and Random Process",S Chand and Company, 2008.*

3. *VeerarajanT," Engineering Mathematics", for Semester-III Transforms and Partial Differential Equations Tata McGraw-Hill publishing company Ltd Fifth Edition,2012.*

4. *VeerarajanT,"ProbabilityStatisticsandRandomProcess,"Thirdedition McGraw Hill Education Private Limited, NewDelhi,2013.*

REFERENCE BOOKS

1. ErwinKreyszig,"Advanced Engineering Mathematics",10th Edition, Wiley India Pvt Ltd. 2011.

2. GrewalB.S,"Higher Engineering Mathematics"43rd Edition, Khanna Publishers 2015.

3. KapoorJ.NandSaxenaH.C., "Mathematical Statistics" 12th Edition, SChandand Company 2003.

4. Grewal B.S,"Numerical Methodsin Science and Engineering",40th Edition,Khanna Publishers 2007.

5. TrivediK.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications,Prentice-Hall,Inc., Englewood Cliffs,NewJercy 2003.

6. VenkataramanM.K., "Numerical Methods in Science and Engineering" ,5th Edition, National Publishing Company,2008.

15CH41 - PHYSICAL CHEMISTRY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : *Construct the phase diagram for various solid systems and their metallurgical applications.*

CO2 : *Determine the surface properites of the solid, their isotherms and surface area calculation.*

CO3 : *Acquire knowledge on various photo chemical lawas and applyh the same in photo chemical reactions.*

CO4 : *Predict the order of the chemical reaction and determine the rate constant for enzyme catalysis reaction.*

PHASE EQUILIBRIA AND PHASE RULE

Phase rule and its applications to one component system (water, sulphur and carbon dioxide). Two component solid - solid (Eutectic, and Compound formation) and Liquid - Liquid systems.Simple three component systems. Interpretation of phase diagrams. Thermal analysis.Nernst distribution law.Partition coefficient principles.Thermodynamics of ideal solutions - Raoult's law. **(10)**

SURFACE CHEMISTRY

Solid - Gas interface - Langmuir and BET Isotherms. Surface area of solids.Adsorption from solutions.Gibb's equation.Freundlich isotherm.Surface activity of solids - role of chemisorption in heterogeneous catalysis. **(8)**

PHOTOCHEMISTRY

Elinstein's law of photochemical equivalence - photochemical reactions - Examples - decomposition of hydrogen iodide - Reaction between hydrogen and chlorine - Quantu mefficiency - photosensitization, fluorescence, phosphorescence and chemiluminescence. **(7)**

CHEMICAL KINETICS

Rate of chemical reactions.Determination of order and molecularity of a reaction.Calculation of rate constants.Theories of reaction rates.Consecutive, Parallel and opposing reactions - reactions in solutions - catalysis - homogeneous and heterogeneous catalysis, enzyme catalysis, applications of catalysis. **(10)**

THERMODYNAMICS

Thermodynamic functions-their significance and interdependence-partial molar properties-chemical potential-Gibb's Duhem equation. Kirchoff's equation - C as a function of temperature - Bond energies-Maxwell's relation, Joule Thomson Coefficient.Thermodynamic criteria of spontaneity and equilibrium - Gibbs Helmholtz equation -   955EG04179 Vant Hoff's isotherm and isochore equation, Clausius - Clapeyron equation.Third law of Thermodynamics - Nernst heat theorem - applications of third law. **(10)**

TOTAL : 45

TEXT BOOKS

1. *Puri .B.R., Sharma. L.R., Pathania M.S., Elements of Physical Chemistry, Second Edition, Vishal Publishing company, Jalandhar, fourth edition 2013.*

2. *Peter Atkins, Julio De Paula, Atkins' Physical Chemistry, Tenth Edition, Oxford University Press, London, 2012.*

3. *Bahl.B.S.,Tuli. G.D., ArunBahl, Essentials of Physical Chemistry, S Chand Publisher, New Delhi 2012.*

REFERENCE BOOKS

1. *Soni .P.L., Charmarha.O.P, Dash.U.N, Textbook of Physical Chemistry, Twenty Second Edition, S.Chand and Sons, New Delhi, 2012.*

2. *Raj.G Advanced Physical Chemistry, Twenty Seventh Edition, Goel Publishing Company, New Delhi, 2014.*

3. *Kundu.M, Jain. S.K., Physical Chemistry, S Chand and Sons, New Delhi, 2015.*

15CH42 - CHEMICAL PROCESS INDUSTRIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

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

CO2 : *Desing 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, Acetate and 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).*

15CH43 - CHEMICAL ENGINEERING THERMODYNAMICS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

Students will be able to

CO1 : *Outline the terminology associated with engineering thermodynamics, apply the concepts of heat, work and energy conversion to calculate heat and work quantities for industrial processes and predict the properties of ideal and real mixtures besed on thermodynamic principles.*

CO2 : *Apply the basic concepts of first and second laws of themodynamics for the design and analyze of the open and closed system in chemical process plants.*

CO3 : *Predict the changes in the properties of real fluids undergoing changes in process plant eqipments.*

CO4 : *Use empirical correlations and experimental date to evaluate thermodynamic quantities that relate to the vapour - liquid or liquid-liquid equilibria of ideal and non-ideal chemical mixtutes.*

CO5 : *Determine equilibrium constants, standard enthalpy, Gibbs free Energy and equilidrium compositions for single and multiple reaction systems.*

BASIC CONCEPTS AND LAWS OF THERMODYNAMICS

Terminologies of thermodynamics, categorization of systems and processes, Laws of Thermodynamics. Reversible and Irreversible process. PVT behaviour gases. Equation of state. Entropy change in reversible and irreversible process, Internal energy and entropy as a function of temperature and pressure **(10)**

THERMODYNAMIC PROPERTIES

Thermodynamics relations, Maxwell relations. Fugacity and fugacity coefficients. Estimation of thermodynamic properties. Types of thermodynamic diagrams. **(14)**

PHASE EQUILIBRIA AND VAPOUR LIQUID EQUILIBRIA

Phase equilibria - Activity and activity coefficients. Gibbs-Duhem equations. Van laar, Margules equation. Consistency test. Prediction of VLE. **(12)**

CHEMICAL REACTION EQUILIBRIA

Criteria of equilibrium. Standard free energy change and equilibrium constants. Effect of temperature. Evaluation of equilibrium constants. **(12)**

APPLICATION OF LAWS OF THERMODYNAMICS

Compression and expansion of fluids. Theory of multistage compression. Refrigeration principles and applications. **(12)**

TOTAL : 30+30 =60

TEXT BOOK

1. *Smith J.M., Van Ness H.C., Abbott M.M., Introduction to Chemical Engineering Thermodynamics, Seventh Edition, Tata McGraw Hill International Student Edition, 2007.*

REFERENCE BOOKS

1. *Dodge, B.F., Chemical Engineering Thermodynamics, McGraw Hill International Student Edition, 1960.*

2. *Sandler, S.I., Chemical and Engineering Thermodynamics, Second Edition, John WileyInternational Student Edition, 1989.*

3. *Rao .Y.V.C., Chemical Engineering Thermodynamics, United press (India) ltd.1997.*

4. *Narayanan K.V., A Text Book of Chemical Engineering Thermodynamics, Prentice- Hall ofIndia Private Limited, New Delhi,2001.*

5. *Merle Potter , Craig Somerton., Schaum's outline of Thermodynamics for Engineers, Second Edition, McGraw Hill ,2009*

6. *Hendrick.C.Vanness, Michael M.Abbott., Schaum's outline of Thermodynamics with Chemical Applications, McGraw Hill Professional, 1989.*

15CH44 - MECHANICAL OPERATIONS

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After the completion of course, students would be able to

CO1 : *Calculate the Particle size, shape and surface area by both differential, cumulative analysis and compute the power requirement for particle size reduction screen effectiveness by sieve analysis.*

CO2 : *Compute the pressure due to storage of particles and formulate the method of transportation and fine particle recovery.*

CO3 : *Estimate the power required by mixers using power number and Reynolds number*

CO4 : *Determine the terminal settling velocity, settling time and calculate the thickener area*

CO5 : *Calculate the pressure drop in filters, filter medium resistance and cake resistance*

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. Industrial applications of size reduction equipments. Shape factor of particulate solids. Standard sieves and sieve scales. Differential and cumulative analysis - Plotting of sieve analysis data.Specific surface area determination - Calculation of particle size fromsieveanalysisdata. Industrialscreeningequipments. Screen effectiveness. **(12)**

TRANSPORTATION, STORAGE AND RECOVERY OF FINE PARTICLES

Mechanical and pneumatic conveying equipments.Storage of solids - Angle of repose and angle of internal friction.Pressures in bins - Janssen equation. Gas cleaning methods - Cyclone separators, Bag filters, Scrubbers and electrostatic precipitators. Dense Media Separation (DMS), Flotation process -Separation by Magnetic and Impingement methods. **(12)**

MIXING AND AGITATION

Types of Mixers and mixing equipments for liquids, pastes, rubber and plastic materials and for dry powders.Power consumption in mixers.Criteria for mixing of Solids - Mixing Index - Scale up of agitator design. **(12)**

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. **(12)**

FILTRATION AND CENTRIFUGAL SEPARATION

Batch and continuous filtration equipments.Theories of filtration and washing.Compressibility of filter cakes. Filter media and Filter aids. Industrial filtration practice.Centrifugal filtration, Centrifugal settling, Centrifugal sedimentation and centrifugal clarification. **(12)**

TOTAL : 30+30 = 60

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.*

REFERENCE BOOKS

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.*

15CH45 - PROCESS INSTRUMENTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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.*

REFERENCE BOOKS

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.*

15CH46 - TECHNICAL SEMINAR AND REPORT WRITING

L	T	P	C
0	2	0	1

ASSESSMENT : PRACTICAL

COURSE OUTCOME

CO1 : *Abilitytoparticipate actively in writing activities (individually and in collaboration) that model effective scientific and technical communication in the workplace.*

CO2 : *Ability to recognize, explain, and use the rhetorical strategies and the formal elements of these the following the specific genres of technical communication such as technical abstracts, data based research reports, instructional manuals, and technical descriptions.*

CO3 : *Ability to collect, analyze, document, and report research clearly, concisely, logically, and ethically; understand the standards for legitimate interpretations of research data within scientific and technical communities.*

The students are expected to carry out fundamental theoretical and/or experimental studies, connected with physical properties or on process development studies or a design projects and an oral presentation on the work done. The students should maintain a record of the work done regularly and submit the same periodically for assessment. At the end of the semester, the students must submit a report of the work done in the standard format which will be evaluated by a team of senior faculty members and Head of the Department.

15CH47 - PHYSICAL CHEMISTRY LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOME

CO1 : *Student is able to purify a given organic compound*

EXPERIMENTS

- Determination of transition point of the given salt hydrate.

- Determination of partition coefficient of iodine between water and Carbon tetrachloride

- Determination of association factor of benzoic acid between benzene and water

- Determination of equilibrium constant for the triiodide formation by partition method.

- Determination of heat of neutralization of hydrochloric acid and sodium hydroxide.

- Determination of heat of solution of ammonium chloride, ammonium nitrate and   potassium nitrate.

- Determination of specific rate constant for the reaction between potassium persulphate and potassium iodide.

- Determination of velocity constant of acid hydrolysis of methyl acetate.

- Determination of CST for phenol-water system.

- Study of effect of impurity on CST of phenol water system.

- Construction of binodal curve for water, nitrobenzene, and acetic acid.

- Determination of the strength of an acid by conductometric method.

- Determination of the strength of ferrous sulphate potentiometrically.

- Determination of Freundlich and Langmuir adsorption isotherms of acetic acid in aqueous solution by activated charcoal.

TEXT BOOKS

1. *Puri .B.R., Sharma. L.R., Pathania M.S., Elements of Physical Chemistry, Fourth Edition, Vishal Publishing company, Jalandhar, 2013.*

REFERENCE BOOKS

1. *Bahl.B.S.,Tuli. G.D., ArunBahl, Essentials of Physical Chemistry, S Chand Publisher, New Delhi 2009.*

15CH48 - FLUID MECHANICS LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOME

CO1 : *Ability to operate all the fluid flow measuring devices and able to calculate their coefficients.*

CO2 : *Ability to operate different fluid flow machineries and able to test their performance characteristics.*

EXPERIMENTS

- Venturimeter and Orifice Meter
- Helical Coil and Spiral Coil
- Pipe Friction and Expansion Losses
- Reciprocating Pump
- Globe Valve and Loses in Bends
- Centrifugal Pumps
- Open orifice and V notch
- Fluidized Bed
- Packed Bed
- Annular pipes
- Bernoulli's Theorem
- Drag on Sphere
- Pitot Tube
- Elutriator

15CH51 - INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : *identify the structure of the organic compound from the spectroscopic studies, no. of Hydrogen atoms and the position of hydrogen atoms in a molecule.*

CO2 : *discuss about types of precipitants, their advantages and disadvantages; theories of precipitation; general rules for precipitation and types of crucibles.*

CO3 : *interpret the thermal stability from TGA, exothermic & endothermic reactions of the sample from DTA.*

CO4 : *determine the concentration of the solutes in a mixture using solvent extraction, chromatography methods and polarographic studies.*

CO5 : *predict the nature of the organic compounds and the functional groups from the various spectroscopic techniques.*

UV SPECTROSCOPY AND NMR SPECTROSCOPY

UV SPECTROSCOPY

Characteristics of electromagnetic radiations - Definition-wave length, wave number, frequency, energy. The absorption laws - Theory of electronic spectroscopy - Double beam spectrophotometer. Chromospheres - Auxochrome - Types of absorption bands - Absorption and intensity shifts - Applications. **(5)**

NMR SPECTROSCOPY

Theory - number of signals - Instrumentation - Chemical shift - Factors influencing chemical shift - Spin - Spin coupling - Applications. **(4)**

IR SPECTROSCOPY AND MASS SPECTROSCOPY IR SPECTROS COPY

Theory - Vibrational frequency - Number of fundamental vibrations - Hook's law Scanning of IR spectrum - Applications **(5)**

MASS SPECTROSCOPY

Basic principles - Theory - Instrumentation - Nitrogen rule - Molecular ion - McLafferty rearrangement - Applications. **(4)**

SEPARATION METHODS

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

Principles of chromatography - Different types - Thin layer, column and gas chromatography. **(4)**

Radio chemical methods - Activation analysis - Isotopic dilution methods. **(2)**

THERMAL METHODS AND ELECTROCHEMICAL METHOD

THERMAL METHODS

Thermogravimetry - Factors influencing the thermogram - TGA instrument - Applications of TGA - DTA - Definition - Instrumentation - Thermal analysis of calcium oxalate monohydrate and calcium acetate monohydrate - Applications of DTA. **(4)**

FLUORIMETRIC METHOD - Fluorescence - Phosphorescence - Theory - Fluorimeter **(2)**

ELECTROCHEMICAL METHOD

Principles of polarography - Half wave potential - Factors affecting the limiting current - Applications of polarography. **(3)**

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. **(4)**

Theories of precipitation - Co-precipitation - Post-precipitation. **(2)**

Effects of digestion - General rules for precipitation - Precipitation from homogeneous medium - Washing of precipitates - Drying of precipitates - Types, care and use of crucibles. **(3)**

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.*

REFERENCE BOOKS

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.*

15CH52 - CHEMICAL REACTION ENGINEERING

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are 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 a 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   :   *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.*

CO5   :   *Develop the reaction kinetics for a heterogeneous catalytic and non-catalytic reaction with chemical reaction and mass transfer controlling regime.*

CHEMICAL KINETICS

Classification of reactions, Types of rate expressions, Elementary and Non elementary reactions, Types of intermediates and testing a mechanism in non elementary reactions, Temperature dependency of the rate constant based on Arrhenius, Collision and Transition state theories.   **(12)**

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.   **(12)**

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.   **(12)**

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. Reactor modeling with RTD.   **(12)**

HETEROGENEOUS REACTIONS

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. Heterogeneous Catalysis: Kinetics and rate expressions for fluid-solid catalytic reactions. Langmuir Hinshelwood and Eley Rideal mechanisms for surface Reactions. Reaction and diffusion within porous catalysts. Concept of effectiveness factor.   **(12)**

TOTAL : 30+30 = 60

TEXT BOOKS

1. Octave Levenspiel, *Chemical Reaction Engineering, Third Edition., John Wiley and sons, New Delhi,2007.*
2. *Smith J.M., Chemical Engineering kinetics, Third Edition, McGraw Hill, 1981.*

REFERENCE BOOK

1. *Scott Fogler H., Elements of Chemical Reaction Engineering, Third Edition, Prentice Hall of India, Eastern Economy Edition, New Delhi, 2006.*

15CH53 - HEAT TRANSFER

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : Solve one-dimensional steady state heat conduction problems for the rectangular, cylindrical and spherical composite walls.

CO2 : Analyze the convection heat-transfer problems for laminar and turbulent flows in internal and external configurations, including the basics of the boundary layer concept.

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 film wise and drop wise condensation, boiling heat transfer using empirical correlations.

