KONGU ENGINEERING COLLEGE
PERUNDURAI ERODE – 638 052
(Autonomous)

VISION

To be a centre of excellence for development and dissemination of knowledge in Applied Sciences, Technology, Engineering and Management for the Nation and beyond.

MISSION

We are committed to value based Education, Research and Consultancy in Engineering and Management and to bring out technically competent, ethically strong and quality professionals to keep our Nation ahead in the competitive knowledge intensive world.

QUALITY POLICY

We are committed to

- Providing value based quality education for the development of students as competent and responsible citizens.
- Contributing to the nation and beyond through research and development
- Continuously improving our services

DEPARTMENT OF CHEMICAL ENGINEERING

VISION

To be a centre of excellence for development and dissemination of knowledge in Chemical Engineering for the Nation and beyond

MISSION

Department of Chemical Engineering is committed to:

MS1: Impart knowledge to students at all levels through a vibrant, dynamic and state of the art intellectual delivery to ensure the creation of a complete Chemical Engineer with a high sense of social responsibility and professional ethics

MS2: Synergize the efforts of the students and faculty to evolve innovative engineering practices and teaching methodologies

MS3: Generate an environment of continuous learning and research

2014 REGULATIONS

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of Chemical Engineering will

PEO1: Exhibit professional competency in design and development of chemical products, Processes and equipment in chemical and allied industries.

PEO2: Perform research and development work by utilizing the experimental skills. Mathematical tools and applied software and simulation practices.

PEO3: Demonstrate interpersonal skills and leadership qualities and contribute to solution of multidisciplinary problems

PEO4: Contribute to national and global economic growth through continuous education and by following socially responsible practices

MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

MS\PEO	PEO1	PEO2	PEO3	PEO4
MS1	3	2	1	2
MS2	2	2	2	2
MS3	1	3		3

1 – Slight, 2 – Moderate, 3 – Substantial

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1 **Essentials of Chemical Engineering:** Correlate theoretical concepts with real time experimental and field data through application of process simulation and analytical techniques

PSO2 **Chemical Process Design and Development:** Develop cutting edge chemical processes, equipment and products for the benefit of the human kind using innovative research and development skills and continuous learning efforts

MAPPING OF PEOs WITH POs AND PSOs

PEO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
PEO1		3	3	3	3	2	2				2	1	3	3
PEO2	3		2		2	1	1	1	2	2	1	2	2	3
PEO3						3	3	2	3	3	2	1	3	1
PEO4		1	2	1	2	3	3	3	1	2	2	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

CURRICULUM BREAKDOWN STRUCTURE UNDER REGULATION 2014

Curriculum Breakdown Structure(CBS)	**Curriculum Content (% of total number of credits of the program)**	**Total number of contact hours**	**Total number of credits**
Basic Sciences(BS)	17.68	510	32
Engineering Sciences(ES)	16.02	450	29
Humanities and Social Sciences(HS)	9.41	210	17
Program Core(PC)	36.46	1485	66
Program Electives(PE)	9.94	270	18
Open Electives(OE)	4.97	135	9
Project(s)/Internships(PR)	5.52	135	10
Total			**181**

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
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B.Tech. DEGREE IN CHEMICAL ENGINEERING

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – I

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14EGT11	Communicative English I	3	0	0	3	40	60	100	HS
14MAT11	Mathematics I	3	1	0	4	40	60	100	BS
14PHT11	Applied Physics	3	0	0	3	40	60	100	BS
14CYT11	Applied Chemistry	3	0	0	3	40	60	100	BS
14MET11	Basics of Civil and Mechanical Engineering	3	0	0	3	40	60	100	ES
14MEC11	Engineering Drawing	2	0	3	3	40	60	100	ES
14VEC11	Value Education	0	2	1	1	100	0	100	HS
	PRACTICAL								
14PHL11	Physical Sciences Laboratory I	0	0	3	1	100	0	100	BS
14MEL11	Basics of Civil and Mechanical Engineering Laboratory	0	0	3	1	100	0	100	ES
				Total	**22**				

CA - Continuous Assessment, ESE – End Semester Examination

CBS – Curriculum Breakdown Structure

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
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B.Tech. DEGREE IN CHEMICAL ENGINEERING

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – II

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14EGT21	Communicative English II	3	0	0	3	40	60	100	HS
14MAT21	Mathematics II	3	1	0	4	40	60	100	BS
14PHT21	Materials Science	3	0	0	3	40	60	100	BS
14CYT21	Environmental Science	3	0	0	3	40	60	100	BS
14CSC11	Problem Solving and Programming	3	0	3	4	40	60	100	ES
14EET11	Basics of Electrical and Electronics Engineering	3	0	0	3	40	60	100	ES
	PRACTICAL								
14PHL21	Physical Sciences Laboratory – II	0	0	3	1	100	0	100	BS
14EEL11	Basics of Electrical and Electronics Engineering Laboratory	0	0	3	1	100	0	100	ES
				Total	**22**				

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B.Tech. DEGREE IN CHEMICAL ENGINEERING

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – III

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14MAT31	Mathematics III	3	1	0	4	40	60	100	BS
14EET33	Electrical Drives and Industrial Electronics	3	0	0	3	40	60	100	ES
14CHT31	Heat Power Engineering	3	1	0	4	40	60	100	PC
14CHT32	Industrial Chemistry	3	0	0	3	40	60	100	PC
14CHT33	Fluid Mechanics	3	1	0	4	40	60	100	PC
14CHT34	Chemical Process Calculations	3	1	0	4	40	60	100	PC
	PRACTICAL								
14CHL31	Applied Chemistry Laboratory I	0	0	3	1	100	0	100	PC
14CHL32	Fluid Mechanics Laboratory	0	0	3	1	100	0	100	PC
				Total	**24**				

CA - Continuous Assessment, ESE – End Semester Examination

CBS – Curriculum Breakdown Structure

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B.Tech. DEGREE IN CHEMICAL ENGINEERING

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – IV

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14MAT41	Numerical Methods	3	1	0	4	40	60	100	BS
14CHT41	Process Organic Synthesis	3	0	0	3	40	60	100	PC
14CHT42	Process Heat Transfer	3	1	0	4	40	60	100	PC
14CHT43	Mechanical Operations	3	0	0	3	40	60	100	PC
14CHT44	Process Thermodynamics	3	1	0	4	40	60	100	PC
14CHT45	Materials of Construction for Process Industries	3	0	0	3	40	60	100	PC
	PRACTICAL								
14CHL41	Applied Chemistry Laboratory II	0	0	3	1	100	0	100	PC
14CHL42	Mechanical Operations Laboratory	0	0	3	1	100	0	100	PC
				Total	**23**				

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CBS – Curriculum Breakdown Structure

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B.Tech. DEGREE IN CHEMICAL ENGINEERING

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – V

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14CHT51	Mass Transfer I	3	1	0	4	40	60	100	PC
14CHT52	Chemical Process Industries	3	0	0	3	40	60	100	PC
14CHT53	Chemical Reaction Engineering	3	1	0	4	40	60	100	PC
14CHT54	Chemical Process Plant Safety and Hazard Analysis	3	0	0	3	40	60	100	PC
14CHT55	Chemical Equipment Design I	3	1	0	4	40	60	100	PC
	Elective-I (Professional)	3	0	0	3	40	60	100	PE
	PRACTICAL								
14CHL51	Process Heat Transfer Laboratory	0	0	3	1	100	0	100	PC
14CHL52	Chemical Reaction Engineering Laboratory	0	0	3	1	100	0	100	PC
14EGL41	Communication Skills Laboratory	0	0	3	1	100	0	100	HS
				Total	**24**				

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CBS – Curriculum Breakdown Structure

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B.Tech. DEGREE IN CHEMICAL ENGINEERING

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – VI

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14GET61	Economics and Management for Engineers	3	0	0	3	40	60	100	ES
14CHT61	Mass Transfer II	3	1	0	4	40	60	100	PC
14CHT62	Process Dynamics and Control	3	1	0	4	40	60	100	PC
14CHT63	Chemical Equipment Design II	3	1	0	4	40	60	100	PC
	Elective – II (Professional)	3	0	0	3	40	60	100	PE
	Elective – III (Open)	3	0	0	3	40	60	100	OE
	PRACTICAL								
14CHL61	Mass Transfer Laboratory	0	0	3	1	100	0	100	PC
14CHL62	Process Computation Laboratory	0	0	3	1	100	0	100	PC
				Total	**23**				

CA - Continuous Assessment, ESE – End Semester Examination

CBS – Curriculum Breakdown Structure

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CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER – VII

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14GET71	Total Quality Management	3	0	0	3	40	60	100	ES
14CHT71	Transport Phenomena	3	1	0	4	40	60	100	PC
14CHT72	Process Modeling and Simulation	3	0	0	3	40	60	100	PC
	Elective – IV (Professional)	3	0	0	3	40	60	100	PE
	Elective – V (Open)	3	0	0	3	40	60	100	OE
	Elective – VI (Open)	3	0	0	3	40	60	100	OE
	PRACTICAL								
14CHL71	Process Simulation Laboratory	0	0	3	1	100	0	100	PC
14CHL72	Process Dynamics and Control Laboratory	0	0	3	1	100	0	100	PC
14CHI71	Industrial Training	0	0	0	1	0	100	100	PC
				Total	**22**				

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CBS – Curriculum Breakdown Structure

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B.Tech. DEGREE IN CHEMICAL ENGINEERING

CURRICULUM

(For the candidates admitted from academic year 2014 – 15 onwards)

SEMESTER –VIII

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	THEORY								
14GET81	Professional Ethics and Human Values	3	0	0	3	40	60	100	HS
	Elective – VII (Professional)	3	0	0	3	40	60	100	PE
	Elective – VIII (Professional)	3	0	0	3	40	60	100	PE
	Elective – IX (Professional)	3	0	0	3	40	60	100	PE
	PRACTICAL								
14CHP81	Project Work	0	0	18	9	100	100	200	PR
				Total	**21**				