CO5 : Apply fundamental laws of radiation to determine the heat transfer rate between two 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, - 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. **(12)**

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. **(12)**

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. **(12)**

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. **(12)**

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. **(12)**

TOTAL : 30+30 = 60

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, Eighth Edition, McGraw Hill, 1997.*

REFERENCE BOOKS

1. *McCabe W.L., Smith J.C., Harriott. P., Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill International Student Edition, 2005.*

2. *Kern, D.Q., Process Heat Transfer, McGraw-Hill, 1999.*

3. *Coulson, J.M. and Richardson, J.F., Chemical Engineering, Vol-1, Fourth Edition, Asian Books Private Limited, India, 1998.*

15CH54 - MASS TRANSFER - I

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO2 : *Analyze mass transfer theories to predict the mass transfer coefficients, develop the analogy between momentum, heat and mass transfer and draw the operating line for stage-wise operations.*

CO3 : *Compute the number of plates required for a given separation by graphical and analytical method and choose the packing material for gas-liquid operations.*

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

CO5 : *Determine the number of 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. Effective diffusivity, steady state diffusion in multicomponent mixtures.Measurement of diffusivity Molecular diffusion in liquids.   **(12)**

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.   **(12)**

ABSORPTION

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. Countercurrent multistage operation, one component transferred continuous contact equipment, absorption of one component in packed tower, overall coefficients, Concept of NTU and HTU - graphical, analytical methods and overall height of transfer units. Hydrodynamic consideration. Tower packings and packed tower.   **(12)**

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.

(12)

EQUIPMENT FOR CONTINUOUS DISTILLATION

Plate columns, packed columns.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.   **(12)**

TOTAL : 30+30 = 60

TEXT BOOKS

1. *McCabe W.L., Smith J.C., Harriott P., Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill International Student Edition, 2005.*

2. *Treybal R.E., Mass Transfer Operations, Third Edition, McGraw Hill International Student Edition, 1980.*

REFERENCE BOOKS

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*

3. *Binay K Dutta, Principles of Mass Transfer and Separation Processes, PHI learning Private Limited, New Delhi, 2009.*

15CH55 - TECHNICAL AND INSTRUMENTAL ANALYSIS LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOME

After completion of the course, the students are able to

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

CO2 : *Attain skills in analyzing 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

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

15CH56 - MECHANICAL OPERATIONS LABORATORY

	L	T	P	C
	0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOME

After completion of the course, students are able to

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

CO2   :   perform the size reduction process using various mechanical operation equipments.

CO3   :   estimate the performance characteristic parameters for solid-fluid and solid-solid separation equipments.

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

- Ball Mill
- Roll Crusher
- Sedimentation
- Filtration
- Air Classifier
- Plate and Frame Filter Press
- Screen Effectiveness
- Hammer Mill
- Jaw Crusher
- Leaf filter
- Drag on Sphere

15CH61- PROCESS DYNAMICS AND CONTROL

L	T	P	C
2	2	0	4

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are 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 : *Analyze closed loop stability systems by applying transient responses and also to test the stability of the control system by Root Locus methods. Draw the bode diagram for the stability of process for the frequency response processes.*

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 a 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*

OPEN LOOP SYSTEMS

Laplace Transforms - Standard functions, Open loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics. **(14)**

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, transportation lag, transient response of closed-loop control systems, Routh-Huritz and root-locus stability of a control system. **(14)**

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, tuning of controller settings. **(12)**

ADVANCED CONTROL SYSTEMS

Introduction to advanced control systems, cascade control, feed forward control, feed back controller model predictive control, Adaptive controller and Ratio controller and its industrial application. **(10)**

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. **(10)**

TOTAL : 30+30 = 60

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.*

REFERENCE BOOKS

1. *Dale E. Seborg, Duncan A. Mellichamp, Thomas F. Edgar, Francis J. Doyle, III, Process Dynamics and Control, Third Edition, John Wiley and sons, New York, 2010.*

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.*

15CH62 - PROCESS PLANT UTILITIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : *Discuss about the role of water as process utility and recognize importance of treatment and conservation of water.*

CO2 : *Explain the various types of compressors and vacuum pumps, piping systems used in industries.*

CO3 : *Identify the role of refrigerant for different refrigeration systems and their importations, ventilation systems.*

CO4 : *Outline the basic properties of steam along with their generation and utilization of steam in process plants.*

CO5 : *Examine the suitable insulation for different materials piping, fittings and valves.*

WATER

Sources of water, softening of water- lime-soda process, zeolite and ion-exchange process, Storage and distribution of water. Treatment of Boiler feed water, Re-use and conservation of water.   **(9)**

COMPRESSORS AND VACUUM PUMPS

Compressors and Vacuum pumps- Performance characteristics of Compressor and Vacuum pumps. Piping systems. Air leaks. Lubrication. Oil and moisture removal.   **(9)**

REFRIGERATION AND VENTILATION

Principles of refrigeration, refrigeration systems like vapour compression and vapour absorption cycles, types of refrigerants and their importance. Production of cryogenic temperatures. Exhaust ventilation   **(9)**

STEAM

Steam generation: cochran, locomotive, babcock and wilcox, lamont boiler,Properties of steam. Steam turbines- de-laval, compounding of impulse steam turbine, parsons reaction turbine. Steam handling and distribution. Steam economy.   **(9)**

INSULATION

Importance of insulation for meeting the process requirement, insulation materials and their effect on various material of equipment piping, fitting and valves etc. insulation for high intermediate, low and sub zero temperatures, including cryogenic insulation.

(9)

TOTAL : 45

TEXT BOOKS

1. Nordell,Eskel, "Water treatment for industrial and other uses", Reinhold publishing corporation, Newyork.(1961).

2. Goodall,P.M., " The efficient use of steam", IPC Science and Technology(1980).

3. Ashutosh Pande, "Plant Utilities", Vipul Prakashan,Mumbai.

REFERENCE BOOKS

1. Perry, R.H., and Green, D.W,: Perry's Chemical Engineers Handbook, Eighth Edition, McGraw Hill (ISE), 2008.

2. W.L McCabe J.C.Smith, and Harriot. P.: Unit Operations of Chemical Engineering, Seventh Edition, McGraw Hill, Publication, 2008.

3. Ludwig, E.E.: Applied Process Design for Chemical and Petrochemical Plants, Gulf Publishing Company, Texas, Vol.1, 4th Edition 2007, Vol.2, 4th Edition 2010, Vol.3, 3rd Edition 2011.

15CH63 - MASS TRANSFER - II

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *Determine the number of stages and recovery efficiency for solid-liquid and liquid-liquid separation 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. **(12)**

ADSORPTION AND ION EXCHANGE

Types of adsorption - physical adsorption and chemical adsorption, factors influencing adsorption, nature of adsorbents, Industrial adsorbents, Freundlich adsorption isotherm and its application, Adsorption operation - single stage, crosscurrent and countercurrent operations, Recovery of solvent vapours, Principles of ion exchange - techniques and applications - equilibria rate of ion exchange. **(12)**

HUMIDIFICATION

Humidification operation of air-water system, Psychometric chart, Methods of humidification and dehumidification, Lewis relation, Theory and principles of cooling towers, Types of cooling towers. **(12)**

DRYING

Theory and mechanism of drying. Batch drying, drying tests, drying curve, time of drying. Mechanism of moisture movement, drying rate during constant rate period, unsaturated surface drying, drying with internal diffusion. Continuous drying operations and equipment.Classification of dryers.Application of dryers in process industries. **(12)**

CRYSTALLIZATION

Factors governing nucleation and crystal growth, theory of crystallization.Batch and continuous crystallizers.Performance and applications of industrial crystallizers. **(12)**

TOTAL : 30+30=60

TEXT BOOKS

1. *McCabe W. L., Smith J.C., and Harriott P., Unit Operations of chemical Engineering, seventh Edition, McGraw Hill (ISE),2005.*

2. *Treybal R.E., Mass Transfer Operations, Third Edition, McGraw Hill (ISE), 1980.*

REFERENCE BOOKS

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.*

15CH64 - PROCESS EQUIPMENT DESIGN AND DRAWING

L	T	P	C
1	0	4	3

ASSESSMENT : PRACTICAL

COURSE OUTCOME

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), (1950).*

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).*

15CH65 - REACTION ENGINEERING LABORATORY

	L	T	P	C
	0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOME

After completion of the course, students are able to

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

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

CO3   :   Collect RTD data from steady state reactors and analyze 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.

EXPERIMENTS

- Kinetic Studies in Batch Reactor-I
- Kinetic Studies in Batch Reactor-II
- Performance Characteristics of Semi-Batch Reactor-I
- Performance Characteristics of Semi-Batch Reactor-II
- Performance Characteristics of Mixed Flow Reactor
- Performance Characteristics of Plug Flow Reactor
- Adiabatic Reactor
- Residence Time Distribution Studies in Plug Flow Reactor
- Residence Time Distribution Studies in Mixed Flow Reactor
- Performance Characteristics of Tubular Reactor
- Performance Studies of Mixed Flow Reactor in Series
- Determination of Activation Energy

15CH66 - HEAT TRANSFER LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOME

After completion of the course, students are 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

• Heat transfer studies in metal bar apparatus

• Heat transfer studies in Agitated vessel

• Heat transfer studies in Fluidized bed dryer

• Natural convection Heat transfer

• Heat transfer in pool boiling and Nucleate boiling

• Studies in plate fin Heat Exchanger

• Studies in shell and Tube Heat Exchanger

• Heat transfer studies in Stefan - Boltzmaan apparatus

• Studies in Spiral type Heat Exchanger

• Studies in Packed bed Heat Exchanger

• Film wise and dropwise condensation

15CH67 - MINI PROJECT

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOME

After completion of the course, students are 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.

15CH71 - TRANSPORT PHENOMENA

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 : *Analyze 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 transfer 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 : 30+30 = 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.*

REFERENCE BOOKS

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.*

15CH72 - PROCESS ECONOMICS AND INDUSTRIAL MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are 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 : *Specify the economic balance in batch, cyclic and continuous operations and study the optimum conditions of operating variables.*

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 - equivalence, Depreciation, Depletion, estimation of capital cost, Capital requirement for complete plant, cost indices, capital recovery and its real time problems. **(10)**

PROJECT PROFITABILITY AND FINANCIAL RATIOS

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

ECONOMIC BALANCE IN EQUIPMENTS

Essentials of economic balance, economic balance in batch operations, cyclic operations, economic balance for insulation, evaporation, heat transfer equipments and its applications. **(9)**

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 and control, role of control charts in production and quality control. **(8)**

TOTAL : 45

TEXT BOOKS

1. *Max Peters, Klaus Timmerhaus, Ronald West, plant design and economics for chemical Engineers, Fifth Edition, McGraw Hill (ISE), 2003.*

2. *Ahuja K.K, Industrial management, khanna publishsers, New Delhi, 2004.*

3. *H.E. Schwyer, Process Engineering Economics, McGraw Hill Book, New York, 1970*

REFERENCE BOOKS

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.*

15CH73 - PROCESS MODELING AND SIMULATION

	L	T	P	C
	2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are 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

Uses of Mathematical Models - Principles of formulation. Fundamental laws: Continuity equations, Energy equation, Equations of motion, Transport equations, Equations of State, Equilibrium and Chemical Kinetics. Simple Examples.   **(12)**

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.   **(12)**

FLUID FLOW AND REACTION KINETICS

Gas flow systems - Example: Three-Volume gas flow system, Hydraulic transients - between two reservoirs, pumping system. Reaction Kinetics: General modelling scheme, Liquid phase CSTR - Radical kinetics - Elementary reduction of Radical Mechanism - Rate limiting steps, Heterogeneous kinetics - Example: Autoclave.   **(12)**

STAGED OPERATIONS AND DISTRIBUTED SYSTEMS

Staged Operations: Counter current extraction, Distillation columns - Binary distillation. Distributed systems: Counter current Heat Exchanger, Membrane Separation Process,and Tubular Reactor and Evaporators   **(12)**

SIMULATION

MATLAB/Simulink - Introduction, Basic components, Operational Blocks, Simple Examples - Three CSTR's in series, Gravity flow tank, Batch Reactor, Digital Simulation: Numerical Methods - Newton Raphson, False Position methods of convergence, Numerical integration - Euler, Runge Kutta fourth-order methods. Simple Examples: Three CSTR's in series, Non isothermal CSTR, Binary distillation column, Batch reactor.   **(12)**

TOTAL : 30+30 = 60

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.

REFERENCE BOOKS

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

15CH74 - CHEMICAL PROCESS PLANT SAFETY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : Acquire the basic knowledge of safety issues in boiler houses, storage vessel for hazardous chemicals.

CO2 : Identify the hazardous element due to fire, radiation, electrical and atmospheric contaminants.

CO3 : Apply the knowledge on handling and storage of chemical hazards

CO4 : Analyze qualitative risk assessment using HAZOP, FMEA and fault tree analysis.

CO5 : Apply the safety principles to identify the fire hazards and its safety protecting system in practices.

DEVELOPMENT OF INDUSTRIAL PLANT SAFETY

Introduction to safety: Concept and importance of industrial safety. Safety in the site selection and lay out. Location and design parameters for chimney, flares rupture discs, location of boiler houses, storage of hazardous chemicals etc. Safety in operations and processes, work permit system, confined space safety practices. **(9)**

INDUSTRIAL SAFETY

Chemical hazards classification, hazards due to fire, explosion, toxic chemicals and radiation. Reduction of process hazards by plant condition monitoring. Electrical exposures, guarding live electrical elements. Electrical wiring switches and fuses. Grounding and ground fault interrupter. Classification of atmospheric contaminants. **(9)**

HANDLING AND STORAGE

TLV - classification and significance. Contamination reduction (or) removal methods. handling and storage of hazardous chemicals. Pressurized lines and containers (LPG, Compressed air, gases or fluids). extreme temperatures - hot and cold, reaction safety. Run away reactions. **(9)**

RISK ANALYSIS

Risk assessment, qualitative, reconnoitres, rapid and comprehensive risk assessment techniques: checklists, indices, HAZOP, maximum credible accident analysis, fault tree analysis, past accident analysis, FMEA (failure mode and effect analysis), quantitative risk assessment, domino effect and its assessment. **(9)**

PROTECTION SYSTEMS

Emergency preparedness: Fire and explosion. Fire hazards. Fire pyramid. Types of fires. Types of fire extinguishers and its handling. Types of built in extinguishing system. Fire fighting techniques, Emergency procedures and types of alarm systems. **(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

REFERENCE BOOKS

1.   *Lees, F.P., Loss Prevention in Process Industries, Butterworths, NewDelhi, 3rd Edn., 2005.*

2.   *Buschmann, Loss Prevention and Safety Promotion in the Process Industries, Elsevier Scientific, New York.*

3.   *K.V. Raghavan and A.A.Khan: Methodologies in Hazard Identification and Assessment Manual by CLRI, December 1990.*

15CH75 - TOTAL QUALITY MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

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

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

CO3 : *Apply and acquire knowledge of quality tools.*

CO4 : *Formulate the Quality Management System for use in an industry.*

CO5 : *Justify and Gain confidence in implementing Total Quality Management in an industry.*

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.*

REFERENCE BOOKS

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.*

15CH76 - MASS TRANSFER LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOME

After completion of the course, the students are 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.

EXPERIMENTS

- Measurement of Diffusion coefficient
- Determination of HETP in Randompacking
- Wetted wall column
- Ternary Liquid-liquid Equilibrium
- Counter current & crosscurrent leaching
- Extraction in packed and plate columns
- Steam distillation
- Simple distillation
- Vapour- Liquid Equilibrium
- Drying rate measurements

15CH77 - PROCESS CONTROL AND SIMULATION LABORATORY

L	T	P	C
0	0	4	2

ASSESSMENT : PRACTICAL

COURSE OUTCOME

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.*

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 Processes Using Software Packages Such As Matlab, Fluent

15CH78 - IN-PLANT TRAINING PRESENTATION

L	T	P	C
0	0	2	1

ASSESSMENT : PRACTICAL

COURSE OUTCOME

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.

A written report and an oral presentation/ interview during the semester after successful completion of four week industrial in-plant training with a chemical industry taken during the programme.

15CH81- PROJECT WORK AND VIVA-VOCE

L	T	P	C
0	0	6	6

ASSESSMENT : PRACTICAL

COURSE OUTCOME

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 reference books.

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 reference books 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.

15CHE01 - SUGAR TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 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 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 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.*

REFERENCE BOOKS

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.*

15CHE02 - BIOCHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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.

REFERENCE BOOKS

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.

15CHE03 - ELECTROCHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : *Explain balanced electrochemical reactions, analyse the open-circuit potentials of electrochemical cells including liquid-junction potentials and describe the structure of the electric double layer, based partly on surface-tension data.*

CO2 : *Discuss the reaction mechanisms and kinetics and obtain electrode over potentials and mass- transfer phenomena, including the estimation of limiting currents.*

CO3 : *Devise the methodology for the development of corrosion control techniques for the industrial boiler water corrosion.*

CO4 : *To explain the principles and working conditions of the different types of primary and secondary batteries.*

CO5 : *Specify the electrodes used in electrochemical industries like metal finishing, electroplating and electro polishing.*

REVIEW OF BASICS ELECTROCHEMISTRY

Faraday's law - Nernst potential - Galvanic cells - Polarography, The electrical double layer: It's role in electrochemical processes - Electro capillary   curve - Helmholtz layer - Guoy - Steven's layer - fields at the interface. **(9)**

MASS TRANSFER IN ELECTROCHEMICAL SYSTEMS

Diffusion controlled electrochemical reaction - the importance of convention and the concept of limiting current. over potential, primary-secondary current distribution - rotating disc electrode. **(9)**

CORROSION PROCESS

Introduction to corrosion, series, 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 methods of various forms of corrosio - corrosion control measures - industrial boiler water corrosion contro - protective coatings - Vapor phase inhibitors - cathodic protection, sacrificial anodes - Paint removers. **(9)**

ELECTROCHEMICAL PROCESSES

Electro deposition - electro refining - electroforming - electro polishing - anodizing - Selective solar coatings, Primary and secondary batteries - types of batteries, Fuel cells. **(9)**

TYPES OF ELECTRODES

Metals - Graphite - Lead dioxid - Titanium substrate insoluble electrodes - Iron oxide - semi conducting 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 merits of different type of electrochemical reactors. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Picket, Electrochemical Engineering, Prentice Hall. 1977.*

2. *Newman J., Thomas K.E.A., Electrochemical systems, Third Edition, John Wiley and Sons,Inc., New Jersey,2004.*

REFERENCE BOOKS

1. *Barak M., Stevenge U.K., Electrochemical Power Sources - Primary and Secondary Batteries, The Institution of Electrical Engineers, 1980.*

2. *Mantell C., Electrochemical Engineering, Fourth Edition, McGraw Hill, 1972.*

15CHE04 - DRUGS AND PHARMACEUTICALS TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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.

REFERENCE BOOKS

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.

15CHE05 - FOOD TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : *Identify the major and minor constituents of food and its standards*

CO2 : *Analyse the spoilage and deterioration mechanisms in foods and methods to control*

CO3 : *Apply principles of food preservation and evaluate variation in processing parameters*

CO4 : *Evaluate the suitability of packaging material for a particular type of food.*

CO5 : *Point out processing and preservation techniques of cereals, pulses, fruits and vegetables, egg, Meat, and milk and its products.*

INTRODUCTION

General aspects of food industry; World food need and Indian situation; Constituents of food; Quality and nutrition aspects; Food additive and standards; **(8)**

PRESERVATION METHODS

Preservation by heat and cold; Dehydration; Concentration; Frying; Drying; Irradiation; Microwave heating **(8)**

DETERIORATIVE FACTORS

Deteriorative factor and their control; Preliminary processing methods; Conservation and Preservation operations **(8)**

PACKING METHODS

Sterilization and pasteurization; Fermentation; Pickling; Packing methods. Cereal, grains; pulses; Vegetables; Fruits; Spices; Fats and Oils **(8)**

PRODUCTION AND UTILIZATION OF FOOD PRODUCTS

Bakery, confectionery and chocolate products; Soft and alcoholic beverages; Dairy products; Meat; poultry and fish products: - Factory Hygiene **(13)**

TOTAL : 45

TEXT BOOKS

1. *John Laurence Heid, Maynard Alexander Joslyn, Fundamentals of Food Processing Operations, The AVI Publishing Co., Westport, 1975.*

2. *Potter N.N., Food Science, Fifth Edition, The AVI Publishing Co., Westport, 2006.*

3. *Watson E.L., Elements of Food Engineering, Second Edition, Van Nostrand - Reinhold, New York, 1988.*

REFERENCE BOOKS

1. *Ronsivalli L.J., Elementary Food Science, Van Nostrand - Reinhold, New York, 1991.*

2. *Considine D.M., Considine G.D., Considine P.E., Foods and Food production Encyclopedia, Vol. 8, Van Nostrand - Reinhold, 1982*

3. *Considine D.M., Foods and Food Production Encyclopedia, First Edition, Springer, 1995.*

4. *Hall C.W., Farrall A.W., Rippen A., Encyclopedia of Food Engineering, Second Edition,VanNostrand - Reinhold, New York, 1986.*

5. *Ernest R.V., Elementary Food Science, Fourth Edition, Springer, 2001.*

15CHE06 - ENVIRONMENTAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : *Impact and effect of air pollution on the environment.*

CO2 : *Examine the SO2,CO2, CO, particulate matter and its control using settling chamber, cyclone separator, electrostatic precipitator, absorption and adsorption.*

CO3 : *Analysis of wastewater sample, determination of organic and inorganic substances-BOD,COD,TOC,DO, Nitrogen, Phosphorous, Trace elements, Alkalinity present in wastewater.*

CO4 : *Synthesis of polluted water to reusable water using screening, flotation, activated sludge, trickling filter, ion-exchange, reverse osmosis processes.*

CO5 : *Synthesis of solid waste from pulp and paper, glass, metals and plastic, solid waste disposal methods- land filling, incineration and composting.*

ENVIRONMENTAL POLLUTION: AN OVERVIEW

Impact of man on the environment, various cycles, effect of environment due to pollution, pollution of air, water and soil, classification and properties of air pollutants, various emission sources, photochemical smog, effects of air pollution on human health, vegetation, etc., Air pollution laws and standards. Impact Assessment and analysis-Concepts, Methodologies. **(9)**

AIR POLLUTION - SAMPLING, MEASUREMENT AND CONTROL METHODS

Atmospheric and Stack sampling methods, analysis of air pollutants - SO2, NO2, CO and particulate matter etc. Types of particulate pollution control methods - Settling chambers, Cyclone separators, Scrubbers, Filters and Electrostatic precipitators, Types of gaseous pollution control methods - absorption, adsorption and combustion processes **(9)**

WATER POLLUTION - SAMPLING AND ANALYSIS

Water resources, various types of water pollutants and their effects, waste water sampling-Grab sample and composite sample, determination of organic substances- BOD, COD, dissolved oxygen, TOC, determination of inorganic substances- Nitrogen, Phosphorous, alkalinity and water quality standards. **(9)**

WASTE WATER TREATMENT METHODS

Basic processes of water treatment, primary- Screening, Sedimentation, Flotation, secondary-Activated sludge process, trickling filters, sludge treatment and advanced treatment methods- ion exchange, reverse osmosis, electro dialysis, removal of nitrogen and phosphorous. **(9)**

SOLID WASTE TREATMENT AND DISPOSAL METHODS

Sources and classification, methods of collection, disposal methods -Land filling, incineration, composting, nuclear waste disposal and solid waste disposal from pulp and paper, sugar, alcohol, cement and aluminium industries. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Rao, C.S, Environmental Pollution Control Engineering, Wiley Eastern, New Delhi, 1991.*

2. *Met Calf and Eddy., Waste Water Engineering, Treatment and Disposal, Tata McGraw Hill, New Delhi, 1987.*

REFERENCE BOOKS

1. *Pandey, G.N. And Carney, G.C, Environmental Engineering, Tata McGraw Hill, New Delhi, 1998.*

2. *Kapoor B.S., Environmental Engineering, Third Edition, Khanna Publishers, Delhi, 1989.*

15CHE07 - ENERGY TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1   :   *Explain the formation of coal and its classification, ranking, analysis, testing, carbonization, gasification, liquefication and manufacture of coke.*

CO2   :   *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   :   *State the occurrence, properties, production and storage of gaseous fuels, combustion, furnaces for different gaseous fuels and waste heat recovery.*

CO4   :   *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   :   *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, bio fuels, 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.*

REFERENCES

1.   *Considine D.M., Energy Technology Handbook, McGraw Hill, New York, 1977.*

15CHE08 - POLYMER SCIENCE AND TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of course, the students are able to

CO1 : *Reproduce the basic concepts of polymer science, thermodynamics, phase separations and conformational analysis.*

CO2 : *Describe the physico-chemical, morphology, rheology and mechanical properties of bulk polymers by evaluating through respective experimentations.*

CO3 : *Classify the polymers, polymerization techniques and perform the kinetic and statistical considerations of polymers.*

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

CO5 : *Develop the recent advancements and apply in polymeric processing techniques like molding, compounding and vulcanizing.*

POLYMER CHAINS AND THEIR CHARACTERIZATION

The science of large molecules - Basic concepts of polymer science. History of macromolecular science, molecular forces and chemical bonding in polymers. Polymer solutions. Criteria for polymer solubility, Conformations of dissolved polymer chains, Thermodynamics of polymer solutions, Phase separation in polymer solutions. **(9)**

STRUCTURE AND PROPERTIES OF BULK POLYMERS

Morphology and order in crystalline polymers - Configurations of polymer chains, 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. Polymer structure and physical properties - The crystalline melting point, the glass transition, properties involving large deformations, properties involving small deformations, property requirement and polymer utilization. **(9)**

POLYMERIZATION

Step-reaction (Condensation) polymerization - Classification of polymers and polymerization mechanisms, chemistry of stepwise polymerization, kinetics and statistics of linear stepwise polymerizations. Radical chain (Addition) polymerization - chemistry of vinyl polymerization, laboratory methods in vinyl polymerization, steady state kinetics of vinyl radical polymerization. Ionic and coordination chain (Addition) polymerization - chemistry of non-radical chain polymerization, cationic polymerization, anionic polymerization, coordination polymerization. copolymerization - Kinetics of copolymerization, composition of copolymers, chemistry of copolymerization. **(9)**

PROPERTIES OF COMMERCIAL POLYMERS

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

POLYMER PROCESSING

Plastic Technology - Molding, other processing methods, fillers, plasticizers, and other additives. Fiber Technology - Textile and fabric properties, spinning, fiber after treatments. Elastomer technology - Compounding and elastomer properties, vulcanization, 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.

REFERENCE BOOKS

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.

15CHE09 - MODERN SEPARATION TECHNIQUES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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.

REFERENCE BOOKS

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.

15CHE10 - ENERGY MANAGEMENT IN CHEMICAL INDUSTRIES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 movement of substances in the entire globe

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.*

REFERENCE BOOKS

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.*

15CHE11 - INTEGRATED DESIGN OF CHEMICAL PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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.*

REFERENCE BOOKS

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.*

15CHE12 - PETROCHEMICALS TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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.*

REFERENCE BOOKS

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.*

15CHE13 - FERTILIZER TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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*

REFERENCE BOOKS

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.*

15CHE14 - OPTIMIZATION OF CHEMICAL PROCESSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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.*

REFERENCE BOOKS

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.*

15CHE15 - COMPUTER AIDED DESIGN

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 : 30 +30 = 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.*

REFERENCE BOOKS

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*

15CHE16 - PIPING AND INSTRUMENTATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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*

15CHE17 - MINERAL PROCESSING TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : Construct binary phase diagrams to analyze the solidification of ferrous and non ferrous alloys and estimate amount of phases at different temperatures and compositions and to find the hardness, toughness, fatigue, tension and compression of given materials.

CO2 : Understand and choose the required heat treatment technique for enhancing the mechanical properties of the steels and cast iron components.

CO3 : Recognize various corrosion processes and their influence on metals.

CO4 : Find the applicable corrosion control techniques and their limitations.

CO5 : Identify the appropriate alloying elements for ferrous and non ferrous alloys to improve the mechanical properties according to the application to discuss the properties and applications of nonmetallic materials such as timber, rubber, plastic and glass.

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 sledges. 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

REFERENCE BOOKS

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.

15CHE18 - FLUIDIZATION ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1   :   *Discuss the various fluidization behavior, operating conditions and its industrial application*

CO2   :   *Outline the various flow models and test their empirical correlations*

CO3   :   *Synthesize and 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   :   *Discuss the correlation for the solid- liquid mixing processes 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.   Leva M, Fluidization, McGraw Hill, New York, 1959.

2.   Kunii D., Levenspiel O., Fluidization Engineering, Second Edition, Butterworth-Heinemann, 2013.

3.   J.F. Davidson, R. Clift and D. Harrison, Fluidization. Second Edition, 1985, Academic Press, New York.

REFERENCE BOOKS

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.

15CHE19 - PULP AND PAPER TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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.*

REFERENCE BOOKS

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.*

15CHE20 - INDUSTRIAL WASTE WATER TREATMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1   :   *Examine the constituents of waste water and its effects.*

CO2   :   *Separate the contaminants from the effluent for treatability.*

CO3   :   *Determine the biomass yield and substrate utilization rate for biological treatment process and design of activated sludge process.*

CO4   :   *Develop a flow sheet for the waste water treatment from dairy, sugar, pulp and paper, textile and pharmaceutical industries.*

CO5   :   *Develop process flow diagram for water reuse and sludge disposal.*

INTRODUCTION TO WASTE WATER ENGINEERING

Waste Water Engineering - Overview, inorganic non-metallic constituents and metallic constituents, physical and biological characteristics.   **(7)**

UNIT OPERATIONS AND UNIT PROCESS

Screening, Flow Equalization, Mixing, Flocculation, Grit removal, Sedimentation, Coagulation, Precipitation, Oxidation and Neutralization   **(11)**

FUNDAMENTALS OF BIOLOGICAL TREATMENT

Introduction, Microbial growth kinetics, types of biological process for wastewater treatment -aerobic and anaerobic oxidation, Biological Nitrification and De-nitrification, biological phosphorous removal, activated sludge process (with design considerations),trickling filters and lagoons.   **(9)**

WASTE WATER TREATMENT IN SPECIFIC INDUSTRIES

Dairy, Sugar, Pulp and Paper, Textile and Pharmaceutical Industries.   **(9)**

WATER REUSE

Wastewater reclamation technologies and reuse, Solid processing flow diagrams, sludge and scum pumping, grinding, screening, degritting, blending, anaerobic digestion, composting, conditioning, dewatering and incineration.   **(9)**

TOTAL : 45

TEXT BOOK

1.   *Metcalf Eddy, Wastewater Engineering -Treatment and Reuse, Fourth Edition, Tata McGraw Hill, New Delhi, 2002.*

REFERENCE BOOKS

1.   *Mark J. Hammer, Water and Wastewater Technology, Seventh Edition, Prentice Hall of India Pvt Limited, New Delhi, 2012.*

2.   *James M. Montgomery, Water Treatment Principles and Design, First Edition, A Wiley Interscience publication, New York, 1985*

15CHE21 - SURFACE COATING TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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.*

REFERENCE BOOKS

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.*

15CHE22 - PETROLEUM REFINERY ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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".*

REFERENCE BOOKS

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"*

13CHE23 - ENVIRONMENTAL IMPACT ASSESSMENT AND CLEAN TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : *Devise methodologies for environmentally sound and sustainable development.*

CO2 : *Apply Impact assessment methods to examine the underlying need for developmental projects.*

CO3 : *Generate report contents for thermal power projects, refinery process and chemical process industries.*

CO4 : *Evaluate the environmental issues associated with product by identifying energy consumption, materials used and wastes released to environment.*

CO5 : *Analyze the waste stream and segregate the products to apply clean and clean-up technology for reduction of waste at source.*

INTRODUCTION

Introduction and need for impact assessment. Legislation and pollution control acts and Regulations. Methodologies - collection of data and analysis, cost benefit analysis. **(9)**

APPLICATIONS

Application of Impact assessment methods in specific developmental projects, advantages, disadvantages of different methods, applicability of specific methods with examples. **(9)**

PROJECTS

Impact assessment report contents for developmental projects like thermal power projects, refinery process and chemical process industries. **(9)**

CONCEPTS AND AUDITS

Ranking of impacts, concepts of environmental management plan, Environmental audits, waste audit, Life Cycle Assessment (LCA), Industrial symbiosis. **(9)**

CLEAN TECHNOLOGY

Clean Technology Options: Clean technology and Clean up technology, materials reuse, waste reduction at source and clean synthesis. **(9)**

TOTAL : 45

TEXT BOOK

1. *Kirkwood R. C., Longley A. J., Clean Technology and the Environment, First Edition Chapman and Hall, 1995.*

2. *Larry W. Canter., Environmental Impact Assessment, Second Edition, McGraw Hill book Co., 1997.*

REFERENCE BOOKS

1. *Peter W., Environmental Impact Assessment theory and practice, Taylor and Francis, 1990.*

2. *Harrison L., Environmental Health and Safety Auditing Handbook, Second Edition, McGraw Hill, Inc., New York, 1995.*

15CHE24 - PROCESS AUTOMATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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.*

REFERENCE BOOKS

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.*

15CHE25 - HEAT POWER ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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.*

REFERENCE BOOKS

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.*

15CHE26 - SYNTHESIS AND APPLICATIONS OF NANOMATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 nanostructural characterization of suchmaterials 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.

15CHOE01 - INDUSTRIAL SAFETY ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 t the safety concepts in welding, gas cutting,storage and handling of gascylinders, 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 protectivedevices, machine guarding, types, fixed guard, interlock guard,automatic guard, trip guard, electron eye, positional control guard, fixedguard fencing- guard construction- guard opening. Selection andsuitability: lathe - drilling - boring - milling - grinding - shaping - sawing- shearing presses - forge hammer - flywheels - shafts - couplings -gears - sprockets wheels and chains pulleys and belts - authorized entryto hazardous installations-benefits of good guarding systems **(9)**

SAFETY IN WELDING AND GAS CUTTING

Gas welding and oxygen cutting, resistance welding, arc welding andcutting, common hazards, personal protective equipment, training,safety precautions in brazing, soldering and metalizing - explosive welding, selection, care and maintenance of the associated equipmentand instruments - safety in generation, distribution and handling ofindustrial 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, auxiliarymechanisms, feeding and cutting mechanism, hand or foot-operatedpresses, power press electric controls, power press set up and dieremoval, inspection and maintenance-metal sheers-press brakes. Hotworking safety in forging, hot rolling mill operation, safe guards in hotrolling 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 leaktest, 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.

15CHOE02- RISK ANALYSIS AND HAZOP

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 BOOKS

1.   Daniel A Crowl., Louvar J.F., Chemical Process Safety: Fundamentals with Applications, Prentice Hall, New Jersey, 2002.

15CHOE03 - GREEN TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 : Analyze 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 Jacquelin Ottman.*

6. *Green and World by Andrew S. Winston.*

15CHOE04 - CORROSION SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 : *Analyze 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, $Fe-H_2O$ 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.*

REFERENCES

1. *Banarjee.S.N., An introduction to corrosion and corrosion inhibitors, Oxonian Press Ltd., New Delhi, 1985.*

15CHOE05 - INTRODUCTION TO CHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, the 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 equipments for transport and separation processes.*

CO4 : *Apply material and Energy Balance to precisely caculate material requirement of a process.*

CO5 : *Apply steady state balance to develop process flowsheet.*

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*, Sixth 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.