CA - Continuous Assessment, ESE – End Semester Examination

CBS – Curriculum Breakdown Structure

Total Credits: 181

LIST OF PROFESSIONAL ELECTIVES						
Course Code	**Course Title**	**Hours/Week**			**Credit**	**CBS**
		L	**T**	**P**		
SEMESTER V						
14CHE01	Oil and Natural Gas Engineering	3	0	0	3	PE
14CHE02	Biochemical Engineering	3	0	0	3	PE
14CHE03	Instrumental Methods of Analysis	3	0	0	3	PE
SEMESTER VI						
14CHE04	Food Technology	3	0	0	3	PE
14CHE05	Fluid Movers	3	0	0	3	PE
14CHE06	Petroleum Refining Engineering	3	0	0	3	PE
SEMESTER VII						
14CHE07	Drugs and Pharmaceuticals Technology	3	0	0	3	PE
14CHE08	Computational Fluid Dynamics for Process Engineers	3	0	0	3	PE
14CHE09	Chemical Process Utilities	3	0	0	3	PE
SEMESTER VIII						
14CHE10	Modern Separation Processes	3	0	0	3	PE
14CHE11	Air Pollution and Control	3	0	0	3	PE
14CHE12	Employability Skills	3	0	0	3	PE
14CHE13	Polymer Technology	3	0	0	3	PE
14CHE14	Pilot Plant and Scale up Methods	3	0	0	3	PE
14CHE15	Power Plant Management	3	0	0	3	PE
14CHE16	Pulp and Paper Technology	3	0	0	3	PE
14CHE17	Heterogeneous Catalytic Reactions	3	0	0	3	PE
14CHE18	Process Optimization	3	0	0	3	PE

LIST OF OPEN ELECTIVES						
Course Code	**Course Title**	**Hours/Week**			**Credit**	**CBS**
		L	**T**	**P**		
SEMESTER VI						
14CHO01	Waste Water Treatment	3	0	0	3	OE
14CHO02	Energy Technology	3	0	0	3	OE
SEMESTER VII						
14CHO03	Piping Engineering	3	0	0	3	OE
14CHO04	Process Automation	3	0	0	3	OE
14CHO05	Process Instrumentation	3	0	0	3	OE
14CHO06	Corrosion Technology	3	0	0	3	OE

14EGT11 COMMUNICATIVE ENGLISH I

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Functional Grammar: Basics of Vocabulary - Parts of speech or Word Classes including Determiners - Prefixes and Suffixes - Homonyms and Homophones - Connectives - Compound Nouns. **Listening:** Introduction to Listening / Types of Listening – Extensive / Intensive Listening - Listening Activities. **Speaking:** Verbal and non verbal communication – An introduction to speech sounds, syllables & word stress – Speaking Activities. **Reading:** Introduction to Skimming and scanning as reading techniques - understanding discourse coherence – sequencing of sentences – Reading activities. **Writing:** Introduction to aspects of technical writing – writing definitions and descriptions- Letter Writing – Informal letters-Punctuation in Letter Writing

UNIT – II **9**

Functional Grammar: Concord - Tenses - Voice - Use of Articles and prepositions. **Listening:** Listening Comprehension – Cloze Test - Extensive listening – listening for general information. **Speaking:** Role Play – Situational Conversations. **Reading:** Reading newspaper articles – global understanding skills and ability to infer, extract gist and understand main ideas. **Writing:** Letter Writing - Formal letters, Writing a Profile about an organization—Punctuation (General).

UNIT – III **9**

Functional Grammar: Phrasal verbs - Clauses - Simple, Compound and Complex Sentences - Synonyms and Antonyms. **Listening:** Listening Comprehension – Cloze Text - Intensive listening – listening for specific information. **Speaking:** Describing Places, People, Technical Processes. **Reading:** Reading different types of texts – Understanding general and specific information. **Writing:** Paragraph Writing – Writing reviews on short films and videos - Offering suggestions and recommendations

UNIT – IV **9**

Functional Grammar: Conditional clauses (If clause) - Adjectives, Compound Adjectives and Degrees of Comparison. **Listening:** Listening to different accents, listening to speeches / presentations. **Speaking:** Describing Technical Processes and Machines and Gadgets - Telephone Skills. **Reading:** Reading Texts with focus on use of verbs and verb phrases. **Writing:** Writing e-mails –Transcoding - Using Charts, pictures and tables for interpretations.

UNIT – V **9**

Functional Grammar: Modals – Types of Sentences – Idioms and Phrases and proverbs - identifying odd words. **Listening:** Retrieval of factual information – listening to identify topic, context, function, speaker's opinion, attitude, etc. **Speaking:** Interviews - Personal and Telephonic - Giving impromptu talks, making presentations on given topics. **Reading:** Reading for structure and detail – finding key information in a given text and finding topic sentences. **Writing:** Designing and Making Posters – Writing Advertisements-Free writing on any given topic (Technical and topics on current affairs)

TOTAL : 45

TEXT BOOKS :

1. "Learn English – A Fun Book of Functional Language, Grammar and Vocabulary", McGraw Hill Education [India] Pvt. Ltd., Santanu Sinha Chaudhuri, 2013.

REFERENCE BOOKS :

1. Raman, Meenakshi and Sangeetha Sharma, "Technical Communication: Principles and Practice", Oxford University Press, New Delhi, 2011.
2. Regional Institute of English, "English for Engineers", Cambridge University Press, New Delhi, 2006.
3. Rizvi, Ashraf M., "Effective Technical Communication", Tata McGrawHill, New Delhi. 2009.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: speak clearly, confidently, comprehensibly, and communicate with others using appropriate communicative strategies

CO2: write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide range of vocabulary, organizing their ideas logically on a topic

CO3: read different genres of texts adopting various reading strategies

CO4: listen/view and comprehend different spoken discourses / excerpts in different accents

CO5: use language effectively and accurately acquiring vocabulary from real-life context

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14MAT11 MATHEMATICS I

(Common to all Engineering and Technology branches)

3 1 0 4

Pre-requisites: Basics concepts of matrices, Basic idea of differentiation, Knowledge of differential equations

UNIT – I **9**

Matrices: Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors (without proof) – Cayley-Hamilton Theorem (Statement and Applications) - Similarity transformation (concept only) – Orthogonal matrices – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form – Nature of quadratic forms – Reduction of a quadratic form to canonical form by orthogonal transformation.

UNIT – II **9**

Functions of Several Variables: Functions of two variables – Partial derivatives – Total differential – Taylor's Series expansion –Maxima and Minima – Constrained maxima and minima – Lagrange's multiplier method – Jacobians – Properties.

UNIT – III **9**

Ordinary Differential Equations of First Order: Solutions of equations in separable form – Exact differential equations – Integrating factors – Linear first order differential equations – Bernoulli's equation – Clairaut's equation.

UNIT – IV **9**

Ordinary Differential Equations of Higher Order: Linear differential equations of second and higher order with constant coefficients – Particular Integrals for the types: e^{ax} – cos(ax) / sin(ax) – x^n – $e^{ax}x^n$, $e^{ax}\sin(bx)$ and $e^{ax}\cos(bx)$ – $x^n\sin(ax)$ and $x^n\cos(ax)$ – Linear differential equations with variable coefficients: Euler-Cauchy's equation – Legendre's equation.

UNIT – V **9**

Applications of Ordinary Differential Equations: Method of variation of parameters – Simultaneous first order linear equations with constant coefficients – Simple harmonic motion – Deflection of beams – Electric circuits (Differential equations and associated conditions need to be given).

Lecture: 45, Tutorial: 15, TOTAL: 60

TEXT BOOKS:

1. Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi.
2. Veerarajan T., "Engineering Mathematics, (for first year)", Reprint Edition 2013, Tata McGraw-Hill, New Delhi.

REFERENCE BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, New Delhi, 2011.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", 4th Edition, Narosa Publishing House, New Delhi, Reprint 2014.
3. Bali N.P. and Manish Goyal, "Text Book of Engineering Mathematics", 8th Edition, Laxmi Publications, New Delhi, 2011.
4. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2011.
5. Kreyszig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley Sons, 2010.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: solve engineering problems which needs matrix computations
CO2: solve extremal problems which arise in function of several variables
CO3: identify the appropriate method for solving first order ordinary differential equations
CO4: classify and find the solution of ordinary differential equations of higher order
CO5: apply the concept of ordinary differential equations for modeling and finding solutions to engineering problems

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14PHT11 APPLIED PHYSICS

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Properties of Matter: Elasticity – Hooke's law – Modulus of elasticity (qualitative) – Stress-strain diagram – Poisson's ratio – Bending moment – Depression of a cantilever (theory) – Derivation of Young's modulus of the material of the beam – Uniform and non-uniform bending – I-shaped girders. **Thermal Physics:** Modes of heat transfer – Thermal conductivity – Derivation of rectilinear flow of heat along a bar – Radial and cylindrical heat flow – Conduction through compound media (series and parallel).

UNIT – II **9**

Acoustics: Classification of sound – Weber–Fechner law – Sabine's formula- derivation using growth and decay method – Absorption coefficient and its determination –Factors affecting acoustics of buildings and their remedies. **Ultrasonics:** Production – Magnetostrictive generator – Piezoelectric generator – Determination of velocity using acoustic grating – Cavitation – Industrial applications – Drilling, welding, soldering and cleaning – Non destructive testing – Ultrasonic pulse echo system.

UNIT – III **9**

Laser and Applications: Spontaneous emission and stimulated emission – Population inversion – Pumping methods – Derivation of Einstein's coefficients (A&B) – Types of lasers – Nd:YAG laser, CO_2 laser, Semiconductor lasers: homojunction and heterojunction – Laser Applications – Industrial applications: laser welding, laser cutting, laser drilling – Holography – Construction and reconstruction of images.