15CEE35 - DISASTER MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

At the end of this course, the 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.   **(9)**

TOTAL : 45

TEXT BOOKS

1. *Khanna B K, "All You Wanted To Know About Disasters", New India Publishing Agency, New Delhi, 2005.*
2. *Ramana Murthy, "Disaster Management", Dominant, New Delhi, 2004.*
3. *Rajdeep Dasgupta, "Disaster Management and Rehabilitation", Mittal Publishers, New Delhi, 2007.*

REFERENCE BOOKS

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.*

15CEE36 - RENEWABLE ENERGY RESOURCES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After successful completion of the course, student will be able to

CO1 : *Explain the current energy scenario and future energy usage in India.*

CO2 : *Explain 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 : *Discuss 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 BOOK

1.   *Sukathme, S.P, "Solar Energy", Tata McGraw-Hill Book Co., New Delhi, 1993.*

REFERENCE BOOKS

1.   *Rai, G.D., "Solar Energy Utilization", Khanna Publishers, New Delhi, 1993.*

2.   *Angrist, S.W, "Direct Energy Conversion", Allied Publishers Ltd., Boston, 1971.*

15CEE38 - ENVIRONMENTAL IMPACT ASSESMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Outline the overall perspectives of Environmental Impact Assessment.*

CO2 : *Design the necessary tools pertaining to assessment of various impacts.*

CO3 : *Recognize and synthesis the diversified socio-economic impacts on the society.*

CO4 : *Design and develop the significant protocols for Environment Management Plan.*

CO5 : *Synthesize and discretise the various impacts originating from typical developmental projects.*

ENVIRONMENTAL IMPACT ASSESMENT PERSPECTIVES

Impact assessment introduction -Historical perspective -Scope and goals of EIA - Legal and Regulatory aspects in India - Types and limitations of EIA - Scope studies for Environmental Impact Studies (EIS). Preparation for EIS Planning, Public Participation and Review of EIS. **(9)**

ASSESSMENT AND MONITORING

Environmental setting - environmental impact assessment methodology- cost benefit analysis, environmental indices and indicators for describing affected environment, Life cycle assessment. Role of remote sensing and GIS in Environmental Impact Assessment **(9)**

SOCIO-ECONOMIC IMPACT ASSESSMENT

Types, steps in performing socio-economic impact assessment, analysis of public services and facilities impacts, social impacts, impacts of economic profile of the community. **(9)**

ENVIRONMENTAL MANAGEMENT PLAN

Environmental Management Plan - preparation, implementation and review - Mitigation and Rehabilitation Plans - Policy and guidelines for planning and monitoring programmes - Post project audit - Ethical and Quality aspects of Environmental Impact Assessment. **(9)**

SECTORAL ENVIRONMENTAL IMPACT ASSESMENT

EIA related to the following sectors - Infrastructure -construction and housing Mining - Industrial - Thermal Power - River valley and Hydroelectric projects-Nuclear Power- EIA for coastal projects. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Canter.R.L, "Environmental Impact Assessment", McGraw Hill, New Delhi, 1996.*
2. *Shukla,S.K., Srivastava.P.R., "Concepts in Environmental Impact Analysis", Common Wealth Publishers, New Delhi, 1992.*

REFERENCE BOOKS

1. *Rao, J.G., and Wotten, D.C., "Environmental Impact Analysis, Handbook", McGraw-Hill, 1980.*
2. *Van Nostr, and Reinhold, J.E. Heer, Hagerty,D. J., "Environmental Assessment and Statement", 1977.*
3. *Canter, L.W., "Environmental Impact Assessment", McGraw-Hill, New York, 1996.*
4. *"Environmental Assessment Source book", Vol. I, II &III, The World Bank, Washington, D.C, 1991.*

15CEE39 - SOLID AND HAZARDOUS WASTE MANAGEMENT

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OUTCOME

After successful completion of the course, student will be able to

CO1 : *Outline the salient features of solid waste management and handling.*

CO2 : *Deduce the source reduction, recycling and reuse techniques of solid waste.*

CO3 : *Analyze the collection systems and method of transfer of solid waste.*

CO4 : *Describe the processing techniques for solid and hazardous waste.*

CO5 : *Select the suitable methods for disposal of solid and hazardous waste.*

CO6 : *Interpret the legislation for management, handling and disposal of solid and hazardous waste.*

CHARACTERISTICS AND SOURCE REDUCTION OF SOLID WASTE

Definition, sources, and types of solid waste - Composition, physical, chemical and biological properties of solid wastes - Per capita generation rates - Sampling and characterization of solid waste - Source reduction of wastes -Waste exchange - Recycling and reuses - Salient features of Indian legislations on management and handling of municipal solid wastes. **(9)**

COLLECTION AND TRANSPORT OF SOLID WASTE

Estimation of solid waste and factors affecting generation rates - On-site handling, storage, and processing- Collection services: municipal and commercial - Industrial services - Collection systems: Hauled-container system (HCS) and stationary container system (SCS) - Vehicle and labour assessment - Assessment of collection route - Transfer and transport - Transfer station location- Means and methods of transfer. **(9)**

PROCESSING AND DISPOSAL OF SOLID WASTE

Objective of processing - material separation and processing technologies- biological, chemical and thermal conversion technologies- disposal in Landfills: site selection methods and operations, leachate and gas generations and movement and control of gas and leachate techniques - Composting: aerobic and anaerobic - Resource and energy recovery schemes. **(9)**

HAZARDOUS WASTE CHARACTERIZATION AND MANAGEMENT

Definitions and Identifications of hazardous waste - Origin and characterization of hazardous solid waste- Typical hazardous wastes in MSW - Hazardous waste management: minimization, collection, storage, handling, transport, and disposal - design of hazardous waste landfills - TCLP tests - National and International legislation for hazardous waste management - Atomic Energy Regulatory Board -International Atomic Energy Agency - Department of Atomic Energy - Nuclear Power Corporation - Nuclear power plants in India. **(9)**

NUCLEAR WASTE AND e-WASTE

Sources - classification - effects of nuclear waste- initial treatment of nuclear waste - vitrification, ion exchange, synroc - long term management - above ground disposal, geological disposal, ocean dumping, transmutation, space disposal - reuse of waste - nuclear safety and waste regulation - case study on nuclear disaster - source of e-waste - material composition of e-waste - recycling and recovery - integrated approaches to e-waste recycling - socio economic factors - treatment option - disposal option - e-waste legislation. **(9)**

TOTAL : 45

TEXT BOOKS

1. Tchobanoglous, G. et al., "Integrated Solid Waste Management", McGraw-Hill Publication., New York, 1993.

2. Ronald E. Hester, Roy M. Harrison "Electronic Waste Management", Royal Society of Chemistry, 2009.

REFERENCE BOOKS

1. Peavy, SH, Rowe, RD and Tchobanoglous, G, "Environmental Engineering", McGraw-Hill Inter Edition, 1985.

2. Charles, A.W., "Hazardous Waste Management", McGraw-Hill Publication, 2002

15CEE40 - PRINCIPLES OF SUSTAINABLE DEVELOPMENT

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OUTCOME

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

CO1 : *Outline the concepts, components and factors affecting Sustainable development.*

CO2 : *Discuss the significance of International summits, conventions and agreements on Sustainable development.*

CO3 : *Describe the necessity and importance of Indian and International legal aspects in Sustainability.*

CO4 : *Illustrate the socio economic policies and public participation in Sustainable development.*

CO5 : *Discuss the role and commitment of developed countries in Sustainable development.*

CO6 : *Describe the concepts of Life cycle Assessment and Environmental Standards.*

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 -International Environmental summits, conventions and agreements- Action plan for Sustainable development- Transboundary issues - Role of developed and developing countries in sustainable development. **(9)**

ENVIRONMENTAL ASPECTS

Biodiversity- Types of biodiversity-Threats to biodiversity- Ecological indicators- Ecological foot print- Carbon foot print-Conservation biology- Strategic species concepts- Ecological economics- Environmental impact of agriculture, animal husbandry, fishery and land use- Habitat fragmentation- Desertification- Natural disasters, geological, hydrological, meteorological and health- Nuclear issues. **(9)**

ECONOMIC ASPECTS

Production, Consumption, Investment and Exchange of Goods and Services - Macroeconomic Aggregates, Circular Flow of Income and its Criticism- Methods of Calculating National Income- GNP and GDP- The Goods Market: determination of equilibrium output -Financial Markets: demand for money and interest rates- Goods and Financial markets: IS-LM Model- General Overview of Fiscal and Monetary Policies-relative effectiveness- International Transactions and exchange rates- Market failure & Incomplete markets Externalities -UN Sustainable development policies through trade- World Trade Organization- International monetary fund and World bank. **(9)**

SOCIAL ASPECTS

Indigenous Knowledge and Natural Resource Management (NRM) - Commodification, marginalization and degradation - Indigenous knowledge and its relevance to sustainable development - Biopiracy and Biopolitics over Traditional Ecological knowledge (TEK)- Environmental Degradation in developing countries - Overview of development- Globalisation and the structural adjustments- Governance and welfare state- Development processes and social justice -Social inequality as a global challenge-marginalized/vulnerable groups, indigenous people, resettlement & rehabilitation and development. **(9)**

STRATEGIES FOR SUSTAINABLE DEVELOPMENT

Economic growth, carrying capacity- Resource depletion and resource protection-Sustainable Management of Forest, Land, water, fishery, agriculture, energy and ecosystem- Natural Disaster management- Cleaner Production, definition, aim, application- Generic process of Cleaner Production Assessment- Life cycle Assessment- definition, necessity and elements- ISO Environmental standards- Environmental Audit. **(9)**

TOTAL : 45

TEXT BOOKS

1. Brian Snowdon and Howard R. Vane, "Modern Macroeconomics", Edward Elgar, USA, 2005

2. Gupta N.K., "Macroeconomics", National Council of Educational Research and Training, New Delhi, 2012

3. Arun Kumar, "Macroeconomic Aspects of Goods and Services Tax", Economic and Political Weekly, 2015

4. Ramakrishnan, P. S., "Ecology and Sustainable Development", National Book Trust, New Delhi, 2001

5. Paul Robbins, John Hintz, and Sarah A. Moore, "Environment and Society: A Critical Introduction", Wiley-Blackwell, 2014

REFERENCE BOOKS

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. Kolstad Charles D., "Environmental Economics", Oxford University Press, 2003

15CEE41 - SAFETY ENGINEERING IN BUILDINGS

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OUTCOME

After successful completion of the course, student will be able to

CO1 : *Demonstrate the safety concepts, policy and techniques.*

CO2 : *Demonstrate the issues related to physical and chemical hazards and control methods to reduce hazards.*

CO3 : *Outline the fire engineering and explosion control.*

CO4 : *Identify the method of safety provision in execution of civil works.*

CO5 : *Identify the safety consideration in erection and closing operations and material handling in civil construction works.*

CONCEPTS OF SAFETY ENGINEERING

Concept of safety - Evolution of modern safety concept- Safety policy - Safety Organization - line and staff - functions for safety- Safety Committee- budgeting for safety. Techniques- Incident Recall Technique (IRT), disaster control, Job Safety Analysis (JSA), safety survey, safety inspection, safety sampling, Safety Audit. **(9)**

OCCUPATIONAL HEALTH AND HYGIENE

Physical hazards - Noise, noise exposure regulation, occupational damage, risk factors, and permissible exposure limit. Ionizing radiation, types, effects, monitoring instruments, control programs, control measures. Chemical hazards - Recognition of chemical hazards-dust, fumes, mist, vapour, fog, gases, types, concentration, Exposure vs. dose, Methods of Control. Concept and spectrum of health - functional units and activities of occupational health services, pre-employment and post-employment medical examinations - occupational related diseases, levels of prevention of diseases. **(9)**

FIRE ENGINEERING AND EXPLOSION CONTROL

Fire chemistry - Dynamics of fire behavior - Fire properties of solid, liquid and gas - Fire spread - Toxicity of products of combustion. Building evaluation for fire safety - Fire load -Fire resistance materials and fire testing -Structural Fire protection - Exits and egress. Statutory Rules and Techniques of fire fighting - Indian Explosive acts and rules -Techniques of fire fighting and demonstration. **(9)**

SAFETY IN CONSTRUCTION

General safety consideration - analyzing construction jobs for safety - Contract document -Safety certificate for statutory authorities for old building and construction. Safety in Erection and closing operation - Construction materials -Specifications - suitability - Limitations. Safety in typical civil structures - Dams-bridges-water Tanks-Retaining walls-Critical factors for failure-Regular Inspection and monitoring. **(9)**

SAFETY IN MATERIAL HANDLING

General safety consideration in material handling - Ropes, Chains, Sling, Hoops, Clamps, Arresting gears. Selection, operation and maintenance of Industrial Trucks - Mobile Cranes - Tower crane -Checklist - Competent persons. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Krishnan N.V., "Safety Management in Industry", Jaico Publishing House, Bombay, 1997.*
2. *"Accident Prevention Manual for Industrial Operations", NSC Chicago, 1982.*

REFERENCE BOOKS

1. *"Handbook of Occupational Health and Safety", NSC Chicago, 1982.*
2. *James, D., "Fire Prevention Handbook", Butterworths, London, 1986.*
3. *Gupta R.S., "Handbook of Fire Technology", Orient Longman, Bombay, 1997.*
4. *Fulman, J.B., "Construction Safety, Security, and Loss Prevention", John Wiley and Sons, 1979.*
5. *Alexandrov, M.P., "Material Handling Equipment", Mir Publishers, Moscow, 1981.*
6. *Rudenko N., "Material Handling Equipments", Mir Publishers, Moscow, 1981.*

15MEOE01 - ROBOTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

At the end of this 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 for a specific robot.*

CO3 : *Calculate mass and inertia for the links of a robot manipulator and also find its forward and inverse dynamics.*

CO4 : *Choose appropriate vision system for the robot and extract images for the desired output.*

CO5 : *Write a program to determine a path for obstacle avoidance for a specific task 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. **(6)**

GENERAL CONSIDERATION OF ROBOTIC MANIPULATORS

Introduction - Brief history of robotics- Robot geometrical configurations - wrist and gripper subassemblies - robot drive systems - robot software. **(7)**

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. **(13)**

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. **(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. **(10)**

TOTAL : 45

TEXT BOOK

1. *Fu.K S, Gonzales.R.C., and Lee.C.S.G., "Robotic Control, Sensing, Vision and Intelligence", McGraw Hill International, 2006.*

REFERENCE BOOKS

1. *Mikell.P.Groover, MitchellWeiss, Tooger.N.Nager, and NicholasG.Odrey, "Industrial Robotics Technology, Programming and Applications", McGraw Hill International, 2004.*

2. *Richard.D.Klafter, Thomas.A.Chmielewski, and Michaelnegin, "Robotic Engineering - An Integral Approach", Prentice Hall of India, 2002.*

15MEOE02 - LOW COST AUTOMATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Design and control simple automation systems using fluidics.*

CO2 : *Carry out design, selection and enhance existing automated system using fluidics.*

CO3 : *Demonstrate the importance of using electro mechanical systems in automation.*

CO4 : *Analysis and design of hydraulic circuits and some safety precautions in such circuits.*

INTRODUCTION

Fluid Power - Hydraulic and Pneumatic fluids - properties and selection. Advantages and applications of Fluid Power.   **(2)**

HYDRAULIC PUMPS AND MOTORS

Symbolic representation of fluid power elements. Hydraulic pumps and motors- principle of working, calculation of discharge, power and efficiency - simple problems.   **(8)**

HYDRAULIC VALVES

Pressure, flow and direction control valves, Electro hydraulic elements, accumulators, intensifiers, power calculations, size of accumulators - fluid seals - types and constructional details.   **(8)**

BASIC HYDRAULIC CIRCUITS

Unloading, speed control, regenerative and sequencing circuits. Servo systems, typical hydraulic circuits for machine tools and other industrial applications. Circuit design for given functional requirements.   **(9)**

PNEUMATICS

Air preparation units - Filter, Regulator and Lubricator. Valve configuration and controls. Pneumatic actuators, diaphragm actuators, back pressure sensors. Pneumatic circuits design - Cascade method.   **(7)**

HYDRO PNEUMATICS AND ELECTRO PNEUMATICS

Hydro-pneumatics and electro-pneumatic elements and circuits, KV map method and Ladder diagram   **(5)**

FLUIDICS

Fluidics - Coanda effect, wall attachment devices, digital and proportional devices. Fluidic amplifiers, typical application of fluidics for control in fluid power circuits.   **(6)**

TOTAL : 45

TEXT BOOKS

1. *Anthony Esposito, "Fluid Power with Application", Prentice Hall,2008.*

2. *Stewart, "Practical Guide to Fluid Power", Taraporevala Sons & Co., Bombay, 2002.*

REFERENCE BOOKS

1. *Subir Kar, "An Introduction to Fluidics", Oxford and IBH Publishing Co., New Delhi, 1984.*

2. *Fitch, E.C. Jr., "Fluid Power and Control Systems", McGraw Hill Book Co., 1966.*

3. *Pippenger, J.J. and Hicks, T.G., "Industrial Hydraulics", McGraw Hill Book Co., 1979.*

4. *Andrew Parr, "Hydraulics and Pneumatics", Jaico Publishing House, 2008.*

15MEOE03 - ADAPTIVE CONTROL AND PROCESS DYNAMICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Explain the different computer process control systems and its application.*

CO2 : *Develop the different digital controllers to suitable processes with or without time delay systems.*

CO3 : *Evaluate the advanced control concepts, system identification and process modeling.*

REVIEW OF SYSTEMS

Basic equation - Integral and instantaneous balances - Material and Energy balances - General form of dynamic models. Linearization of nonlinear systems in state space form - Response of lead-lag modules- Self-regulating system - transfer function analysis of higher order systems. **(6)**

SECOND ORDER SYSTEMS

A second order system - Pole-Zero cancellation - Systems in series - Blocks in parallel - linear boundary value problems - Parameter estimation of discrete linear systems. Phase plane analysis - generalization of phase plane behavior - nonlinear systems - Introduction to nonlinear dynamics - bifurcation behavior of systems **(9)**

APPLICATIONS

Stirred tank heaters, Absorption-isothermal, continuous stirred tank chemical reactors, Biochemical reactors - adiabatic continuous stirred tank reactor - ideal binary distillation columns. **(6)**

LINEAR DYNAMIC SYSTEM IDENTIFICATION

System Identification: Introduction, dynamic systems, models, system identification procedure. Simulation and Prediction. Non-parametric time and frequency domain methods. Linear dynamic system Identification: Overview, excitation signals, general model structure, time series models, models with output feedback, models without output feedback. Convergence and consistency. **(9)**

ADAPTIVE CONTROL

Parameter estimation methods, minimizing prediction errors, linear regressions and Least squares method, Instrumental - variable method, prediction error method. Recursive algorithms.Closed-loop Identification. Adaptive Control: Close loop and open loop adaptive control. Self-tuning controller. Auto tuning for PID controllers: Relay feedback, pattern recognition, and correlation technique. **(9)**

ADAPTIVE ADVANCED CONTROL

Adaptive Smith predictor control: Auto-tuning and self-tuning Smith predictor. Adaptive advanced control: Pole placement control, minimum variance control, generalized predictive control. **(6)**

TOTAL : 45

TEXT BOOKS

1. *Bequette B.W., "Process Dynamics - Modeling, Analysis and Simulation", PHIPE, New Delhi, 1998.*

2. *Stephanopoulos G., "Chemical Process Control: An Introduction to Theory and Practice", Prentice Hall of India (P) Ltd., New Delhi, 2009.*

REFERENCE BOOKS

1. Shinsky F.G., "Process Control Systems: Application, Design and Adjustment", 3rd Edition, McGraw Hill Book Co., New York, 1988.