UNIT – IV **9**

Fiber Optics and Applications: Principle and propagation of light through optical fibers – Derivation of numerical aperture and acceptance angle – Classification of optical fibers (based on refractive index, modes and materials) – Crucible-crucible technique for fiber fabrication – Sources (LED and LASER) and detectors (p-i-n photodiode and avalanche photodiode) for fiber optics - Fiber optical communication links – Losses in optical fibers – Fiber optic sensors – Temperature and displacement sensors.

UNIT – V **9**

Quantum Physics and Applications: Black body radiation – Planck's theory (derivation) – Compton effect (theory) – Matter waves – Uncertainty principle (qualitative) – Schroedinger's wave equations – Time independent and time dependent wave equations – Physical significance of wave function – Particle in a box (One dimensional) – Electron microscopes – Scanning electron microscope – Transmission electron microscope.

TOTAL : 45

TEXT BOOKS:

1. Tamilarasan K and Prabu K, "Engineering Physics-I", Tata McGraw Hill Education Private Limited, New Delhi, 2014.

REFERENCE BOOKS:

1. Gaur R.K. and Gupta S.L., "Engineering Physics", Dhanpat Rai and Sons, New Delhi, 2009.
2. Uma Mukherji, "Engineering Physics", Narosa Publishing House, New Delhi, 2011.
3. Laud B.B., "Lasers and non- linear optics", New Age International (P) Limited Publishers, New Delhi, 1996.
4. Ajoy Ghatak and Thyagarajan K., "Introduction to Fiber Optics", Cambridge University Press, New York, USA, 2000
5. Mehta and Neeraj, "Applied Physics for Engineers", Prentice-Hall of India Private Limited, New Delhi, 2011.
6. Douglas Brandt and Douglas C. Giancoli, "Physics for Scientists and Engineers", Prentice-Hall of India Private Limited, New Delhi, 2000.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: Infer the extensive properties of matter and heat conduction in metal.
CO2: Demonstrate acoustically good buildings and non-destructive testing using ultrasonic waves.
CO3: Employ the laser in engineering and technology.
CO4: Sketch the principle of fiber optics and fiber optic communication link.
CO5: Interpret the concepts of quantum physics to optical phenomena and electrons in a metal.

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CYT11 APPLIED CHEMISTRY

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Water: Introduction - Sources of water - Impurities in water - Types of water - Water quality standards - Water quality parameters (Brief discussion only) - Hardness of water- Expression of hardness - Units of hardness –Estimation of Hardness of water by EDTA method – Determination of alkalinity - Disadvantages of using hard water - Boiler troubles due to hard water - scale and sludge formation – boiler corrosion – caustic embrittlement- priming and foaming- Softening of water- External treatment methods - zeolite and demineralization process (principle, process, advantages and disadvantages only) - Internal treatment process - colloidal, carbonate, calgon and phosphate conditioning (brief discussion only) - desalination by reverse osmosis method

UNIT – II **9**

Electrochemistry: Introduction – Electrolytic and Electrochemical Cells – Representation of a galvanic cell - Reversible and Irreversible cells - EMF and its determinations – Electrode potential - Nernst Equation – Reference electrodes (hydrogen and calomel electrodes) – Electrochemical series and its applications – Conductometric titrations (strong acid vs strong base only) - Batteries (Lead Acid battery, NICAD, Lithium battery, Lithium Sulphur battery) – Proton exchange membrane cells.

UNIT – III **9**

Corrosion and Its Control: Introduction – Mechanism of chemical and electrochemical corrosion – galvanic corrosion - concentration cell corrosion – Galvanic series - Factors influencing rate of corrosion – corrosion control methods - Sacrificial anode and impressed current cathodic protection methods – Corrosion inhibitors - Protective coatings - classifications - Pretreatment of metal surface - Metallic coating -electroplating and electrolessplating (General discussion) - Hot dipping (Tinning and galvanising) - Non-metallic coating - surface conversion coating (phosphate coating and anodized coating) - Organic coating - paints – constituents and their function – Special paints (Fire retardant, temperature indicating, water repellant and luminescent paints)

UNIT – IV **9**

Fuels: Coal and its varieties – proximate and ultimate analysis – their significance – metallurgical coke - Otto-Hoffman byproduct method - Liquid fuel - refining of petroleum – Manufacture of synthetic petrol – Cracking - Polymerization - Hydrogenation of coal (Fisher Tropsch and Bergius methods) - knocking - octane number – improving octane number by additives – Diesel – cetane number – Gaseous fuels (Water gas and LPG).

Combustion: Introduction – Calorific Values – Gross and Net Calorific Values – Dulong's formula (simple problems)- Flue gas analysis by Orsat's method - Explosive range and Spontaneous Ignition Temperature

UNIT – V **9**

Polymers: Introduction – Nomenclature of polymers – functionality – polymerization - types – addition, condensation and co-polymerization with examples – Effect of polymer structure on properties (strength, plastic deformation, glass transition temperature and melting point of polymers (Tg and Tm), crystallinity and chemical resistance) - plastics – types (thermo and thermosetting plastics) - individual polymers - Polyethylene, Polypropylene, PVC, Teflon and Bakelite (preparation, properties and uses only) - Compounding of plastics- Fabrication of plastics (compression, injection and extrusion moulding methods) – conducting polymers

TOTAL : 45

TEXT BOOKS:

1. Palanisamy P.N, Geetha A, Manjula Rani K, "Applied Chemistry", 2nd Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2013.
2. Jain P C and Monica Jain, "Engineering Chemistry", 15th Edition, Dhanpat Rai Publication Co., New Delhi, 2008.

REFERENCE BOOKS:

1. Sharma B.K., "Engineering Chemistry", Krishna Prakasan Media (P) Ltd., Meerut, 2001.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill, New Delhi, 2008.
3. Krishnamurthy N., "Engineering Chemistry", 2nd Edition, PHI Learning Private Limited, New Delhi, 2008.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: get the basic knowledge of water quality parameters and treatment methods
CO2: obtain the principles of electrochemical cells, EMF series and energy storing devices
CO3: acquire the knowledge of the types and prevention methods of corrosion
CO4: know the concepts and developments in combustion and various types of fuels
CO5: understand the knowledge about the types of polymers, plastics and moulding methods

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14MET11 BASICS OF CIVIL AND MECHANICAL ENGINEERING

(Common to all Engineering and Technology branches)

3 0 0 3

PART-A: CIVIL ENGINEERING

UNIT – I **5**

Introduction: History of civil engineering - Role and Functions of civil engineer - Fields of civil engineering

UNIT– II **5**

Building Materials: Introduction – Properties and applications of Construction Materials – bricks – stones – sand – cement – mortar- concrete – steel – glass-wood –plastics- ceramics -rubber- FRP – Non ferrous materials - Geosynthetics – Smart materials.

UNIT – III **4**

Sub Structure: Soil **–** classification- bearing capacity- foundation -function- requirements- types-failures -remedial measures- machine foundation

UNIT – IV **4**

Super Structures: Brick masonry – stone masonry – beams – columns – lintels – roofing – flooring – plastering- damp proofing- weathering course

UNIT – V **4**

Interior design and Landscaping: History of Interior design-Importance of Interior design- Basic elements of Interior design. Landscape Architecture-Elements of Landscaping- Green Engineering

PART-B: MECHANICAL ENGINEERING

UNIT – I **5**

Thermal Science: Laws of thermodynamics and their applications – Principle of operation of Steam, Diesel, Hydro-electric and Nuclear power plants - Classification of internal combustion engines and their working principles – Components of basic Vapour Compression Refrigeration system.

UNIT – II **4**

Fluid Science: Properties of fluids – Classification of hydraulic turbines, working principle of Pelton turbine – Applications of steam and gas turbines. Classification of pumps, working principle of centrifugal and reciprocating pump

UNIT – III **4**

Mechanics and Materials: Classification of engineering materials - Mechanical properties of engineering materials- Definition and importance of stress and strain - Definition and importance of centre of gravity and moment of inertia.

UNIT – IV **5**

Mechanical Components And Their Applications: Basic principles and applications of power transmission systems such as belt, rope, chain and gear drives – Function and principles of coupling, clutch, brake, flywheel and governor

UNIT – V **5**

Manufacturing Technology: Principle and applications of Metal forming process – Foundry, Forging. Principle and applications of Metal Joining process – Welding, Soldering and Brazing, Basics of CAD/CAM/CIM.

TOTAL : 45

TEXT BOOKS:

1. Palanichamy M.S., "Basic Civil Engineering", Tata McGraw-Hill, New Delhi, 2006.
2. Pravin Kumar, "Basic Mechanical Engineering", Pearson Publishers, New Delhi, 2013.

REFERENCE BOOKS:

1. Rangawala S.C., "Engineering Materials" Charotor Publishing House(P) Ltd., Anand, 2013.
2. Punmia B.C., Ashok Kumar Jain, Arun Kumar Jain, "Building Construction," Laxmi Publications (P) Ltd., NewDelhi, 2005.
3. Shanmugam G., "Basic Mechanical Engineering", Tata McGraw-Hill, New Delhi, 2005.
4. Venugopal K. and Prabhu Raja V., "Basic Mechanical Engineering", 6th Edition, Anuradha Publishers, Kumbakonam, 2005.
5. https://www.youtube.com/watch?v=WH2vSp_p56k
6. https://www.acs.org/content/acs/en/greenchemistry/what-is-green-chemistry/principles/12-principles-of-green-engineering-html
7. https://www.youtube.com/watch?v=on-_oUajNso

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: know the various functions of Civil Engineer and to identify the suitable construction materials

CO2: demonstrate the various elements of sub-structure and super-structure

CO3: apply the elements of interior design and landscaping in Civil Engineering

CO4: demonstrate an understanding of basic concepts in thermal engineering, fluid mechanics and material properties

CO5: demonstrate an understanding of principles and applications of mechanical power transmission components and basic manufacturing process

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14MEC11 ENGINEERING DRAWING

(Common to all Engineering and Technology branches)

2 0 3 3

Pre-requisites: Basic knowledge in practical geometry construction and mathematics

UNIT – I **9**

General Principles of Orthographic Projection: Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning. Projections of Points, Lines and Planes. General principles of orthographic projection – First angle projection – Layout of views – Projection of points, located in all quadrant and straight lines located in the first quadrant – Determination of true lengths and true inclinations and location of traces – Projection of polygonal surface and circular lamina inclined to both reference planes.

UNIT – II **9**

Projections of Solid: Projections of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method.

UNIT – III **9**

Sectioning of Solids: Sectioning of solids- prisms, pyramids, cylinder and cone in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other – Obtaining true shape of section.

UNIT – IV **9**

Development of Surfaces: Development of lateral surfaces of simple and truncated solids – prisms, pyramids, cylinders and cone with cutout, perpendicular and inclined to the horizontal axis.

UNIT – V **9**

Isometric and Perspective Projection: Principles of isometric projection – isometric scale – isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones Conversion of isometric projection into orthographic projection. Perspective projection of prisms, pyramids and cylinders by visual ray method.

TOTAL : 45

TEXT BOOKS:

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw-Hill, New Delhi, 2008.
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, New Delhi, 2008.

REFERENCE BOOKS:

1. Bhatt N.D., "Engineering Drawing", 46th Edition, Charotar Publishing House, Anand, 2003.
2. Gopalakrishnana K.R., "Engineering Drawing", Volume. I & II, Subhas Publications, Bangaluru, 2006.
3. Dhananjay A. Jolhe, "Engineering Drawing with an introduction to AutoCAD", Tata McGraw Hill, New Delhi, 2008.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: gain knowledge on international standards of drawings and to draw the different types of projections for points, lines and planes
CO2: draw the different projections of 3D primitive objects like cube, cone, cylinder, etc.
CO3: draw sections of solids including prisms, pyramids, cylinders and cones
CO4: understand the concepts of development of surfaces of simple and truncated solids
CO5: draw the isometric and perspective projections for the given object

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14VEC11 VALUE EDUCATION

(Common to all Engineering and Technology branches)

0 2 1 1

UNIT – I **6**

Philosophy of Life Science: Life – Purpose of life (four stages of life) – Philosophy of life (who am 'I') – Law of nature (cause of the life and body) – Content of the Life (five sheaths) – Goal of life. Five duties in life.

Methodology: Life and messages of spiritual and national leaders– The forgotten hero, etc.

Project report: Complementing with happiness - Every soul is potentially divine

UNIT – II **6**

Human Values-Moral foundation: Truth, forgiveness, compassion, endurance, humility, non violence, moderate diet, non stealing, self purification, self discipline, self study, content, cleanliness, honesty, and totality in faith– Good habits – Attitude forming for Individual peace.

Practical Methods: Personal experience with above characters, Puranic Stories - Self resolve diary maintenance

UNIT – III **6**

Social Values: Family – Family System - Greatness of women – World brotherhood (vasudeiva kudumbagam) – Glorious Bharath - Bharathian systems - Past –Present – Future - Team spirit - Goal setting – Economics – Education – Politics – Responsibilities of people – Preserving natural resources.

Methodology: Preparing an album on glorious Bharath Past, Present and Future Plans. Goal setting - Management Games. Team Spirit - Yogic Games.

UNIT – IV **6**

Development of Mental Prosperity: Prosperity of mind – Functions of mind - Obstacles of mind - Practical method to perfect mind is yoga – Types – Uses – Precaution – Contradiction – Kriyas - Asanas – Pranayamas – Meditative techniques.

Methodology: Asana - Pranayama – Cyclic meditation – Nada anu sandhana – Meditation – Yogic games for memory. Album on asanas , pranayama and mantra.

UNIT – V **6**

Maintenance of Physical Health: Human body – Structure - Ten Systems of the body as per modern science. Five elements - Harmonious relationship – Life force – Conserving vitality & health through natural life – Pranic food and its importance – Uses of herbs - Right way of cooking to preserve nutrients - Cause of the disease – Acute and chronic - Disease - Life and death.

Methodology: Natural food making, traditional millet dishes. Asanas, pranayamas, cleansing procedures, Quiz on healthy living, Uses of herbs or kitchen garden.

TOTAL : 30

TEXT BOOK:

1. "Value Education", compiled by Vethathiri Maharishi Institute for Spiritual and Intuitional Education, Aliyar, Pollachi, for Kongu Engineering College.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the purpose and value of life
CO2: exhibit positive human values
CO3: understand social values
CO4: take steps to develop mental and physical health

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3		3				3		
CO2						3		3				3		
CO3						3		3				3		
CO4						3		3				3		

1 – Slight, 2 – Moderate, 3 – Substantial

14PHL11 PHYSICAL SCIENCES LABORATORY I

(Common to all Engineering and Technology branches)

0 0 3 1

PART-A: APPLIED PHYSICS LABORATORY
(Any five experiments)

LIST OF EXPERIMENTS:

1. Determination of Young's modulus of a given material using uniform bending.
2. Determination of thermal conductivity of bad conductor using Lee's disc arrangement.
3. Determination of velocity of ultrasonic waves in liquid and compressibility of liquid using ultrasonic interferometer.
4. (a) Particle size determination using diode laser.

(b) Determination of wavelength of laser

5. Determination of specific resistance of a given coil of wire using Carey Foster bridge.
6. Determination of wavelength of Hg spectrum using spectrometer and grating.

Demonstration

1. Measurement of efficiency of a solar cell
2. Non destructive testing
3. Tyndall effect

PART-B: APPLIED CHEMISTRY LABORATORY
(Any five experiments)

LIST OF EXPERIMENTS:

1. Estimation of Total, Temporary and Permanent hardness of water by EDTA method.
2. Estimation of Ca^{2+} and Mg^{2+} hardness separately by EDTA method.
3. Estimation of Alkalinity of the given water sample.
4. Conductometric titration - Mixture of acids.
5. Estimation of Hydrochloric acid using pH meter.
6. Estimation of Ferrous ion by potentiometric titration.

Demonstration

1. Distillation system
2. RO water treatment system
3. UV Spectrophotometer

REFERENCES / MANUALS / SOFTWARE:

1. Physics Laboratory Manual –Dr.K.Tamilarasan and Dr.K.Prabu
2. Chemistry Laboratory Manual- Dr.P.N.Palanisamy, P.Manikandan, A.Geetha and K.Manjularani

TOTAL : 45

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: Describe the basics of modulus of elasticity, thermal conductivity, ultrasonics and compressibility of water, laser parameters, specific resistance of electrical conductors, and interference and diffraction of light waves.

CO2: Operate thebasic measuring devices, travelling microscope, Lee's disc arrangement, ultrasonic interferometer, Carrey Foster bridge and spectrometer, and to measure the related physical parameters.

CO3: Analyze the hardness, amount of Ca^{2+} and Mg^{2+} ions, and presence of alkalinity in water.

CO4: Employ the instruments like pH meter, conductivity meter and potentiometer for the estimation of unknown concentration of acids and ferrous ion.

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14MEL11 BASICS OF CIVIL AND MECHANICAL ENGINEERING LABORATORY

(Common to all Engineering and Technology branches)

0 0 3 1

LIST OF EXPERIMENTS:

1. To prepare a square or rectangular shaped two identical MS plates by cutting and filing operations
2. To prepare a square/rectangular/circular/trapezoidal/Vshaped projection and its counterpart formating from the given square or rectangular MS plates.
3. To carryout drilling, tapping and assembly on the given MS plates.
4. To carryout thread forming on a GI and PVC pipes and cut to the required length.
5. To use various pipe fitting accessories and prepare water leak proof water line from overhead tank.
6. To prepare a T/L/Lap joint from the given wooden work pieces.
7. To prepare a plywood box/tray to the given dimensions.
8. To prepare a leak proof sheet metal tray/box/funnel to the given dimensions.
9. Cutting of MS plates by gas cutting method and arc weld joining by Lap/Butt/T joint method
10. Preparing a simple PVC window/door frame assembly.
11. Preparing a simple memento or similar articles using wood/sheet metal
12. Preparing innovative articles involving waste metals.

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Introduction to basic manufacturing processes and workshop technology by Rajender Singh, New Age International (P) Limited, 2006.
2. Elements of Workshop Technology by S.K.Hajra Choudhury, Media Promoters, 2009.

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: demonstrate knowledge on safety and adhere to safety features

CO2: mark the given dimensions accurately and execute cutting and joining operations

CO3: select methods and tools and execute the given experiments

CO4: finish the job to the requirements and quantify the accuracy

CO5: plan and complete simple and innovative articles

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14EGT21 COMMUNICATIVE ENGLISH II

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Functional Grammar: Sentences – Affirmative / Negative – Asking questions in the simple present – Using reference words - Cause and Effect expressions. **Listening:** Listening practice - listening to different types of conversation and answering questions - listening to Audio texts and completing cloze exercises. **Speaking:** Opening a conversation and getting acquainted with people. **Reading:** Reading excerpts from a novel, itinerary, magazine and news paper articles. **Writing:** Formal Letter writing – Job Application Letter – CV and Resume – Writing Instructions

UNIT – II **9**

Functional Grammar: Sentences – Interrogative & WH questions - SI units – Numerical Adjectives

Listening: Listening to situation based dialogues – listening to short and long conversations in different domains of activity. **Speaking** : Conversation practice in real life situations, describing places, narration, introducing ideas. **Reading:** Reading historic writing – biographical writing – Non fictional book extracts and news feeds. **Writing:** Filling Forms – Academic Writing - Basics of Business Writing – Calling for Quotation, Placing Orders, Letter of Complaint

UNIT – III **9**

Functional Grammar: Sentences – Imperative – Gerunds & Infinitives - Commonly confused words. **Listening:** Understanding the structure of conversations - Listening to academic lectures and live speech – advertisements and announcements. **Speaking:** Giving and Justifying opinions – apologizing – extempore. **Reading:** Reading Blogs - Website articles – e-mails. **Writing:** e-mails – Tweets – Texting and SMS language

UNIT – IV **9**

Functional Grammar: Transformation of Sentences – Simple, Compound and Complex - Vocabulary (single word substitute) – conjunctions - reporting verbs – Direct and Indirect speech. **Listening:** Listening to a telephone conversation, viewing of model interviews (face–to–face, telephonic and video conferencing). **Speaking:** Giving instructions – Role play – Interviews. **Reading:** Reading job advertisements and profile of the company concerned **Writing:** Writing Reports - Preparing a Check list

UNIT – V **9**

Grammar: Analyzing sentence structures in a given short passage - Identifying parts of speech in a given short passage. **Listening:** Viewing a model group discussion and reviewing the performance of each participant – identifying the characteristics of a good listener – casual conversation. **Speaking:** Group discussion skills – initiating, turn taking and concluding the discussion. **Reading:** Making notes from long passages or any form of written materials – providing a suitable title – identifying main points, supporting points. **Writing:** Email writing – Effective use of email.