2. Nelles O., "Nonlinear System Identification", Springer Verlag, Berlin, 2011.

3. Ljung L., "System Identification: Theory for The User", Prentice Hall, Englewood Cliffs, 1999.

4. Astrom K., "Adaptive Control", Second Edition, Pearson Education Asia Pvt. Ltd., 2002.

15MEOE04 - PROJECT PLANNING AND MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Evaluate and select the most desirable projects.*

CO2 : *Identify desirable characteristics of effective project managers.*

CO3 : *Apply appropriate approaches to plan a new project and develop a project schedule.*

CO4 : *Develop a suitable budget for a new project and Identify important risks.*

CO5 : *Apply appropriate techniques to assess ongoing project performance.*

INTRODUCTION

Project management- an overview, project identification and Screening; Project Appraisal. Introduction to Production Systems and a Generalized Model of Production. Life cycle of a Production System and Major managerial Decisions. **(7)**

PROJECT PLANNING

Project Planning- Development of Project Network; Project Representation; Consistency and Redundancy in Project Networks; Project Scheduling- Basic Scheduling with A-O-A Networks; Basic Scheduling with A-O-N Networks; Project Scheduling with Probabilistic Activity Times. **(7)**

TIME MANAGEMENT

Time/Cost Tradeoffs in Projects -Linear Time - Cost Tradeoffs in Projects: A Heuristic Approach; Resource Considerations in Projects - Resource Profiles and leveling. Limited Resource Allocation. **(8)**

PROJECT IMPLEMENTATION

Project Monitoring and Control with PERT / Cost. Team Building and Leadership in Projects; Project Completion, Review and Future directions. **(8)**

DECISION MAKING IN MANAGEMENT

Financial Evaluation of Production Related Decisions- Performance Measures of a Production System. Financial Evaluation of Capital Decisions. Decision Trees and evaluation of risk; Designing Products & Services - Introducing New Products and Services, Product Mix Decisions. **(8)**

MANAGEMENT CONTROLS

Fundamentals of MRP I & MRP-II, Toyota production system - evolution of JIT - Waste elimination techniques - Pull control - kanban, kaizen. Lean manufacturing - agile manufacturing, Value chain analysis, Theory of Constraints (TOC) - bottleneck vs constrained resource - bottleneck identification and elimination - drum buffer rope systems. **(7)**

TOTAL : 45

TEXT BOOKS

1. *Shtub A., Bard J. F. &Globerson S., "Project management: engineering, technology, and implementation", 2nd Edition Prentice Hall, 2004.*

2. *Lock D., "Project management", Gower Publishing Ltd., 9th Edition, 2007.*

3. *Kerzner H., "Project Management: A Systems Approach to Planning, Scheduling and Controlling", John Wiley & Sons, 11th Edition, 2013.*

REFERENCE BOOKS

1. *Murthy P.R., "Production and Operations Management", New Age International (P) Ltd. Publishers,2nd Edition, 2006.*

2. *Mayer R.R., "Production management", McGraw-Hill, 1968.*

3. *Harding H.A., "Production management", Macdonald and Evans Ltd, 1974.*

15MEOE05 - SUPPLY CHAIN MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1   : *Outline the manufacturing and product life cycle management process involved in a product.*

CO2   : *Formulate the forecasting methods and inventory modelling*

CO3   : *Estimate the right procurement and logistics strategy based on the supply chain and product criterion requirements.*

CO4   : *Design and analyze the right supply chain structure for the product along with distribution network*

CO5   : *Produce the supply chain network diagram incorporating supply chain strategy and competitive strategies involving material and information flow lines*

INTRODUCTION

Supply Chain, Objectives & Stages, power of SCM - Process views of a supply chain - Strategic planning, Achieving a strategic fit in a supply chain and factors affecting the strategic fit - Value chain, supply chain flow lines - Understanding a product, Product life cycle, Fishers classification of products - Effective and efficient supply chain - case studies on products.   **(9)**

SUPPLY CHAIN PROCESS

Forecasting in supply chain, forecast error distribution order quantity and reorder point characteristics & components of forecasting - time series methods of forecasting, Demand Management in MPC - MTS - ATO - MTO. Inventory, role of cycle inventory, economies of scale to exploit fixed costs, Economies of scale to exploit quantity discounts, Short term discounting and trade promotions Managing multi-echelon cycle inventory - Bullwhip effect - Product substitution, Postponement.   **(9)**

PRODUCT PROCUREMENT & TRANSPORTATION

Procurement process, EOQ - Sourcing in a supply chain - deciding factors for in-house or outsourcing -Supplier selection - auctions and negotiations, risk management in sourcing Freight management, Transportation networks, Milk run, Cross Docking, tailored transportation, 3PL - 4 PL, Risk management in transportation.   **(9)**

DESIGNING A SUPPLY CHAIN

Supply chain drivers - Supply chain performance measures - SCOR Model - Network design in a supply chain, factors influencing design, Framework for network design network, models for facility location and capacity allocation - Uncertainty in network design - Discounted cash flow analysis, Decision trees in evaluating network design - Distribution, factors influencing distribution, design options for a distribution network.   **(9)**

INFORMATION TECHNOLOGY IN SUPPLY CHAIN

Lean Supply Chain, agile supply chain, Dynamic supply chain design, Impact of technology on SCM, Key trends in SCM, IT in supply chain coordination and design - MRP, ERP, CRM, ISCM - Performance metrics.Discussion on supply chain adopted by primary industrial sectors and case studies.   **(9)**

TOTAL : 45

TEXT BOOK

1.   *Ayers J., "Hand Book of Supply Chain Management", The St. Lencie Press/ APICS Series on Resource Management, 2000.*

REFERENCE BOOKS

1. Burt N.D., Dobler. W.D. and Starling L.S., "World Class Supply Chain Management, The Key to Supply Chain Management", Tata McGraw Hill Publishing Company Limited, 2005.

2. Chopra S., Meindl P. and Kalra, D.V., "Supply Chain Management, Strategy, Planning and Operation", Pearson Education, Inc., 2008

3. Fredendall D.L. and Hill E., "Basics of Supply Chain Management", The St. Lucie Press / APICS Series on Resource Management, 2001.

4. Monczka R., Trent R. and Handfield R., "Purchasing and Supply Chain Management", 3rd edition, Thompson Learning Inc., 2007.

5. Sople V.V, "Supply Chain Management", Pearson Education, 2012

6. Vollmann T.E., Berry L.W., Whybark D.C. and Jacobs, R.F., "Manufacturing Planning and Control for Supply Chain Management", Tata McGraw Hill Publishing Company Limited, 2008.

7. Wild T., "Best Practice in Inventory Management", Butterworth - Heinmann, Elsevier Science Ltd.,2002.

ADDITIONAL READING

1. European Journal of Innovation Management

2. Logistics Information Management an International Journal

3. Supply Chain Management an International Journal

4. Sethi P.S., Yan H. and Zhang H., "Inventory and Supply Chain Management with Forecast Updates", Springer International Series, 2006.

5. Mohantry P.R. and Deshmukh G.S., "Supply Chain Management, Theories and Practices", Published by Biztantra Innovations in Management, 2005.

6. Kulkarani S and Sharma A., "Supply Chain Management", Tata McGraw Hill Publishing Company Limited, 2008.

15MEOE06 - RESOURCE MANAGEMENT TECHNIQUES

L	T	P	C
2	2	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Mathematically formulate a given engineering problem as a linear programming problem, and apply Graphical, Simplex, Two-Phase or Big-M methods to obtain the optimal solution.*

CO2 : *Construct or modify objective functions and constraints using primal and dual relationship, and apply the Dual Simplex Method to obtain optimal solutions.*

CO3 : *Justify the determined feasible solution (processing time and transportation cost) as optimal solution using MODI method and Hungarian method.*

CO4 : *Determine the optimal project duration and cost using CPM and PERT technique, also construct complex project network and control the complex project.*

CO5 : *Categorize (Inventory, Game Theory, Sequencing and Queuing) and solve various decision making problems using mathematical modeling.*

LINEAR PROGRAMMING

Linear programming formulation, graphical solutions, the essence of simplex method, setting up the simplex method, the simplex method in tabular form, Theory of simplex method, Big M Method, Two Phase Method.   **(5)**

DUALITY AND SENSITIVITY ANALYSIS

Primal - Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis.   **(4)**

TRANSPORTATION AND ASSIGNMENT

Formulation of Transportation Problem, Initial Feasible Solution Methods, Optimality Test, Degeneracy in Transportation Problem; Assignment Problem, Hungarian Method, Traveling Salesman Problem.   **(5)**

NETWORK MODELS

Definition of network models - minimal spanning tree algorithm, shortest route algorithm, maximal flow algorithms, PERT, CPM - LP formulation of minimal spanning, maximum flow and PERT, CPM calculations.   **(5)**

INVENTORY AND MODELS

Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model, Newsboy Problem.

(3)

GAME THEORY AND SEQUENCING

Two Person Zero Sum Game, Pure and Mixed Strategies, Algebraic Solution Procedure, Graphical Solution, Solving by Linear Programming; Sequencing Problem, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem.   **(4)**

QUEUING AND SIMULATION

Elements of Queuing Model, Pure Birth Death Model, Single Server and Multi-server Markovian Models with Infinite and Finite Capacity, Machine Repair Model, Networks of Queues. System concepts - Types of systems and models - system simulation procedure - Monte- Carlo simulation method (simple problems) - Introduction to simulation languages.   **(4)**

TOTAL : 60

TEXT BOOKS

1. Mohan, C. and Deep, Kusum: "Optimization Techniques", New Age, 2009.

2. Mittal, K. V. and Mohan, C. "Optimization Methods in Operations Research and Systems Analysis", Fourth Edition, New Age, 2016.

3. Taha, H. A, "Operations Research - An Introduction", Pearson, (9th Edition), 2014.

REFERENCE BOOKS

1. Ravindran, A., Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2014.

2. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2015.

3. S. S. Rao, "Engineering Optimization: Theory and Practice", 4th Edition, John Wiley & Sons, 2009.

15MEOE07 - SUSTAINABLE DEVELOPMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Infer environmental sustainability and to implement in more suitable ways to the society.*

CO2 : *Identify methods for reducing energy consumption and to implement lower carbon technologies to achieve sustainable society.*

CO3 : *Collect and organize information about historical perspectives of sustainability and for further development of sustainable industries.*

CO4 : *Compare the balance between food production and population growth to plan the optimal usage of water resources and to evaluate the solution for the problems of urban sprawl.*

CO5 : *Explore the fossil fuels formation of oil, natural gas and coal, environmental effects of mining and metals processing and it's time to depletion.*

INTRODUCTION

The concept of environmental sustainability, Examples of non-sustainability and sustainability. The special role of engineers in helping society transition to a more sustainable state. Definitions, principles, and indicators of sustainability. Overall criteria for development that is sustainable. Indicator studies. **(12)**

THE RISE OF SUSTAINABILITY

Historical perspectives in Europe and in the US. Modern debates: Sustainability extremists, Environmentalists, Traditional Engineers, and Anti-sustainability extremists. "Tragedy of the commons" and the ethics of sustainability. Models for achieving sustainable industries. **(12)**

POPULATION GROWTH ON A FINITE EARTH

Population models, population growth, exponential and logistic growth, variation in population among nations,population policy, Food production,Protecting and Promoting Human Health - Food security and nutrition and sustainable agriculture- Water resources, Urban sprawl. **(9)**

NON-RENEWABLE RESOURCES

Fossil fuels - Formation of fossil fuels: oil, natural gas, coal. Modelling of oil reserves. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies-Time-to-depletion. **(12)**

TOTAL : 45

TEXT BOOK

1. *Tatyana P. Soubbotina, "An Introduction to Sustainable Development", Washington, 2nd Edition, 2004.*

REFERENCE BOOKS

1. *Jeffrey D. Sachs, "The Age of Sustainable Development", Columbia University Press, 4th Edition, 2015.*

2. *K.A.Rasure, "Globalization And Sustainable Development", Oxford book company, 2nd Edition, 2010.*

3. *Barry Dalal Clayton and Stephen Bass., "Sustainable Development Strategies- a resource book", Earthscan Publications Ltd, London, 2002.*

4. *Karel Mulder, "Sustainable Development for Engineers"- A Handbook and Resource Guide, Green Leaf Publishing, 2006.*

15MEOE08 - PROCESSING AND APPLICATIONS OF BIOMATERIALS

	L	T	P	C
	3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : Identify the suitable material for human implants and perform mechanical and tribological characterization. (Tensile, compression, hardness, wear, corrosion and water absorption).

CO2 : Choose a bio compact material (calcium phosphate, ceramic, glass, bioinert ceramics, polymeric, HDPE, hybrid, metals and alloys, Ti Alloys - Co-Cr-Mo, Ni or Ta-Based Alloys - Other Non-Ferrous alloys) for a orthopedic joints.

CO3 : Develop successful implants (biological, mechanical, morphological Compatibility) for dental and bone applications.

CO4 : Evaluate biomaterials, metals, ceramics, polymers, micro/nano for Surface modification, micro/nano fabrication to find the tensile strength and micro structure.

CO5 : Estimate the percentage of reinforcement (particle, fiber, laminates) to increasing the strength (tensile, flexural, bending, fatigue, wear, and corrosion) under specified constraints (density) for human implants.

CO6 : Design a suitable shape of the implants for orthopedic joint applications.

FUNDAMENTALS OF BIOMATERIALS AND BIOCOMPATIBILITY

Introduction - definitions and their Implications - Biomaterial - Biocompatibility -Host response - Cell-Material Interactions - Experimental Evaluation of Biocompatibility - In vitro Tests - In vivo Tests - Steps for characterizations of biomaterials - Broad overview of Fundamentals. **(7)**

MATERIALS FOR ORTHOPEDIC APPLICATIONS

Introduction - Structure and Properties of Hard Tissues - Processing and Properties of Bioceramics and Bioceramic Composites - Calcium Phosphate Based Biomaterials - Hydroxyapatite-Ceramic Composites - Glass-Ceramics Based Biomaterials - Mica Based Glass Ceramics - Other Bioglass-Ceramics - Bioinert Ceramics - Polymeric Biomaterials - Polymer-Polymer Composites - Polymer-Ceramic Composites - HDPE-Hap-Al2O3 Hybrid Composites - Metals and Alloys in Biomedical Applications - Issues Limiting Performance of Metallic Biomaterials - Wear of Implants - Corrosion of Metallic Implants - Ti-Based Alloys - Co-Cr-Mo, Ni or Ta-Based Alloys - Other Non-Ferrous Metals and Their Alloys - Coating on Metals. **(12)**

TITANIUM DENTAL IMPLANT SYSTEMS

Introduction - Requirements for Successful Implant Systems - Biological Compatibility - Mechanical Compatibility - Morphological Compatibility - Osseo integration and Bone/Implant Interface - Integrated Implant System. **(7)**

PROCESSING OF BIOMATERIALS

Introduction - Processing of Biomaterials - Metals - Ceramics - Polymers - Biocomposites - Sterilization - Processing for Scale - Micro/Nano Surface Modification - Micro/Nano Fabrication-Tensile testing, microscopy (SEM,AFM)evaluation. **(7)**

BIOMATERIAL APPLICATIONS

Introduction - Applications in Medicine, Biology, and Artificial Organs - Cardiovascular Medical Devices - Extracorporeal Artificial Organs - Orthopedic Implants - Dental Implantation - Bioadhesive - Opthalmologic Applications - Cochlear Prosthesis - Drug Delivery - Tissue Engineering - 2-D and 3-D tissue engineering applications and their mechanical characterization -Array Technologies and Specific Medical Applications. **(12)**

TOTAL : 45

TEXT BOOK

1. *BikramjitBasu, Ashok Kumar and Katti S., 'Advanced Biomaterials - Fundamentals, Processing and Applications', John Wiley & Sons, INC, Publication, 2015.*