TOTAL: 45

TEXT BOOKS :

1. Dr. Elango et al. "Resonance: English for Engineers and Technologists", Foundation, Chennai, 2013.

REFERENCE BOOKS:

1. Anderson, Paul V., " Technical Communication **:** A Reader–Centered Approach", Cengage.
2. Muralikrishna and Sunita Mishra, "Communication Skills for Engineers", Pearson, New Delhi, 2011.
3. Sharma, Sangeetha and Binod Mishra, "Communication Skills for Engineers and Scientists", PHI Learning, New Delhi, 2009.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: speak effectively, express their opinions clearly, initiate and sustain a discussion and also negotiate using appropriate communicative strategies

CO2: write effectively and persuasively and produce different types of writing such as narration, description, exposition and argument as well as creative, critical, analytical and evaluative writing

CO3: read different genres of texts, infer implied meanings and critically analyze and evaluate them for ideas as well as for method of presentation

CO4: listen and comprehend different spoken excerpts critically and infer unspoken and implied meanings

CO5: use functional grammar for improving employment oriented skills

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14MAT21 MATHEMATICS II

(Common to all Engineering and Technology branches)

3 1 0 4

Pre-requisites: Basic ideas of integration, Basic ideas of vectors and complex numbers

UNIT – I **9**

Multiple Integrals: Double integration in Cartesian coordinates – Change of order of integration – Area between two curves – Triple integration in Cartesian coordinates –Volume as Triple integrals (Simple problems only).

UNIT – II **9**

Vector Calculus: Gradient of a scalar point function – Directional derivative – Divergence of a vector point function – Curl of a vector – Irrotational and Solenoidal vectors – Line Integral, Surface integral and Volume integral (Concept only) – Green's, Stoke's and Gauss divergence theorems (Statement only) – Verification of the above theorems and evaluation of integrals using them (Simple problems only).

UNIT – III **9**

Analytic Functions: Functions of a complex variable – Analytic functions – Necessary conditions and Sufficient conditions (excluding proofs) – Cauchy– Riemann equations (Statement only) – Properties of analytic function (Statement only) – Harmonic functions – Construction of Analytic functions – Conformal mapping: $w = z + a$, az, $1/z$ – Bilinear transformation.

UNIT – IV **9**

Complex Integration: Cauchy's theorem and Cauchy's integral formula (Statement and applications) – Taylor's and Laurent series – Singularities – Classification – Cauchy's Residue theorem (Statement only) – Contour integration – circular and semi-circular contours (excluding poles on real axis).

UNIT – V **9**

Laplace Transform: Conditions for existence – Transform of elementary functions – Basic properties – Derivatives and integrals of transforms – Transforms of derivatives and integrals – Initial and final value theorems – Transform of unit step function – Transform of periodic functions - Inverse Laplace transform of elementary functions – Partial fraction method – Convolution theorem (Statement only) – Solution of linear ODE of second order with constant coefficients.

Lecture: 45, Tutorial: 15, TOTAL: 60

TEXT BOOKS:

1. Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi.
2. Veerarajan T., "Engineering Mathematics", (for first year), Reprint Edition 2013, Tata McGraw-Hill, New Delhi.

REFERENCE BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, New Delhi, 2011.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", 4th Edition, Narosa Publishing House, New Delhi, Reprint 2014.
3. Bali N.P. and Manish Goyal, "Text Book of Engineering Mathematics", 8th Edition, Laxmi Publications, New Delhi, 2011.
4. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2011.
5. Kreyszig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley Sons, 2010.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: Solve problems involving double and triple integrals.
CO2: Apply the concept of vectors in engineering problems.
CO3: Have a clear idea about functions of complex variables and analytic function which are widely used in study of fluid and heat flow problems.
CO4: Evaluate complex integrals which is extensively applied in engineering.
CO5: Handle Laplace transforms to solve practical problems.

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14PHT21 MATERIALS SCIENCE

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Crystal Physics: Crystalline and amorphous solids – Lattice – Unit cell – Crystal systems – Bravais lattice – Lattice planes – Miller indices – Derivation of '*d*' spacing in cubic lattice – Atomic radius – Coordination number– Packing factor for SC, BCC, FCC and HCP structures – Crystal imperfections: Point and line imperfections.

UNIT – II **9**

Conducting Materials: Conductors – Classical free electron theory of metals – Electrical and thermal conductivities – Wiedemann–Franz law – Lorentz number – Draw backs of classical theory – Quantum theory – Fermi distribution function – Effect of temperature on Fermi function – Density of energy states – Carrier concentration in metals.

UNIT – III **9**

Semiconducting Materials: Intrinsic semiconductor – Carrier concentration derivation – Electrical conductivity and band gap (theory) – Extrinsic semiconductors – Carrier concentration derivation in n-type and p-type semiconductors – Hall effect – Determination of Hall coefficient – Applications –Solar cell – LDR.

UNIT – IV **9**

Magnetic and Superconducting Materials: Magnetic materials - Types of magnetic materials (qualitative) – Domain theory – Hysteresis – Soft and hard magnetic materials – Applications - Transformer core – Magneto optical recording – Superconductors – Properties – Types of superconductors – BCS theory of superconductivity (qualitative) – Josephson effect - Applications of superconductors – SQUID – Cryotron – Magnetic levitation. **Dielectric Materials:** Dielectric constant – Qualitative study of polarization – Frequency and temperature dependence of polarization – Dielectric loss – Dielectric breakdown – Uses of dielectric materials (capacitor) – Ferro electric materials (qualitative).

UNIT – V **9**

Smart Materials: Metallic glasses: Preparation (Melt spinning method only), properties and applications – Shape memory alloys (SMA): Characteristics and applications. **Nano Materials:** Low dimensional structures (quantum dot, wire and well) – Features of nano materials – Synthesis: top down and bottom up approaches – Ball milling and lithographic methods – Physical and chemical vapor phase depositions – Sol gel method – Carbon nanotubes: Structures – Properties – Fabrication by laser ablation – Applications.

TOTAL : 45

TEXT BOOKS:

1. Tamilarasan K. and Prabu K., "Engineering Physics-II", Tata McGraw Hill Education Private Limited, New Delhi, 2014.

REFERENCE BOOKS:

1. Mehta and Neeraj, "Applied Physics for Engineers", Prentice-Hall of India Private Limited, New Delhi, 2011.
2. Raghavan V., "Materials Science and Engineering: A first course", 5th Edition, Prentice-Hall of India, New Delhi, 2009.
3. Poole Charles P. and Ownen Frank J., "Introduction to Nanotechnology", Wiley India, 2007.
4. William Fortune Smith and Javad Hashemi, "Foundations of Materials Science and Engineering", McGraw-Hill Education, 2006, New Delhi.
5. Pillai S.O., "Solid State Physics", 5th Edition, New Age International, New Delhi, 2003.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: Explain the various crystal systems and crystal defects.
CO2: Comprehend the theory of conducting materials.
CO3: Classify the types of semiconducting materials and to illustrate the device applications.
CO4: Summarize the theory and applications of magnetic, superconducting and dielectric materials.
CO5: Outline the properties and applications of smart materials and nano materials.

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CYT21 ENVIRONMENTAL SCIENCE

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Introduction to Environmental Studies and Natural Resources: Introduction to Environmental Science – Forest resources: Use and over-exploitation, deforestation, case studies. – Water resources: Use and over-utilization of surface and ground water, dams - benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture - effects of modern agriculture, fertilizer and pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies – Land resources: Land as a resource – Conservation Practices - Role of an individual in conservation of natural resources.

UNIT – II **9**

Ecosystems: Concept of an ecosystem – Components of an ecosystem - Structural and functional features – Functional attributes (Food chain and Food web only) –Ecological Succession- Introduction, types, characteristic features, structure and functions of the (a) Forest ecosystem (b) Aquatic ecosystems (ponds, rivers and oceans). **Biodiversity:** Introduction – Classification: genetic, species and ecosystem diversity – Bio geographical classification of India- Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic, option values and ecosystem service value – Biodiversity at global, national and local level- Hotspots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – In-situ and Ex-situ conservation of biodiversity.

UNIT – III **9**

Environmental Pollution: Definition – Causes, effects and control measures of: (a) Air pollution - Climate change, global warming, acid rain, ozone layer depletion (b)Water pollution (c) Soil pollution - Solid waste Management - Disaster management: floods, earthquake, cyclones and landslides - Role of an individual in prevention of pollution - Case studies. **Water Treatment methods:** Treatment of Water for Domestic Supply (Screening, Aeration, Sedimentation with Coagulation, Filtration and Disinfection methods) - Break point chlorination- Estimation of dissolved oxygen, BOD and COD - Sewage treatment (Primary, Secondary & Tertiary methods) – Introduction to industrial wastewater treatment using Reverse Osmosis Technology- Membrane Technology for wastewater treatment - Activated carbon in pollution abatement of wastewater.