REFERENCE BOOKS

1. *Joon. B. Park and Joseph D. Bronzino 'Bio Materials - Principles and Applications', CRC press, 2010.*
2. *Park J. B. and Lakes R.S., 'Bio Materials - An Introduction', Plenum Press, New York, 2009*
3. *Dee KC, Puleo and DA, Bizios R, 'An introduction to tissue-biomaterial interactions', John Wiley & Sons, 2007.*

15MEOE09 - NUMERICAL SIMULATION OF FLUID FLOW

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Demonstrate ability to use the Finite-Volume Method to analyze one and two-dimensional problems of heat transfer and irrotational fluid flow*

CO2 : *Apply numerical techniques to solve systems of algebraic equations and integrate ordinary differential equations*

CO3 : *Evaluate heat transfer rates, fluid flow rates, etc.*

CO4 : *Judge the correctness of the numerical solutions;*

CO5 : *Recognize the need for turbulence models*

CONSERVATION LAWS OF FLUID MOTION AND HEAT TRANSFER

Introduction - Governing equations of fluid flow and heat transfer - Navier-Stokes (N-S) equations for a Newtonian fluid **(9)**

IRROTATIONAL FLOWS AND LAMINAR BOUNDARY LAYERS

Introduction - Potential functions and stream functions - Numerical treatment of steady irrotational flows in two dimensions - Simple two-dimensional laminar flows - Boundary layer over a flat plate - Blasius solution - Numerical treatment of ordinary differential equations related to Blasius solution. **(9)**

NUMERICAL HEAT TRANSFER - FINITE VOLUME METHOD

Introduction - Discretization of governing partial differential equations of heat transfer- Applications to steady and unsteady heat conduction in one and two dimensions - Treatment of heat sources - Explicit and implicit solution schemes for steady and unsteady heat conduction. **(9)**

NUMERICAL TREATMENT OF FLUID FLOW - FINITE VOLUME METHOD

Discretization of governing partial differential equations of fluid flow - Differencing schemes for convective-diffusive flows - Treatment of flow boundary conditions - Introduction to the SIMPLE Algorithm. **(9)**

TURBULENT FLOWS

Introduction - Reynolds Averaged N-S equations for turbulent flows - Eddy viscosity concept - Mixing length models - Brief overview of turbulence kinetic energy and dissipation (k-e) models - Brief overview of advanced turbulent flow models. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Ghoshdastidar.P.S, "Computer Simulation of Flow and Heat Transfer", Tata McGrawHill, New Delhi, 1999.*

2. *Versteeg. H.K. and Malalasekara.W, "An Introduction to Computational Fluid Dynamics - The Finite Volume Method", Pearson Education, 2nd Edition, England, 2007.*

REFERENCE BOOKS

1. *Muralidhar. K., Sundararajan. T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.*

2. *Niyogi P., Chakrabarthy. S.K., Laha. M.K., "Introduction to Computational Fluid Dynamics", Pearson Education, 2005.*

3. *Chung T.J., "Computational Fluid Dynamics", Cambridge Univ. Press, New York, 2002.*

4. *Anil W. Date, "Introduction to Computational Fluid Dynamics", Cambridge Press, UK, 2005.*

5. *Titus Petrila and Damian Trif, "Basics of Fluid Mechanics and Introduction to Computational Fluid Dynamics", Springer, Boston, 2005.*

15MEOE10 - SOLAR ENERGY UTILISATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

At the end of the course student will be able to

CO1 : *Calculate solar time, local time, earth-sun angles, direct and indirect solar radiation for the given location using earth-sun geometry.*

CO2 : *Categorize solar cell materials with its properties and calculate energy conversion efficiency of solar cells using I-V characteristic curves.*

CO3 : *Derive the expression for overall heat transfer coefficient using network resistance method, relations for collector efficiency factor and collector heat removal factor of non- concentrating solar collectors.*

CO4 : *Calculate heating loads using F-chart method for air and liquid based solar heating systems.*

CO5 : *Analyze the Performance of the following thermo-electric devices: generators, refrigerators and heat pumps.*

INTRODUCTION TO SOLAR ENERGY

Introduction, overview of applications - calculation of solar constant, terminology related to solar radiation, definition and calculation of solar times, definition and calculation of all solar angles and related earth angles. **(4)**

PHOTOVOLTAICS

Fundamentals of solar cells: types of solar cells, semiconducting materials, band gap theory, absorption of photons, excitons and photoemission of electrons, band engineering; Solar cell properties and design; p-n junction photodiodes, depletion region, electrostatic field across the depletion layer, electron and holes transports, device physics, charge carrier generation, recombination and other losses, I-V characteristics, output power. **(9)**

SOLAR CELL

Solar Cell Applications - Solar cell manufacturing processes: material resources, chemistry, and environmental impacts; low cost manufacturing processes - Thin film solar cells - Single crystal, polycrystalline and amorphous silicon solar cells, cadmium telluride thin-film solar cells, conversion efficiency. **(6)**

SOLAR CALCULATION AND SOLAR COLLECTORS

Calculation of extra-terrestrial irradiation on a horizontal surface on a hourly and daily basis, relationship between radiation on titled and horizontal surfaces, effect of atmosphere on solar radiation, Hottel's estimation of clear sky radiation, types and classification of solar collectors, terminology related to non-concentrating collectors, efficiency of a solar collector. **(4)**

THERMAL MODELLING OF NON- CONCENTRATING COLLECTORS

Modeling of heat transfer processes in flat plate collector, formula for effective transmittance-absorptance product, estimation of top, bottom and overall heat loss coefficient using resistance network method, collector stagnation temperature, temperature distribution between tubes and along tubes, collector efficiency factor F, collector heat removal factor FR, collector heat exchanger modeling and combined efficiency factor FR. **(10)**

SOLAR THERMAL CONVERSION

Overview of active and passive heating - Calculation of space and water heating loads, degree-days, F-chart method for air and liquid based system. Low, medium and high temperature collectors, Heat storage, storage media, steam accumulator, other storage systems, heat exchangers and applications of stored energy. **(6)**

THERMO- ELECTRIC SYSTEMS

Thermoelectricity, Peltier effect, Seebeck effect; thermoelectric materials, Bismuth telluride, automotive thermoelectric generators, radioisotope thermoelectric generator; thermoelectric power generators, thermoelectric refrigerators and heat pumps. **(6)**

TOTAL : 45

TEXT BOOKS

1. *Principles of Solar Engineering, D. Yogi Goswami, Taylor and Francis, 2000, ISBN 10: 1-56032- 714-6*
2. *Garg H.P., Prakash J., "Solar Energy: Fundamentals & Applications", Tata McGraw Hill, New Delhi, 1997.*

REFERENCE BOOKS

1. *Applied Photovoltaics, Stuart Wenham, Martin Green, and Muriel Watt, Earthscan, 2007, ISBN 1-84407-407-3*
2. *Photovoltaic Engineering Handbook, F. Lasnier and T. G. Ang, IOP Publishing UK (Adam Hilger USA) 1990, ISBN 0-85274-311-4*
3. *Semiconductor Devices, Physics, and Technology, Second Edition, S. M., Sze, New York, NY: Wiley, 2001. ISBN: 0471874248*
4. *Solar Cells: Operating Principles, Technology and system Applications, Martin A. Green, Published by the University of New South Wales, 1998, ISBN 0 85823 580 3*
5. *S. P. Sukhatme, "Solar Energy", Tata McGraw Hill, New Delhi, 1999.*
6. *J. A. Duffie and W.A.Beekman, " Solar Engineering of Thermal Processes", John Wiley and Sons, New York, 2005.*
7. *Tiwari G.N.,Suneja S., "Solar Thermal Engineering System", Narosa Publishing House, New Delhi, 1997.*
8. *T.Bhattachariya, "Terrestial solar Photovoltaic", Narosa Publishers, New Delhi, 2008.*
9. *H.S.Rauschenbach, "Solar Cell Array Design Hand Book", Van NostrandReinfold Company, New York, 1980.*

15EEOE01 - ENERGY AUDITING

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OUTCOME

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

CO1 : *Understand the current energy scenario and the need for energy auditing.*

CO2 : *Describe the energy conservation schemes in steam systems.*

CO3 : *Identify the design considerations for minimizing energy consumption in compressors, fans and blowers.*

CO4 : *Understand the concepts of energy efficient electrical systems.*

CO5 : *List the techno commercial statement for the investment for energy saving.*

POWER AND ENERGY MANAGEMENT

Energy Scenario - Role of Energy Managers in Industries - Energy Monitoring, Auditing and Targeting - Economics of various energy conservation schemes - Total Energy Systems. **(9)**

ENERGY CONSERVATION IN MECHANICAL PROCESSES

Energy Audit - Various Energy Conservation Measures in Steam - Losses in Boiler - Energy Conservation in Steam Systems - Case studies. **(9)**

ENERGY CONSERVATION IN PRODUCTIVE PROCESSES

Energy Conservation in Centrifugal pumps, Fans, Blowers and Air compressor - Energy Consumption - Energy saving potentials - Design Consideration. **(9)**

ENERGY CONSERVATION IN NON - PRODUCTIVE PROCESSES

Refrigeration and Air conditioning - Heat load estimation - Energy conservation in cooling towers and Spray ponds - Energy Efficiency in Lighting - Case studies. **(9)**

ENERGY CONSERVATION CONTROL STRATEGIES AND IMPLEMENTATION

Control: Thermostats - Boiler controls - Proportional, Integral and Derivative control - Adaptive control - Compensators. Implementation: Investment and Pay back calculations for energy conservation measures - Organizational support for energy management motivation. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Eastop T.D and Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical publications, 1990.*

2. *Reay D.A, "Industrial Energy Conservation", Pergamon Press, 1st Edition, 1977.*

3. *Larry C Witte et. al, "Industrial Energy Management & Utilization". Springer Publication, 1st Edition, 1990.*

REFERENCE BOOKS

1. *D P Kothari and I J Nagrath, "Power System Engineering", Tata McGraw-Hill Co, 2nd Edition, 2008.*

2. *https://www.beeindia.gov.in/content/energy-auditors (Guide Book link)*

GUIDE BOOKS

2.1. *General Aspects of Energy Management & Energy Audit*

2.2. *Energy Efficiency in Thermal Utilities*

2.3. *Energy Performance Assistance for Equipment And Utility Systems*

2.4. *Energy Efficiency in Electrical Utilities*

15EEOE02 - SOLAR AND WIND ENERGY SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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

CO1 : *Describe the solar radiation, measurements and characteristics of solar PV cell.*

CO2 : *Develop the model of a PV system and its applications.*

CO3 : *Describe the basic types and mechanical characteristics and model of wind turbine.*

CO4 : *Analyse the electrical characteristics and operation of various wind-driven electrical generators.*

CO5 : *Understand 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 Bypass 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 - 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, 2nd Edition, 2011.

REFERENCE BOOKS

1. Roger A. Messenger and Jerry Ventre, 'Photovoltaic Systems Engineering', Taylor and Francis Group Publications, 2nd Edition, 2003.

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, 2010.

15EEOE03 - HYBRID SMART VEHICLES

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OUTCOME

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

CO1 : *Explain the dynamics of vehicle motion and propulsion systems.*

CO2 : *Identify various energy storage devices used in hybrid vehicles.*

CO3 : *Understand the application of electric machines in electric vehicles.*

CO4 : *Describe the working of hybrid electric drive train*

CO5 : *Describe the control and energy management strategies in hybrid vehicles.*

INTRODUCTION

Introduction to Hybrid Electric Vehicles - Social and Environmental importance of hybrid and Electric vehicles - Components, - Vehicle mechanics - Roadway fundamentals - vehicle kinetics - Dynamics of vehicle motion - Propulsion system **(9)**

ENERGY STORAGE

Energy Storage Requirements in Hybrid and Electric Vehicles. Battery, Fuel Cell, Super Capacitor - Flywheel based energy storage and its analysis - Hybridization of different energy storage devices. **(9)**

DC AND AC ELECTRICAL MACHINES

Motor and Engine rating - Requirements, DC machines, Three phase AC machines - Induction machines - Permanent magnet machines - Switched reluctance machines. Matching the electric machine and Internal Combustion Engine (ICE), - Sizing the motor - Sizing the power electronics - Selecting the energy storage technology - Communications - Supporting subsystems. **(9)**

HYBRID ELECTRIC DRIVE-TRAIN

Basic concept of electric traction, Transmission configuration - Components - Gears - Differential - Clutch - Brakes Regenerative braking, Motor sizing. Hybrid traction : Various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel Efficiency Analysis. **(9)**

ENERGY MANAGEMENT STRATEGIES

Energy management strategies used in hybrid and electric vehicles, - Component level control and supervisory control- Comparison and its implementation issues of different energy management strategies. **(9)**

Case study: Volvo XC90 T8 Plug-In Hybrid, Nissan X-Trial hybrid

TOTAL : 45

REFERENCE BOOKS

1. *Iqbal Hussain, "Electric & Hybrid Vehicles - Design Fundamentals", CRC Press, 2nd Edition, New York, 2010,*

2. *Mehrdad Ehsani, Yi mi Gao, Sebastian E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2004.*

3. *James Larminie and John Lowry, "Electric Vehicle Technology", Wiley Publishers, 2003.*

15EEE07 - ELECTRICAL SAFETY

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OUTCOME

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

CO1 : *Expand skills in identifying the presence of electrical hazards, implementing measures to minimize risks.*

CO2 : *Develop skills in investigative techniques for determining the cause of electrical accidents, fires and explosions.*

CO3 : *Analyze and apply various grounding and bonding techniques.*

CO4 : *Select appropriate safety method for low, medium and high voltage equipment.*

CO5 : *Assess and provide solutions to a practical case study.*

INTRODUCTION AND HAZARDS OF ELECTRICITY

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 - Tag out - 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's 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's 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 BOOKS

1. *John Cadick, Mary Capelli-Schellpfeffer and Dennis neitzel and Al Winfield "Electrical Safety Handbook",McGraw-Hill Publishing Company Ltd., 4th Edition, 2012.*

2. *Dennis Neitzel and Al Winfield, "Electrical Safety Handbook", McGraw-Hill Education, 4th Edition, 2012.*

REFERENCE BOOKS

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. James H. Wiggins JR., "Managing Electrical Safety", Abs Consulting, Maryland, 2011.

5. Maxwell Adams. J, "Electrical Safety- A Guide to the Causes and Prevention of Electric Hazards", The Institution of Electric Engineers, 1994.

6. Ray A. Jones and Jane G. Jones, "Electrical Safety in the Workplace", Jones & Bartlett Learning, Technology and Engineering, 2000.

7. Video Link: Electrical Safety in the Workplace Seminar DVD - NFPA National Fire Protection Association.

    http://www.nfpa.org/training-and-events/archived/training-videos/electrical-safety-videos

8. E-Book: Johncadick, Marycapelli-schellpfeffer, Dennis neitzel, "Electrical Safety Handbook", McGraw Hill publishing company Ltd., 3rd Edition, 1994.

    https://installist.files.wordpress.com/2009/12/electrical-safety-handbook.pdf

15EEE14 - ENERGY EFFICIENT LIGHTING SYSTEM

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OUTCOME

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

CO1 : Understand the properties of light, importance of lighting in various fields and types of lighting.

CO2 : Understand the properties and laws of illumination, working of discharge lamps, fluorescent lamps, tungsten filament lamps and light control.

CO3 : Compare the various lighting techniques & employ lighting control methods.

CO4 : Choose the building materials and construction techniques for energy efficient lighting.

CO5 : Employ renewable energy methods for energy efficient lighting.

LIGHTING

Lighting - Importance of lighting in buildings, Interior designing - Photography, Architecture - Difference between good and bad lighting - Challenges in lighting - Types of lighting.   **(9)**

ILLUMINATION FUNDAMENTALS & VARIOUS ILLUMINATION METHODS

Introduction - Terms used in illumination - Laws of illumination - Polar curves - Photometry - Integrating sphere - Sources of light - Discharge lamps, Incandescent lamps - MV and SV lamps.   **(9)**

ENERGY EFFICIENT LIGHTING

Smart lighting - Fluorescent lamps - Comparison between tungsten filament lamps and fluorescent tubes - Basic principles of light control - Types and Design of lighting and flood lighting.- CFL - LED - High Intensity Discharge lamps   **(9)**

BUILDING MANGEMENT SYSTEM

Energy Efficient landscape design - Natural lighting - Choice of building materials for energy efficient lighting - Light pipes - Light fixtures - Green buildings - Construction techniques   **(9)**

CASE STUDY

Solar lighting techniques - Lighting using wind power - Energy conservation building code - Energy efficient buildings in the country.   **(9)**

TOTAL : 45

TEXT BOOKS

1. Philip Gordon, 'Principles and Practices of Lighting Design: The Art of Lighting Composition', Blue Matrix Publications, 2011.

2. Jerry Yudelson, 'Green Building Through Integrated Design', The McGrawHill Publisher, 2009.

REFERENCE BOOKS

1. Derek Phillips, "Daylighting: Natural Light in Architecture" Elsevier, 2004.

2. Jerry Yudelson, "Greening Existing Buildings", The Mc Graw Hill Companies, 1st Edition, 2009.

3. Sam Kubba, "Handbook of Green Building Design and Construction", Elsevier, 2012.

4. Solanki.C.S, 'Solar Photovoltaic Technology and Systems', PHI 2013.

5. J. F. Manwell, J.G. Mcgowan and A.L. Rogers, "Wind Energy Explained : Theory, Design and Applications", Wiley Publications, 2nd Edition, 2009.

15ECOE01 - CONSUMER ELECTRONICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Describe the fundamental concepts, construction and working of Audio systems*

CO2 : *Analyze the recording and reproduction techniques of Audio Systems*

CO3 : *Differentiate between the types of electronic music synthesizers*

CO4 : *Describe the fundamental concepts, construction and working of Video systems*

CO5 : *Identify the problem and troubleshoot the consumer electronic products like TV, Washing Machines, Air Conditioners*

AUDIO SYSTEM

Microphone - Characteristics of Microphones - Gun Microphones - Wireless Microphones - Headphones and Headsets - Electrostatic Phones - Electret Electrostatic Headphones - Hearing Impairments - Hearing Aids - Ideal Loudspeaker - Basic Loudspeaker - Loudspeaker Construction - Woofers - Mid range, Extended range and High frequency Loudspeakers - Multispeaker systems - Baffles - Horns - Stereo Systems. **(10)**

RECORDING AND REPRODUCTION

Making the Record - Stereo Pickup Techniques - Stereo Recording Systems - Disc Equipment: Recording and Playback Characteristics - Stereo Pickup heads - Magnetic recording and Playback - Magnetic Erasing - Optical Recording and Reproduction - Mono, Stereo and Quad - Stereo Multiplexing - Equalisers and Mixers. **(9)**

ELECTRONIC MUSIC SYNTHESIZERS

Typical Generator - Basic Modifiers - Voltage Control - Envelope Generator - Electric Guitar - Electric Wind Instrument -Recording - Digital Computer - Public Address System - Speaker Matching Systems - Theater Sound System: Sound track, Types of sound film, Theater Sound Reproduction system, Working of a Projector. **(9)**

VIDEO SYSTEMS AND DISPLAYS

Monochrome - Color TV standards - TFT, Plasma, HDTV, LCD,LED TV, Video Telephone and Video Conferencing **(9)**

DOMESTIC AND CONSUMER APPLIANCES

In Car Computers - Washing machines - Microwave ovens - Air-conditioners and Refrigerators - Airline Reservations - Remote controls Automated Teller Machines - Set top Boxes - Bar Codes - RFID **(8)**

TOTAL : 45

TEXT BOOKS

1. *Bali, Consumer Electronics, Pearson Education,1st Edition, 2005.*
2. *Philip Hoff, Consumer electronics for Engineers, Cambridge University Press,1st Edition, 1998.*

REFERENCE BOOKS

1. *Sridhar Canumalla, Puligandla Viswanadham P.S.Bimbra, Portable Consumer Electronics: Packaging, Materials, and Reliability, Pennwell Books, 1st Edition, 2010.*
2. *Douglas Kinney, A Beginners Guide to Consumer Electronics Repair: Hand Book and Tutorial, iUniverse, Inc, 1st Edition, 2006.*
3. *Thomas M. Coughlin, Digital Storage in Consumer Electronics: The Essential Guide, Elsevier Inc., 1st Edition, 2008.*
4. *U.S. Consumer Electronics Industry in Review, Electronic Industries Association, Consumer Electronics Group, 1993.*
5. *https://www.pssurvival.com/ps/electronic*

15ECOE02 - ARM SYSTEM ARCHITECTURE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Distinguish between the feature of ARM7 and cortex microcontroller and infer the architecture, instruction set and programming model of ARM Cortex.*

CO2 : *Interpret interrupt service handler & exception types of ARM processor to develop ALP programs.*

CO3 : *Exemplify memory mapping technique in ARM embedded system.*

CO4 : *Illustrate the programming concepts in real time embedded application.*

CO5 : *Examine debugging technique to develop application software for real time system.*

EMBEDDED HARDWARE

ARM Embedded system-CISC and RISC philosophy-Embedded system Hardwar-ARM and Cortex architecture- Programming model- Date flow- Operating modes - Instruction sets. **(9)**

INTERRUPT AND EXCEPTIONS

Interrupts in ARM and cortex- Exception Types- Fault Exceptions- The NVIC and Interrupt Control - Interrupt Behavior. **(9)**

MEMORY SYSTEMS

Memory System Features Overview- Memory Maps- Memory Access Attributes- Default Memory Access Permissions- Bit-Band Operations- Unaligned Transfers- Exclusive Accesses and Endian Mode **(9)**

PROGRAMMING

Exceptions Programming- Advanced Programming Features and System Behavior- Efficient C Programming- FIR and IIR filter implementation-Introduction to RTOS **(9)**

SYSTEM DEBUGGING

Debugging Features- CoreSight- Debug Modes- Debugging Events- Breakpoint- Accessing Register - Debugging Components-Case study: Embedded system (using ARM/cortex) for monitoring- controlling and industrial automation. **(9)**

TOTAL : 45

TEXT BOOKS

1. *Andrew N. Sloss Dominic Symes Chris Wright, "ARM System Developer's Guide Designing and Optimizing System Software", Elsevier Inc 2010.*

2. *Joseph Yiu, "The Definitive Guide to the ARM Cortex-M", Elsevier- Newness, 2014.*

REFERENCE BOOKS

1. *Peter Barry Patrick Crowley "Modern Embedded Computing Designing Connected, Pervasive, Media- Rich Systems", Elsevier, 2012.*

2. *Steve Furber, "ARM system on Chip Architecture", Addision Wesley Professional, 2nd Edition, 2000.*

3. *Jonathan W Valvano, "Embedded systems : Introduction to ARM @ cortex TM - Micro controllers", 5th Edition, 2015.*

4. *Rajkamal, "Embedded system Architecture Programming and Design", Tata Mc Graw Hill, 2nd Edition, 2009.*

5. *Shibu K.V. "Introduction to Embedded Systems", Tata Mc Graw Hill, 1st Edition, 2009.*

15ECOE03 - BROADBAND COMMUNICATION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Describe the concepts and applications of Microwave and Millimeter wave communication*

CO2 : *Comprehend and explain the operation of Satellite communication and navigation systems*

CO3 : *Illustrate the operation of optical communication systems and high speed networks*

CO4 : *Exemplify the features and functionalities of cellular communication from 2G to 4G and beyond*

CO5 : *Distinguish and describe different wireless technologies based on its features and applications*

MICROWAVE AND MILLIMETER WAVE COMMUNICATION

Microwave concepts - devices and lines - waveguides and cavity resonators -Microwave semiconductor diodes-Microwave tubes - antennas - Microwave and millimeter applications **(9)**

SATELLITE COMMUNICATION

Satellite orbits - Satellite Communication Systems - Satellite subsystems - Ground stations - Applications - Global Navigation satellite systems **(9)**

OPTICAL COMMUNICATION

Optical principles - optical communication systems - fiber optics cables - optical transmitters and receivers - wavelength division multiplexing - passive optical networks -40/100Gbps networks and beyond **(9)**

CELLPHONE TECHNOLOGIES

Cellular telephone systems - Cellular industry overview - 2G and 3G digital cell phone systems -Long term evolution and 4G cellular systems - Base stations and small **(9)**

WIRELESS TECHNOLOGIES

Wireless LAN - PANs and Bluetooth - Zigbee and mesh wireless networks - Wi-Max and wireless Meteroploitan area networks - Infrared wireless - Radio frequency identification - Ultra wideband wireless-wireless applications **(9)**

TOTAL : 45

TEXT BOOK

1. *Louis E.Frenzel,"Principles of Electronic Communication Systems", Mc-Graw hill Education,4th edition,2016*

REFERENCE BOOKS

1. *Kennedy G, "Electronic Communication Systems", Tata McGraw Hill, 4th Edition, 1999.*

2. *Rappaport,T.S, "Wireless communications", Pearson Education, 2nd Edition, 2010*

3. *William Stallings, "Wireless Communications and networks", Pearson Prentice Hall of India, 2nd Edition, 2009.*

4. *David Tse, Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 1st Edition, 2005.*

5. *Aditya K.Jagannathan, "Principles of Modern Wireless Communication Systems: Theory and Practice", Mc-Graw hill Education, 2016.*

15ECOE04 - ROBOTICS FOR INDUSTRIAL APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

Upon completion of this course the students will be able to demonstrate an ability to

CO1 : *Comprehend and appreciate the significance and role of industrial robot in the present contemporary world*

CO2 : *Exemplify the features and functionalities of the sensors in Robot*

CO3 : *Develop different language programs to design and develop robotic based systems*

CO4 : *Develop system for industrial automation and medical application*

CO5 : *Illustrate the methodologies to provide automatic solution for replacing humans in life threatening area*

SCOPE OF ROBOTS

The scope of industrial Robots - Definition of an industrial robot - Need for industrial robots -Economic and Social Issues-applications. **(4)**

ROBOT COMPONENTS

Fundamentals of Robot Technology - Automation and Robotics - Robot anatomy - Work volume -Precision of movement - End effectors - Sensors. **(9)**

ROBOT PROGRAMMING

Robot Programming - Methods - interlocks textual languages. Characteristics of Robot level languages, characteristic of task level languages. **(9)**

ROBOT WORK CELL

Robot Cell Design and Control - Remote Center compliance - Safety in Robotics. **(9)**

FUTURE TRENDS

Telepresence robot, Autonomous mobile robots, Walker Robots, Solar-ball Robot, Underwater bots, Aerobots, Advanced robotics in Space - Specific features of space robotics systems - longterm technical developments, Next generation robots. **(14)**

TOTAL : 45

TEXT BOOKS

1. *Robert J. Schilling, "Fundamentals of Robotics- Analysis and Control", Pearson Education, 2006.*

2. *John M. Holland, "Designing Autonomous Mobile Robots-Inside the mind of an Intelligent Machine", Newnes Publication, 2004.*

REFERENCE BOOKS

1. *Mikell P.Groover, Mitchell Weiss, Roger N.Nagel Nicholas G.Odrey, "Industrial Robotics Technology, Programming and Applications", McGraw Hill Book Company 1986.*

2. *John Iovine, "Robots, Android and Animatronics", Second Edition, McGraw-Hill, 2012.*

3. *Fu K.S. Gonzaleaz R.C. and Lee C.S.G.,"Robotics Control Sensing, Vision and Intelligence",McGraw Hill, International Editions, 1987.*

4. *Bernard Hodges and Paul Hallam, "Industrial Robotics", British Library Cataloging in Publication 1990.*

5. *Deb, S.R., "Robotics Technology and flexible automation", Tata McGraw Hill, 1994.*

15ECOE05 - SIGNAL PROCESSING AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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, 4th Edition,2011

2.   Simon Haykins, "Digital Communications Systems", 1st Edition, Wiley, 2013.

REFERENCE BOOKS

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

15CSOE01 - FUNDAMENTALS OF SOFTWARE ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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)*

REFERENCE BOOKS

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.*

15CSOE02 - INTRODUCTION TO DATA WAREHOUSING AND DATA MINING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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. Associtation 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.*

REFERENCE BOOKS

1. *Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Pearson Education, Sixth Edition, 2013.*

2. *Arun K Pujari, "Data Mining Techniques" Universities Press India Ltd., Third Edition, 2012.*

3. *Dunham, "Data Mining- Introductory and Advanced Topics", Pearson Education, New Delhi, First Edition, 2006.*

4. *Pieter Adriaans, Dolf Zantinge, "Data Mining ", Pearson Education, Third Edition 2009,Delhi.*

5. *Sam Anahory, Dennis Murray, "Data Warehousing in the Real World ", Pearson Education, Seventh indian Reprint New Delhi,2003.*

6. *George M. Marakas, " Modern Data Warehousing, Mining, & Visualization Core concepts", Pearson Education, First Edition, 2003*

7. *Paulraj Ponnaiah, "Data Warehousing Fundamentals", Wiley Publishers, Singapore, First Edition, 2001.*

15CSOE03 - INTRODUCTION TO EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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*

REFERENCE BOOKS

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.*

15CSOE04 - INTERNET PROGRAMMING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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.*

REFERENCE BOOKS

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.*

15CSOE05 - CUSTOMER RELATIONSHIP MANAGEMENT ESSENTIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 with proper guidelines for privacy.*

CO3 : *Demonstrate the scoring process and apply the various CRM optimization techniques to optimize CRM process in order to improve customer profitability.*

CO4 : *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 - Other data mining tools -CRM tools - Next generation for CRM. **(10)**

TOTAL : 45

TEXT BOOK

1. Alex Berson, Stephen Smith, Kurt Thearling, "Building Data mining Applications for CRM", Tata McGraw Hill, Fifteenth Reprint, 2008.

REFERENCE BOOKS

1. Francis Buttle, Stan Maklan "Customer Relationship Management: Concepts and Technologies", Routledge, Third Edition, 2015.

2. Roger J. Baran, Robert J. Galka, "CRM: The Foundation of Contemporary Marketing Strategy", S.Chand (G/L) & Company Ltd, Second Edition, 2017.

15CSOE06 - E-COMMERCE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *Describe the features of e-commerce, various business models and marketing strategies used in e-commerce.*

CO2 : *Use the knowledge on the mechanics of building a secure e-commerce website and payment systems.*

CO3 : *Comprehensive online retailing, marketing and impact of social media.*

CO4 : *Illustrate the procurement process and supply chain management in B2B e-commerce.*

INTRODUCTION

E-commerce: E-commerce and E-business - Features of E-commerce Technology - Types of E-commerce. Understanding E-commerce: Technology - Business and Society. E-commerce Business Models and Concepts: Eight Key Elements - Strategy, Structure and Process: Industry Structure - Industry Value Chains - Firm Value Chains - Firm Value Webs - Business Strategy.

(7)

BUILDING E-COMMERCE WEBSITE

Building an Ecommerce Presence: Systematic Approach - Choosing Software and Hardware: Web Server Software - Application Servers - Merchant Server Software Functionality and Packages - Web Services and Open Source Options - Other E-commerce Site Tools - Developing Mobile Website and Building Mobile Applications. **(8)**

E-COMMERCE SECURITY AND PAYMENT SYSTEMS

Ecommerce Security Environment - Security Threats - Management Policies, Business Procedures and Public Laws - Payment Systems - E-commerce Payment Systems. **(7)**

SOCIAL, MOBILE AND LOCAL MARKETING

Introduction to Social, Mobile and Local Marketing - Social Marketing: Social Marketing Players - The Social Marketing Process - Face book Marketing - Twitter Marketing - Pinterest Marketing - The Downside of Social Marketing - Mobile Marketing: Basic Mobile Marketing Features - Mobile Marketing Tools - Mobile Marketing Campaign - Local and Location Based Marketing: Location Based Marketing Platforms - The Technologies - Marketing Tools - Marketing Campaign - Marketing Results. **(8)**

ONLINE RETAIL SERVICES, AUCTIONS AND PORTALS

E-commerce in Action: E-tailing Business Models: Virtual Merchants - Multi-channel Merchants - Catalog Merchants - Manufacturer Direct - Online Financial Services - Online Travel Services - Online Career Services. Online Auctions: Measuring Growth of Auctions and Dynamic Pricing - Benefits of Auctions - Risks and Costs of Auctions for Consumers and Businesses. E Commerce Portals: Types of Portals - Portal Business Models. **(9)**

E-COMMERCE, SUPPLY CHAIN AND COLLABORATIVE MANAGEMENT

Defining and Measuring the Growth of B2B Commerce - Benefits and Challenges of B2B E-commerce - The Procurement Process and Supply Chain - Types of Procurement. Trends in Supply Chain Management and Collaborative Commerce: Just-in-Time and Lean Production - Supply Chain Simplification - Adaptive Supply Chains - Accountable Supply Chains - Sustainable Supply Chains - Electronic Data Interchange - Supply Chain Management Systems - Collaborative Commerce. **(6)**

TOTAL : 45

TEXT BOOK

1. *Kenneth C. Laudon,Carol Guercio Traver, "E-Commerce-Business,Technology, Society", Pearson India, Tenth edition, 2016.*

REFERENCE BOOKS

1. Ravi Kalakota, Andrew Whinston, "Frontiers of Electronic Commerce", Pearson India, fourteenth Reprint 2007.

2. Dave Chaffey, "E - Business and E - Commerce Management: Strategy, Implementation, and Practice:" Pearson India, Sixth Edition, 2013.

3. Henry Chan, Raymond Lee, Tharam Dillon, Elizabeth Chang, "E-Commerce, Fundamentals and Applications", Wiley India Private Ltd Reprint 2008.

15ITOE01 - DIGITAL COMPUTER BASICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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. **(10)**

COMBINATIONAL CIRCUITS

Adder : Half Adder - Full Adder - Binary Parallel Adder - BCD Adder. Subtractor : Half Subtractor - Full Subtractor. Code Conversion. Decoders - De-Multiplexer - Encoders - Multiplexers. **(9)**

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 - Updown 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. Ciletti,"Digital Design with an Introduction to the Verilog HDL, Pearson Education, Fifth edition, 2013.*

REFERENCE BOOKS

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.*

15ITOE02 - PROGRAMMING IN JAVA

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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, Ninth Edition, McGraw Hill Education, 2014.*

REFERENCE BOOKS

1. *Deitel H.M and Deitel P.J, "Java - How to Program", Prentice Hall of India, Ninth Edition, 2012.*

15ITOE03 - FUNDAMENTALS OF DATABASE SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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, Corlos M.Coronel, "Database Systems: Design, Implementation and Management", Thompson Learning Course Technology, Tenth edition, 2012.*

REFERENCE BOOKS

1. *Abraham Silberschatz, Henry F.Korth,S.Sudharshan,"Database System Concepts", McGraw-Hill, Sixth Edition, 2013.*

2. *Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Pearson Education, Sixth Edition, 2013.*

3. *Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", 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, 2014.*

15ITOE04 - CLOUD COMPUTING FUNDAMENTALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 tools. **(9)**

CLOUD SECURITY

Security Overview - Cloud Security Challenges - 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)

REFERENCE BOOKS

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, 2012.

3.   Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.