UNIT – IV **9**

Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation– Environmental ethics - Wasteland reclamation – Environment Production Act – Air (Prevention and control of pollution) Act – Water (Prevention and control of pollution) Act – Wildlife protection Act – Forest conservation Act – Issues involved in enforcement of environmental legislation – Public awareness. **Human Population and the Environment:** Introduction - Population growth - Variation of population based on age structure - Variation among nations – Population explosion – Family welfare programme – Value Education – HIV / AIDS – Women and Child welfare – Role of Information Technology in Environment and human health – Case studies.

UNIT – V **9**

Green Chemistry for Sustainable Future: Water the greenest solvent – Role of catalyst – Biopolymers – Biofertilizers – Principle and applications of green chemistry. **Food and Human Health:** Introduction – Classification and applications of carbohydrates, amino acids, proteins, lipids and vitamins – Food additives – Balanced food – Minerals rich, carbohydrates rich and proteins rich – Chemistry of soft drinks – Oils and fats – Simple tests for identification of adulterants in food stuffs – Impacts of fluoride and arsenic on human health – Fluoride and arsenic removal methods – Significance of iodine, iron and calcium content in human health.

TOTAL : 45

TEXT BOOKS:

1. Palanisamy P.N., Manikandan P., Geetha A., Manjula Rani K., "Environmental Science", Pearson Education, New Delhi, Revised Edition 2014.
2. Anubha Kaushik, and Kaushik C.P., "Environmental Science and Engineering", 4th multicolour Edition, New Age International (P) Ltd., New Delhi, 2014.

REFERENCE BOOKS:

1. Erach Bharucha, "Textbook of Environmental Studies for Undergraduate Courses", 2005, University Grands Commission, Universities Press India Private Limited, Hyderguda, Hyderabad.
2. Uppal M.M. revised by Bhatia S.C., "Environmental Chemistry", 6th Edition, Khanna Publishers, New Delhi, 2002.
3. Bahl B.S. and Arun Bahl, "Advanced Organic Chemistry", 3rd Edition, S. Chand & Co., New Delhi, 2005.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: know the types of natural resources and the individual role in conserving the resources
CO2: understand the ecological balance and the preservation of biodiversity
CO3: gain the knowledge of the various types of pollution and the waste water treatment methods
CO4: attain the knowledge of various social issues and impact of population explosion on environment
CO5: know about the green chemistry for sustainable future, food and human health

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CSC11 PROBLEM SOLVING AND PROGRAMMING

(Common to all Engineering and Technology branches)

3 0 3 4

UNIT – I **9**

Introduction to Computer and Problem Solving: Overview of computers – Applications of computers-Characteristics of computer - Basic computer Organization – Number System - Problem solving: Planning the computer program – Algorithms - Flowcharts – Pseudo codes – Structuring the logic - Top-Down design.

UNIT – II **9**

Case Study on Problem Solving: Algorithm, Flowchart and Pseudo code for the problems: Exchanging the values of two variables – Finding the biggest number - Counting – Summation of numbers – Factorial computation – Generation of Fibonacci Sequence - Summation of series – Base Conversion - Reversing the digits of an Integer.

UNIT – III **9**

Introduction to C and Control Statements: Overview of C – Basic structure of a C Program – Executing a C Program – C Character set – Tokens – Keywords and Identifiers – Constants – Variables – Data types - Storage classes - Managing Input and Output operations – Operators and Expressions - Decision making and Branching - Looping – break and continue statements.

UNIT – IV **9**

Arrays, Strings and Functions: Arrays – One dimensional and Two dimensional arrays - Handling of character strings: Declaring and initializing string variables – String handling functions - Library functions – User defined functions: Elements of User defined Functions – nesting of functions – passing arrays to function – passing strings to functions - recursion.

UNIT – V **9**

Structures, Unions and Pointers: Structure definition – Structure declaration – Accessing a structure member- Structure initialization – Array of Structures - Arrays within structures –Structures within Structures – Structures and Functions , Unions. Understanding pointers – Accessing address of a variable – Declaring pointer variables – Initialization of pointer variables – accessing a variable through its pointer – Pass by value vs. Pass by pointers.

Lecture: 45, Practical: 45, TOTAL: 90

REFERENCE BOOKS:

1. Dromey R.G., "How to Solve it by Computer", Pearson Education, 2009.
2. Balagurusamy E., "Fundamentals of Computing and Programming", Tata McGraw-Hill Education Pvt. Ltd, 2010.
3. Stephen G. Kochan, "Programming in C", 3rd Edition, Pearson Education, 2005.
4. Yashavant P. Kanetkar, " Let Us C", BPB Publications, 2011.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: apply fundamental principles of problem solving techniques
CO2: develop algorithm, flowchart and pseudo code to provide solutions to problems
CO3: develop programs using basic programming principles of C language
CO4: implement modular programming concepts using functions
CO5: design simple applications using arrays, structures and pointers

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14EET11 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT- I **9**

Introduction to Power Systems: Introduction: Electric Potential, Current, Power and Energy. Generation of Electrical Energy: Sources of Energy - Renewable and Non Renewable - Power Generation: Thermal, Hydro and Nuclear Power plants - Solar and Wind (schematic arrangement and operation) Power plants - Structure of Electric Power System - Transmission and Distribution Voltages. Electrical Safety Aspects - Phase-Neutral - Earthing: Need for Earthing and Types - Domestic Wiring (Simple and staircase) - Energy Conservation and Sustainability.

UNIT - II **9**

DC Circuits and AC Circuits: Resistance: Resistors in Series and Parallel - Network Reduction - Voltage and Current Division Rule - Ohm's Law- Kirchhoff's Laws - Mesh Analysis of Simple Resistive Networks.

Single phase systems: Alternating (Sinusoidal) Voltage and Current, R.M.S and Average Value, Power Factor, Form Factor and Peak Factor - AC Series Circuits (RL, RC & RLC). Three phase Systems (Qualitative only): Star and Delta Connected Systems - Line and Phase Voltage/Current - Three Phase Power Measurement by Two Wattmeter Method.

UNIT - III **9**

Electrical Machines: DC Machines: Construction, Principle of Operation of DC Motor-Torque Equation, Types and Applications. AC Machines: Construction and Working Principle of AC Generator , Single Phase Transformer, Three Phase Induction Motor and Single Phase Induction Motor (Split Phase and Capacitor Start Induction Motor) - Applications.

UNIT - IV **9**

Basic Electronics: PN Junction Diode - Operation of Rectifiers (Half wave, Full wave - Bridge Rectifiers with waveforms) and Filters - Zener Diodes - Zener Diode as Voltage Regulator - IC Voltage Regulators (78XX & 79XX) - Transistors: Types - Operation of NPN Transistor - Transistor as an Amplifier - Operation and Characteristics of SCR - UPS and SMPS (Block Diagram approach).

UNIT - V **9**

Digital Electronics: Introduction – Binary Number Systems and Conversions - Binary Addition and Subtraction - Logic Gates and Truth tables - Boolean Algebra - Basic Laws and Demorgan's theorem - Simplification of Boolean Functions - Full Adder and Full Subtractor - Flip Flops - Counters: Asynchronous Binary Ripple Counter .

TOTAL: 45

TEXT BOOKS:

1. Prasad P.V., Sivanagaraju S. and Prasad R., "Basics of Electrical and Electronics Engineering", 1st Edition, Cengage Learning, 2013.
2. Muthusubramanian R. and Salivahanan S., "Basics of Electrical and Electronics Engineering", 1st Edition ,Tata McGraw Hill, 2009.

REFERENCE BOOKS:

1. Jegathesan V., Vinoth Kumar K. and Saravanakumar R., "Basic Electrical and Electronics Engineering", 1st Edition, Wiley India, 2011.
2. Sukhija M.S. and Nagsarkar T.K., "Basics of Electrical and Electronics Engineering", 1st Edition ,Oxford University Press, 2012.
3. Smarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", 2nd Edition, PHI Learning, 2007.
4. Edward Hughes, Ian McKenzie Smith, Dr. John Hiley and Keith Brown, "Electrical and Electronics Technology", 8th Edition, Pearson Education, 2012.
5. http://www.nptelvideos.in/2012/11/basic-electrical-technology.html
6. http://nptel.kongu.edu/Basic%20Courses%20I%20&%20II/Others/BEL/index.html

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: develop a basic understanding of the concept of electrical systems
CO2: analyze the DC and AC circuits
CO3: interpret the construction and working of different types of electric machines
CO4: discuss the basic electronic components
CO5: distinguish analog and digital electronics

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14PHL21 PHYSICAL SCIENCES LABORATORY II

(Common to all Engineering and Technology branches)

0 0 3 1

PART-A: APPLIED PHYSICS LABORATORY

(Any five experiments)

LIST OF EXPERIMENTS:

1. Determination of band gap of a semiconductor material using post office box.
2. Determination of dispersive power of a prism using spectrometer.
3. Determination of viscosity of liquid - Poiseuille's method.
4. Determination of thickness of a thin wire – air wedge method.
5. Determination of AC frequency using Melde's string experiment.
6. Determination of hysteresis loss in a ferromagnetic material.

Demonstration

1. Thin film deposition using RF magnetron sputtering technique
2. Synthesis of nano-particles
3. Phase change memory materials - RW CD / DVD

PART - B: APPLIED CHEMISTRY LABORATORY

(Any five experiments)

LIST OF EXPERIMENTS:

1. Estimation of Chloride in the given water sample.
2. Determination of Dissolved Oxygen in the given wastewater sample.
3. Estimation of Ferrous ion in the given solution.
4. Estimation of Copper in the given solution by Iodometric method.
5. Estimation of Chromium (Cr^{6+}) in the wastewater.
6. Estimation of copper content of the given solution by EDTA method.

Demonstration

1. Turbidity measurement using Nephelometer
2. COD analyzer
3. Dissolved Oxygen measurement using DO analyzer

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Physics Laboratory Manual –Dr.K.Tamilarasan and Dr.K.Prabu
2. Chemistry Laboratory Manual- Dr.P.N.Palanisamy, P.Manikandan, A.Geetha and K.Manjularani

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: describe **t**he basics of band gap of semiconductors, dispersive power of a prism, viscosity of liquids, interference of light, AC frequency and hysteresis of ferromagnetic materials.

CO2: operate the instruments like post office box, air wedge arrangement, Melde's string apparatus and hysteresis arrangement, and to measure the related parameters

CO3: estimate the amount of DO and chloride in a given water sample

CO4: determine the amount of chromium, ferrous ion and copper in waste water

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14EEL11 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

(Common to all Engineering and Technology branches)

0 0 3 1

LIST OF EXPERIMENTS:

1. Control of incandescent and fluorescent lamp by simple and stair-case wiring
2. Resistor color coding and verification of Ohm's Law and Kirchhoff's Laws
3. Measurement of real power, reactive power, power factor and impedance of RC, RL and RLC circuits.
4. Measurement of Earth's resistance
5. Load test on DC shunt motor
6. Performance characteristics of single phase Transformer
7. Load test on single phase induction motor.
8. Verification of basic logic gates and their truth tables.
9. Implementation of Half wave and Full wave Rectifier with simple Capacitor Filter
10. Study of Mixie, Ceiling Fan and Vacuum Cleaner

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

- Lab Manuals

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: create a basic electrical connections for domestic applications
CO2: test basic electrical machines like transformer and DC motors
CO3: construct and analyze basic electronic circuits
CO4: measure the various electrical parameters of the circuit
CO5: explain the working of various domestic appliances

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14MAT31 MATHEMATICS III

(Common to all Engineering and Technology Branches)

3 1 0 4

UNIT – I **9**

Fourier Series: Dirichlet's conditions – General Fourier series – Change of interval - Odd and even functions – Half range Sine series – Half range Cosine series – Harmonic analysis.

UNIT – II **9**

Partial Differential Equations: Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Lagrange's linear equation – Homogeneous linear partial differential equations of higher order with constant coefficients.

UNIT – III **9**

Applications of Partial Differential Equations: Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two dimensional heat equation (excluding insulated edges).

UNIT – IV **9**

Fourier Transform: Fourier Integral theorem (without proof) – Fourier transform pair – Properties – Transforms of simple functions – Fourier Sine and Cosine transforms – Convolution theorem and Parseval's identity (Statement and applications only).

UNIT – V **9**

Z - Transform: Definition – Elementary properties – Z-transform of some basic functions – Inverse Z-transform – Partial fraction method – Residue method – Convolution theorem – Applications of Z-transforms – Solution of difference equations.

Lecture: 45, Tutorial: 15, TOTAL: 60

TEXT BOOKS:

1. Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics, Volume - III", Reprint Edition, S.Chand & Co., New Delhi, 2014.
2. Veerarajan T., "Transforms and Partial Differential Equations", 3rd Reprint, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2013.

REFERENCE BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, Delhi, 2014.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Reprint Edition, Narosa Publishing House, New Delhi, 2014.
3. Bali N.P. and Manish Goyal, "A Text Book of Engineering Mathematics", 9th Edition, Laxmi Publications, New Delhi, 2014.
4. Ramana B.V., "Higher Engineering Mathematics", 11th Reprint, Tata McGraw Hill Publishing Company, New Delhi, 2010.
5. Erwin Kreyzig, "Advanced Engineering Mathematics", 10th Edition, Wiley & Co, 2011.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: expand a function in terms of Fourier series and apply it for solving engineering problems

CO2: model and solve higher order partial differential equations

CO3: apply the methods of solving PDE in practical problems

CO4: gain knowledge on Fourier transforms

CO5: handle problems in Z transforms and apply it to solve difference equations

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14EET33 ELECTRICAL DRIVES AND INDUSTRIAL ELECTRONICS

(Common to Mechanical and Chemical branches)

3 0 0 3

Pre-requisites: Materials Science, Basics of Electrical and Electronics Engineering.

UNIT – I **9**

Electrical Drives and Motor Characteristics: Basic Elements of Drive – Types of Electric Drives – Factors Influence the Choice of Electrical Drives– Classification of Load Torques and Classes of Duty – Selection of Power Rating for Drive Motors. Torque Equation of DC Machine – Speed-Torque Characteristics of DC Motors-Series, Shunt and Compound Motors – Torque Equation and Speed-Torque Characteristics of Three Phase Induction Motors.

UNIT – II **9**

Motor Starting and Braking Methods: Types of D.C Motor Starters – Two Point Starter, Three Point Starter, Four Point Starter – Types of AC Motor Starters – Stator Resistance Starter, DOL Starter, Y-Δ Starter, Auto Transformer Starter and Rotor Resistance Starter. Braking of Electrical Motors – DC Motors: Shunt, Series and Compound – AC Motors: Three Phase Induction Motors.

UNIT – III **9**

Power Electronics: SCR:- Principle of Operation, Static and Dynamic Characteristics, Phase Angle Control – Single Phase Half wave and Full wave Controlled Rectifiers – Three phase Voltage Source Inverters – 120° and 180° Mode-Basics of PWM Inverters – Chopper Operation (Step-Up and Step-Down)- Introduction to Harmonics

UNIT – IV **9**

Conventional and Solid State Speed Control of DC Drives: Speed Control of DC Series and Shunt Motors – Armature and Field Control, Ward-Leonard Control System – Controlled Rectifiers Fed DC Drive and Chopper Based DC Drive (First and Second Quadrant Operation) – Selection of DC Drives for Cranes and Paper Mill.

UNIT – V **9**

Conventional and Solid State Speed Control of AC Drives: Speed Control of Three Phase Induction Motor – Voltage Control, Voltage / Frequency Control, Slip Power Recovery Scheme – Inverter and AC Voltage Controller Based Induction Drives – Selection of AC Drives for Textile Mill and Cement Mill.

TOTAL: 45

TEXT BOOKS:

1. Dubey G.K, "Fundamentals of Electrical Drives", 2nd Edition, Narosa Publishing House, New Delhi, 1995, Reprint – 2013
2. M.D.Singh, K.B.Khanchandani, "Power Electronics", 2nd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2007, Reprint – 2013.

REFERENCE BOOKS:

1. Vedam Subrahmaniam, "Electric Drives: Concepts and Applications", Tata McGraw Hill Publishing Company, New Delhi, 2nd Edition, 2001, Reprint – 2012.
2. Pillai, S. K, "A First Course on Electric Drives", 2nd Edition, Wiley Eastern Limited, New Delhi, 1998, Reprint-2007.
3. Bose B.K., "Power Electronics and Motor Drives", 1st Edition, Academic Press, 2006.

Course Outcomes:

On completion of the course the students will be able to

CO1: categorize and explain the operation of electrical drives

CO2: classify and interpret the operation of starting and braking methods of AC and DC machines

CO3: categorize and explain the working principle of converters

CO4: choose the appropriate speed control techniques for AC and DC motor drives

CO5: select the suitable AC and DC drives for industrial applications

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT31 HEAT POWER ENGINEERING

3 1 0 4

UNIT – I **9**

Laws of Thermodynamics: Thermodynamic systems-closed, open and isolated. Property, state, path and process, quasi-static process, work, Energy. Zeroth, First and Second laws of Thermodynamics (Basic concepts only), Internal energy, Specific heat capacityand Enthalpy.

UNIT – II **9**

Thermodynamic Cycles: Air standard Cycles: Carnot, Otto, Diesel and Combined cycle; Brayton and Rankine cycles – determination of cycle efficiency.

UNIT – III **9**

Boilers: Types and classification of boilers: water tube, fire tube, coal, oil and gas fired boilers; Stoker fired, pulverized and fluidized bed boilers. Mountings and accessories. Performance and efficiency calculation of boilers.

UNIT – IV **9**

Properties of Steam: Properties of steam, Mollier chart, determination of dryness fraction of steam- Different types of calorimeters. Concept of Steam distribution systems. steam traps- types and their characteristics. Energy conservation opportunities in steam systems.

UNIT – V **9**

Turbines and Vacuum Systems: Steam turbines- types and principles: Reaction and impulse turbines; Application of co-generation principles in process industries. Gas turbines- principle and working. Production of Vacuum: Systems and Equipment - Vacuum Pumps, Steam Ejectors; Instrumental methods of Vacuum measurement.

Lecture: 45, Tutorial: 15, TOTAL: 60

TEXT BOOKS:

1. Rajput R.K., "Thermal Engineering", 9th Edition, Laxmi Publications, 2010.
2. Rudramoorthy R., "Thermal Engineering", 4th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2006.

REFERENCE BOOKS:

1. Kothandaraman, C.P., Domkundwar and Domkundwar, "Course in Thermodynamics and Heat Engines", 3rd Edition, Dhanpat Rai & Sons, New Delhi, 2011.
2. Ballaney P.L., "Thermal Engineering", Khanna Publishers, New Delhi, 2005.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the laws of thermodynamics for applications to different thermodynamic cycles
CO2: analyze different thermodynamic cycles and calculate their efficiencies
CO3: understand the basics of boilers, their auxiliaries and assess boiler efficiencies: identify energy conservation opportunities in boilers
CO4: grasp the principles of steam distribution and utilization systems to develop efficient practices
CO5: apply the principles of steam turbines for assessing their efficiencies; Select vacuum pumps and instruments for enhancing the system performance

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT32 INDUSTRIAL CHEMISTRY

3 0 0 3

UNIT – I **9**

Phase Rule: Definition-derivation-application of phase rule to water system-thermal analysis-cooling curves-two component systems-eutectic and compound formation

UNIT – II **9**

Kinetics and Thermo Chemistry: Energy Surfaces and Related Concepts: Transition State Theory and Related Topic, Postulates and Principles Related to Kinetic Analysis, Kinetic Experiments; Introduction to Thermo-chemistry- Thermo-chemistry of Stable Molecules and Reactive Intermediates.