15ITOE05 - INFORMATION SECURITY FUNDAMENTALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *Identify and analyze the security threats and attacks and apply device 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. **(5)**

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. **(6)**

POLICIES, STANDARDS, PRACTICES AND BUSINESS CONTINUITY

Introduction - Information Security Policy, Standards and Practices -The Information Security Blueprint: ISO 17799/BS 7799, ISO 27001and its controls, NIST Security Models, 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 - **(8)**

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 IT Act - 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)

REFERENCE BOOKS

1. Thomas R.Peltier, "Information Security Fundamentals", Auerbach Publications, Second Edition, 2013.

2. Micki 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.

15ITOE06 - INTRODUCTION TO HUMAN COMPUTER INTERACTION

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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. **(11)**

WINDOWS & COMPONENTS

Windows: New Navigation Schemes - Selection of Window - Selection of Devices Based on Screen Based Controls.

Components: Text and Messages - Icons and Increases - Multimedia - Colors - Uses -Problems - Choosing colors. **(9)**

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 BOOKS

1. *Alan Dix, Janet Finlay, G D Abowd and Russel Beale, "Human Computer Interaction", Pearson Education, Third Edition, 2004.*

15ITOE07 - ENTERPRISE RESOURCE PLANNING CONCEPTS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 inorder to define the functionality of various departments in a company.*

CO4 : *Analyze the ERP marketplace 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)*

REFERENCE BOOKS

1. *Ellen F.Monk, Bret Wagner, "Concepts in Enterprise Resource Planning", Course Technology Ptr, Fourth Edition, 2013.*
2. *Vinod Kumar Garg and Venkitakrishnan N.K., "Enterprise Resource Planning - Concepts and Practice", Prentice Hall of India, New Delhi, Second Edition, 2012.*

15CHOE01 - INDUSTRIAL SAFETY ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After completion of the course, students are able to

CO1 : *Practice the safety norms and inspect turning machines, boring machines, milling machine, planning 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 t 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 protectivedevices, machine guarding, types, fixed guard, interlock guard,automatic guard, trip guard, electron eye, positional control guard, fixedguard fencing- guard construction- guard opening. Selection andsuitability: lathe - drilling - boring - milling - grinding - shaping - sawing- shearing presses - forge hammer - flywheels - shafts - couplings -gears - sprockets wheels and chains pulleys and belts - authorized entryto 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 ofindustrial 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, auxiliarymechanisms, feeding and cutting mechanism, hand or foot-operatedpresses, power press electric controls, power press set up and dieremoval, inspection and maintenance-metal sheers-press brakes. Hotworking safety in forging, hot rolling mill operation, safe guards in hotrolling mills - hot bending of pipes, hazards and control measures.Safety in gas furnace operation, cupola, crucibles, ovens, foundry healthhazards, work environment, material handling in foundries, foundryproduction 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 leaktest, 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.*

REFERENCE BOOKS

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.*

15CHOE02- RISK ANALYSIS AND HAZOP

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 BOOKS

1. *Daniel A Crowl., Louvar J.F., Chemical Process Safety: Fundamentals with Applications, Prentice Hall, New Jersey, 2002.*

15CHOE03 - GREEN TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 : *Analyze 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

REFERENCE BOOKS

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.*

15CHOE04 - CORROSION SCIENCE AND ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After successful completion of this course, the students will be 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 : *Analyze 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-H_2O 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 BOOK

1. *Banarjee.S.N., An introduction to corrosion and corrosion inhibitors, Oxonian Press Ltd., New Delhi, 1985.*

15CHOE05 - INTRODUCTION TO CHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

After successful completion of this course, the students will be 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 equipments 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

REFERENCE BOOKS

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.*

15MOE01 - 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 their respective main stream.*

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 AND SUBGRAPHS

Graph --Standard Concepts in Graphs - Subgraphs -Complete Graph - Bipartite Graph - Isomorphism - Adjacency Matrix and Incidence Matrix - Walk, Trail and Path -Bipartite Graph -Connectedness- The Shortest Path Problem- Disjkstra'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, McGraw Hill Education (India), 2006.*
2. *Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall of India Private Limited, 2004.*

REFERENCE BOOKS

1. *Douglas B.West, "Introduction to Graph Theory" II Edition, Prentice Hall of India Private Limited, 2000.*
2. *Reinhard Diestel, "Graph Theory", II Edition, Springer Publications, 2006.*
3. *Clark J. and Holton D.A, "A First Look at Graph Theory", Allied Publishers, 1995.*
4. *Frank Harary, Graph Theory, 10th Edition, Narosa Publishing House, 2001.*

15MOE02 - METHODS OF APPLIED MATHEMATICS

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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, Fourier - Bessel and Legedre Series **(9)**

PARTIAL DIFFERENTITAL EQUATIONS

Linerar and quasi - linear equations of the first and second order. Characterstics 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 Edn. (EEE). Prentice Hall of India P. Ltd., (2014)

REFERENCE BOOKS

1. F.B. Hildebrand - Methods of Applied Mathematics, Second Edn. Prentice Hall of India P.Ltd., (2012)

2. C.Stephenson : An introduction to partial differential equation for Science students, ELBS.

3. E. D. Rainville : Special Functions.

4. Dettman : Mathematical methods in physics and Engineering.

15MOE03 - 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 - Vogle'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 Salesman 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 2007, New Delhi*

2. *Resource management techniques by V.Sundaresan, Tenth Edition, 2016 A.R Publications, Chennai*

REFERENCE BOOKS

1. *Andrews L.C. and Phillips R.L., "Mathematical Techniques for Engineers and Scientists", Prentice Hall of India Pvt.Ltd., New Delhi, 2005.*

2. *O'Neil, P.V., "Advanced Engineering Mathematics", Thomson Asia Pvt. Ltd., Singapore, 2003.*

15MOE04 - 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 idea 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 ,2002.*

2. *T.Veerarajan, Probability, Statistics and Random Processes, Second Edition, TataMcGraw-Hill 2007*

REFERENCE BOOKS

1. *Rohatgi V.K. (2002) : Introduction to Mathematical Statistics, Wiley. 2. Bhat, B. R. (2005) : Modern Probability Theory - An Introductory Text Book, Third Edition, New Age International.*

2. *Cochran, W.G.(2007): Sampling Techniques, Wiley Eastern Private Limited*

3.   Sukhatme, P.V. and Sukhatme, B.V.(1977): Sampling Theory of Survey with Applications, Asia publishing House.

4.   Venkataraman M.K, "Higher mathematics for Engineering and Science" National Publishing Company ,2000

5.   Ibe , O.C., "Fundamentals of Applied Probability and Random processes", 1st Indian Reprint , Elsevier , 2007.

6.   Peebles , P.Z., "Probability, Random Variables and Random Signal Principles", Tata McGraw Hill , 4th Edition , New Delhi, 2002.

15POE01 - INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 - Structural,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 Textbook of Nanoscience and Nanotechnology,Pradeep T., Tata McGrawHill Education Pvt. Ltd., 2012.

3. Nanostructured Materials and Nanotechnology,Hari Singh Nalwa,Academic Press, 2002.

4. Introduction to Nanotechnology, Charles P.Poole, FrankJ.Owens, Wiley Interscience (2003)

5. Textbook of Nanoscience and Nanotechnology, B.S. Murty, P. Shankar, Baldev Raj, B BRath, James Murday, Springer Science & Business Media, 2013.

REFERENCE BOOKS

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. *Nanoscience: Nanotechnologies and Nanophysics, Dupas C., Houdy P., Lahmani M., Springer-Verlag Berlin Heidelberg, 2007*

15POE02 - PHYSICS AND TECHNOLOGY OF THIN FILMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 ablation 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)*

REFERENCE BOOKS

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. *KiyotakaWasa, Makoto Kitabatake, Hideaki Adachi, Thin Films Material Technology, Springer-Verlag Berlin Heidelberg, 2004.*

15POE03 - SOLAR CELL FUNDAMENTALS AND MATERIALS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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.*

REFERENCE BOOKS

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.*

15POE04 - ADVANCED MATERIAL PROCESSING TECHNOLOGIES

ASSESSMENT : THEORY

L	T	P	C
3	0	0	3

COURSE OUTCOME

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*

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 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.   **(9)**

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.   **(9)**

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. BetzalelAvitzu, "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.

REFERENCE BOOKS

1. *Michael Barsoum, "Fundamentals of Ceramics", McGraw Hill Publishing Co., INC, 1997*
2. *Gowariker V R, Viswanathan N V, JayadevSreedhar, "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.*

15COE01 - 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. *GerogeW.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*

REFERENCE BOOKS

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.*

15COE02 - 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

REFERENCE BOOKS

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.*

15COE03 - 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 microporus 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

REFERENCE BOOKS

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.*

15COE04 - 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

REFERENCE BOOKS

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*

15COE05 - 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*

REFERENCE BOOKS

1. *Martin Kaltschmitt; Hermann Hofbauer. "Biomass Conversion and Biorefinery", Springer Publishing, 2008*

15HOE01 - PRINCIPLES OF MANAGEMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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*

INTRODUCTION TO MANAGEMENT

Meaning, Definition and Significance of Management-Basic functions of Management-Development of Management Thought

(9)

MANAGEMENT CONCEPTS

Planning, Organizing, Staffing, Directing and Controlling- MBO-Six sigma **(9)**

ORGANIZATIONAL BEHAVIOR

Significance of OB, Role of Leadership, Personality and Motivation, Stress, Attitudes, Values and Perceptions at work **(9)**

BUSINESS PROCESS REENGINEERING

Need for BPR, Various phases of BPR, Production and Productivity-Factors influencing Productivity. **(8)**

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*

REFERENCE BOOKS

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*

15HOE02 - CURRENT TRENDS IN INDIAN ECONOMY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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*

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)**

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)**

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)**

SERVICE SECTOR

Service sector in India-Banking-Insurance-Telecommunication-IT sector-Sofware exports-BPO-Contribution to GDP **(9)**

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 BOOK

1.   *Ruddar Datt and Sundaram, KPM, Indian Economy, S.Chand and company, New Delhi-2015 Ramesh Singh Indian Economy, McGraw hill Education 7th edition, 2015*

REFERENCE

1.   www.jagranjosh.com

15HOE03 - MONETARY ECONOMICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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*

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)**

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)**

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)**

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)**

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*

REFERENCE BOOKS

1.   *Sethi TT, "Monetary Economic Theory", S Chand & Co, New Delhi 1996*
2.   *Mithani DN, "Money Banking and International Trade", Himalaya, Mumbai 2013*

15HOE04 - ACCOUNTING FOR MANAGERIAL DECISIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *Differentiate Financial and Management Accounting*

CO2 : *Analyze the profit and loss of the firm using the classifications of ratio analysis*

CO3 : *Prepare a fund flow statement*

CO4 : *Sketch the Break even chart and interpret the results for a given data*

MANAGEMENT ACCOUNTING

Introduction to Management Accounting - Nature and Scope of Management Accounting - Importance - Functions - Distinguish between Financial and Management Accounting - Tools in Management Accounting - Limitations - Disadvantages **(9)**

FINANCIAL STATEMENTS

Ratio Analysis - Meaning - Significance - Classifications - Liquidity Ratios - Turnover Ratios - Profitability Ratios - Solvency Ratios **(8)**

FUND FLOW AND CASH FLOW STATEMENT

Meaning and concept of flow of Funds-Meaning of fund Flow Statement - Difference between Fund flow statement and Income statement - Preparation and Interpretation of cash flow statement **(9)**

INVESTMENT DECISION

Budgeting - Objectives - Features - Advantages - Disadvantages - Cash Budget - Flexible Budget **(9)**

MARGINAL COSTING AND WORKING CAPITAL MEASUREMENT

Marginal Costing - Importance - Advantages - Breakeven Point - Breakeven Chart - Margin of Safety - Profit Volume Analysis - Working Capital - Importance - Factors Affecting Working Capital - Computation of Working Capital Requirements **(10)**

TOTAL : 45

TEXT BOOK

1. *R.K.Sharma and Sasi K.Gupta, "Management accounting", 2014*

15HOE05 - ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *Develop an entrepreneurial mindset by learning key skills such as creative thinking, innovations and funding for business*

CO2 : *Formulate a business plan*

CO3 : *Assess the strengths and weaknesses of business plan*

CO4 : *Prepare a business plan for selecting a product*

LAUNCHING ENTREPRENEURIAL VENTURES

Creativity, Innovations, Methods to Initiate Ventures, Legal Challenges, Search for Entrepreneurial Capital **(8)**

BUSINESS PLAN FOR NEW VENTURES

Meaning and Objectives of a Business Plan, Advantages and cost of preparing a Business Plan, Elements, Critical Assessment **(9)**

Strategic Perspectives - Strategic Growth, Need for Strategic Planning, Understanding the growth stage, Unique managerial Concerns of growing enterprise, Valuation Concerns **(10)**

Entrepreneurship - Indian Perspective: Historical Perspective, Global Indian Entrepreneurs, Institutions, Modern Entrepreneurs **(9)**

Project Work - Students have to prepare a detailed business plan selecting a product(s), Presentation of such business plans and submission after necessary corrections suggested by subject faculty. **(9)**

TOTAL : 45

TEXT BOOK

1. *Robert D Hisrich, Michael P Peters & Dean Shepherd, "Entrepreneurship", Tata McGraw Hill, 2013*

REFERENCE BOOKS

1. *Thomas W.Zimmerer, Norman M.Scarborough, "Essentials of Entrepreneurship and Small Business Management", Prentice Hall of India, 2009*
2. *G.S.Sudha, "Management and Entrepreneurship Development", Indus Valley Publication, 2009*

15HOE06 - EMPLOYABILITY SKILLS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *Set a goal and outline stratigies to achieve it*

CO2 : *Prepare a job application letter with a resume for a position in a corporate sector*

CO3 : *Analyse the listening comprehension and answer the questions*

CO4 : *Find a solution for a problem in the corporate sector applying problem solving skills*

GOAL SETTING AND TIME MANAGEMENT

Goal Setting - Immediate, Short Term and Long Term Goals - Smart Goals - Strategies to Achieve Goals - Confidence Building, Self-esteem, Motivation - Time Management - Identifying Time Wasters - Time Management Skills.   **(9)**

SPEAKING

Ice-breakers - Self introduction - Role Play - Debate - Group Discussion: Purpose - Group Behavior - Analyzing Performance. Job Interviews: Identifying Job Openings - Interview Process - Types of Questions - Mock Interviews - Professional Grooming.
(11)

READING AND WRITING

Reading Comprehension - Speed Reading Necessary for Reading Letters and Files - Vocabulary Development - Preparing Job Applications - Writing Covering Letter and Résumé - Applying for Jobs Online - Creative Writing - Article Writing - Book Review
(9)

LISTENING

Listening to - Conversations, Long Speeches, Narrations, Descriptions, Famous Speeches.   **(8)**

LEADERSHIP AND TEAM MANAGEMENT

Qualities of a Good Leader - Leadership Styles - Decision Making - Problem Solving - Etiquettes - Email, Professional, Dining & Telephone - Team Building - Team Work - Delegation.   **(8)**

TOTAL : 45

TEXT BOOKS

1. *Aruna Koneru. "Professional Communication". Tata MacGraw Hill Publishing Company Limited. New Delhi, 2008.*

2. *Jones, Leo and Richard Alexander. "New International Business English" Cambridge University Press, 2003.*

REFERENCE BOOKS

1. *Corneilssen, Joep. "How to Prepare for Group Discussion and Interview". New Delhi: Tata-McGraw-Hill, 2009.*

15HOE07 - ENGLISH FOR ACADEMIC PURPOSES

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *Write a description of a system.*

CO2 : *Formulate a research paper*

CO3 : *Listen to a lecture and prepare a summary.*

CO4 : *Construct dialogues using appropriate expressions.*

FOCUS ON LANGUAGE

Sentence Construction- Types of Clauses- Sequence words - Co ordination- Subordination- Paragraphing Information - Describing a System & Procedure **(8)**

READING

Understand a writer's purpose - Use strategies to ascertain meaning from unfamiliar vocabulary encountered in context - Recall and use vocabulary regarding urbanization and mega cities - 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. **(8)**

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 . The Methodology - The Results - The Discussion - The Conclusion - Citing Sources - Proof reading Your Paper **(10)**

LISTENING

Listening to conversation - Lectures - Topics - Discussions - Listening comprehension on specific topics - Listening to recognize formal and Informal spoken English **(8)**

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 **(11)**

TOTAL : 45

TEXT BOOK

1. *MLA Handbook 8th edition published 2016. ISBN : 9781603292627*

REFERENCE BOOKS

1. *English for writing Research papers, Authors : Wall work, Adrian Published 2016, Spinger Publication.*

15HOE08 - ENGLISH FOR COMPETITIVE EXAMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

CO1 : *Listen to TOEFL, IELTS and GRE 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

TEXT BOOK

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.*

REFERENCE BOOKS

1. *Sharpe J.Pamela. Barron's TOEFL iBT Internet- Based Test. 12th Edition, Galgotia publications Pvt.Ltd: New Delhi, 2009.*

2. *Longman Indroductory course for the TOEFL Test.*

15HOE09 - LIFE AND LITERATURE

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OUTCOME

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 of the fiction*

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)**

POEMS

Stopping By Woods on a Snowy Evening by Robert Frost

The Ballad of Father Gilligan by W.B. Yeats   **(9)**

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   **(10)**

Albert Einstein and Steve Jobs

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

TEXT BOOKS

1.   Kumara Pillai. ed. A Book of Modern Short Stories. Macmillan: New Delhi, 2009

2.   Colleen and Darius Krishnaraj. ed. Convergence, A Book of Short Stories. Macmillan: New Delhi, 2009

3.   Ernest Hemmingway. The Old Man and the Sea. Arrow: Warwickshire, 2000.

4.   Baroness Emma Orczy, The Scarlet Pimpernel. Hutchinson : 1995

REFERENCE BOOKS

1.   Xavier. ed. An Anthology of Popular Essays and Poems. Macmillan: New Delhi, 2009