UNIT – III **9**

Colloids and Catalysis: Introduction to colloids - Preparation - properties - stabilization of colloids -Electro kinetic phenomena - Donnan Membrane equilibrium - Emulsions - Gels -Associated colloids-colloidal electrolytes. Homogeneous catalysis - Heterogeneous catalysis, Brønsted and Lewis Acid/Base Catalysis, Oxidation, Hydrogenation, Cracking - Applications of catalysis in industries.

UNIT – IV **9**

Carbohydrates: Mono, Disaccharides and Polysaccharides – Glucose, Starch and Cellulose - Derivatives of Cellulose - Structural aspects & industrial uses of starch & cellulose. Classification and Properties of Amino Acids.

UNIT – V **9**

Organic Reactions: Mechanism of Electrophilic reaction - Friedel craft reaction, Riemer Timenn Reaction, Beckmann rearrangements; Mechanism of Nucleophilic reactions-Aldol condensation, Perkins reaction, Benzion condensation; Mechanism of Free radical reaction- Halogenations of Alkanes, Addition HBR on Alkenes in presence of peroxide, Thermal halogenations reaction.

TOTAL: 45

TEXT BOOKS:

1. Tiwari K.S. and Vishnoi N.K., "A Textbook of Organic Chemistry ", 3rd Edition, Vikas Publishing House, New Delhi, 2007.
2. Eric V. Anslyn and Dennis A. Dougherty, “Modern Physical Organic Chemistry”, University Science Books, 2006.

REFERENCE BOOKS:

1. Rajbir Singh, “Physical Organic Chemistry”, Mittal Publications, 2002.
2. Felix A. Carroll, “Perspectives on Structure and Mechanism in Organic Chemistry”, John Wiley & Sons, 2011.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: apply the principles of phase rule and phase equilibria to different eutectic systems

CO2: comprehend the principles of kinetics and thermo chemistry for application to reactor design

CO3: grasp the principles of catalysts and colloids for their application to different unit operations/processes

CO4: understand the structure and industrial applications of carbohydrates and amino acids

CO5: understand and apply the different reaction mechanisms to chemical processes

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT33 FLUID MECHANICS

3 1 0 4

UNIT – I **9**

Fluid Properties and Statics: Nature of fluids - properties of fluids; Types of fluids-Newtonian and Non-Newtonian fluids, Compressible and incompressible fluids; Hydrostatic equation and its applications; Pressure measurement - Manometers; Units and Dimensions; Dimensional analysis - types and principles of Similarity.

UNIT – II **9**

Principles of Fluid Flow: Types of flow – laminar and turbulent flow in pipes and closed channels; Equation of Continuity; shear stress distribution; friction factors; Moody Chart; Bernoulli's equation and applications; Introduction - Boundary layer concept.

UNIT – III **9**

Flow Past Immersed Bodies: Drag- types, drag coefficient, friction factor for flow through beds of solids, applications to packed and fluidized beds; packing materials; determination of pressure drop using Ergun equation, Fluidization-types, determination of minimum fluidization velocity and pressure drop**;** Motion of particles through fluids – calculation of terminal settling velocity.

UNIT – IV **9**

Metering of Fluids: Classification and selection of flow meters; variable head and variable area meters: venturi, orifice and rotameters; determination of discharge and discharge coefficient; Pitot tube; Anemometer; Introduction to notches and weirs; Other types: turbine, Coriolis, Vortex and Magnetic flow meters.

UNIT – V **9**

Transportation of Fluids: Classification of fluid moving machinery; Centrifugal pump-characteristics and applications; elementary principles of Reciprocating, gear, air lift, diaphragm and submersible pumps; Introduction to valves and pipe fittings.

Lecture:45, Tutorial:15, TOTAL:60

TEXT BOOKS:

1. McCabe W.L., Smith J.C. and Harriot P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw Hill International Edition, New York, 2006.
2. Noel de Nevers, "Fluid Mechanics for Chemical Engineers", 3rd Edition, McGrawHill, New York, 2004.

REFERENCE BOOKS:

1. Cengel, Yunus and Cimbala John M, " Fluid Mechanics Fundamentals and Applications", 2nd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2006.
2. Munson B.R., Young D.F., Okiishi T.H. and Huebsch W.W., "Fundamentals of Fluid Mechanics", 6th Edition, Wiley India, New Delhi, 2010.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the types and nature of different fluids; Apply the principles of dimensional analysis/ similitude for engineering applications

CO2: grasp the fluid flow phenomena for calculating pressure drop in pipelines; Understand the boundary layer theory

CO3: analyze the flow of fluid past immersed bodies for application to packed and fluidized beds

CO4: understand and identify applications of flow measuring devices in process industries

CO5: appreciate the characteristics and applications of fluid moving machinery and pipe fittings

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT34 CHEMICAL PROCESS CALCULATIONS

3 1 0 4

UNIT – I **9**

Units and Dimensions: Fundamental Concepts: Basic and derived units, use of different system of units in process calculations. Methods of expression- compositions of mixtures and solutions. Ideal and real gas law: Calculations of pressure, volume and temperature using Ideal and Van der Waals equation. Use of partial pressure and pure component volume in gas mixture calculations – Raoult's law and Henry's law.

UNIT – II **9**

Material Balance (without chemical reaction): Stoichiometric principles, Application of material balance to unit operations - distillation, evaporation, crystallization, drying, extraction and mixing/blending. Humidification and Dehumidification**:** Basic concepts - Calculation of absolute, molal, relative and percentage humidities –use of Psychrometric chart.

UNIT – III **9**

Material Balance (with chemical reaction): Material balance for the systems involving chemical reaction - Limiting and excess reactants – yield and selectivity. Bypass, recycle and purging.

UNIT – IV **9**

Energy Balance: Heat capacity of solids, liquids, gases and solutions, evaluation of enthalpy. Heat of reaction, formation, combustion, solution and mixing. Effect of pressure and temperature on heat of reaction.

UNIT – V **9**

Combustion: Fuels and combustion; Calculation of theoretical and excess air from combustion of solid, liquid and gaseous fuels. Composition of flue gases by Orsat analyzer.

Lecture:45, Tutorial:15, TOTAL:60

TEXT BOOKS:

1. Himmelblau D.M., "Basic Principles and Calculations in Chemical Engineering", 8th Edition, Prentice Hall of India, New Delhi, 2013.
2. Venkataramani V. and Anantharaman N. and Sheriffa Begam K.M., "Process Calculations", 2nd Edition, Prentice Hall of India, New Delhi, 2011.

REFERENCE BOOKS:

1. Hougen O.A., Watson K. M. and Ragatz R. A., "Chemical Process Principles. Part I. Material and Energy Balances", 2nd Edition, John Wiley & Sons, New York, 1956.
2. Bhatt B.L and Vora S.M., "Stoichiometry", 4th Edition, Tata McGraw Hill Publishing Company, New Delhi, 2004.

COURSE OUTCOMES

On completion of the course the students will be able to

- CO1: understand and apply different systems of units and dimensions, calculate compositions of mixtures/solutions and determine pressure, volume and temperature of gases using equations of state
- CO2: apply the law of conservation of mass for different batch and continuous unit operations
- CO3: use the law of conservation of mass for unit processes and evaluate yield, conversion, recycle ratio /purge /bypass of chemical reactors
- CO4: comprehend and apply energy balances for reacting systems and understand the effect of temperature and pressure on heat of reaction
- CO5: determine the calorific values of fuels, analyze the combustion reactions and determine the theoretical air / excess air requirement

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHL31 APPLIED CHEMISTRY LABORATORY I

0 0 3 1

LIST OF EXPERIMENTS / EXERCISES:

1. Determination of Transition temperature
2. Determination of partition co-efficient
3. Simple Eutectic system
4. Kinetics of persulphate-iodide reaction
5. Freundlich adsorption isotherm.
6. Determination of relative viscosity of liquid
7. Acid hydrolysis of ester
8. Estimate the acid value and Iodine value of the given oil sample
9. Estimate the saponification value of oil
10. Determine the alkali content and fatty acid content in the given sample of soap
11. Estimate the amount of moisture content and mixed oxide in the given sample of cement
12. Analysis of coal
13. Determine the sucrose content in the given sample of sugar

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Lab Manual

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: determine the transition temperature and eutectic point of chemical mixtures

CO2: perform experiment to validate the Freundlich Adsorption Isotherm

CO3: conduct experiments to estimate the rate constant of different reactions

CO4: determine acid / iodine value of oils and alkali / fatty acid content of soaps

CO5: estimate the purity of sugar and moisture / mixed oxide content of cement

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHL32 FLUID MECHANICS LABORATORY

0 0 3 1

LIST OF EXPERIMENTS / EXERCISES:

1. Verifying Moody diagram for flow through straight pipe
2. Determination of loss coefficient of valves and pipe fittings
3. Verifying Moody diagram for flow through concentric pipes
4. Flow through helical coil
5. Determination of discharge coefficient of variable head flow meters
6. Calibration of variable area flow meter
7. Determination of velocity profile in Pitot tube
8. Determination of discharge coefficient of orifice meter for air flow
9. Determination of discharge coefficient of notch
10. Determination of discharge coefficient of orifice in open drum
11. Verifying Ergun equation for flow through packed column
12. Fluidization characteristics in liquid fluidized bed
13. Characteristics of centrifugal pump
14. Characteristics of reciprocating pump

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Lab Manual

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: determine the coefficient of discharge for venturi/ orifice meter, open drum orifice and v-notch

CO2: validate the Moody's diagram for flow through straight pipe/ concentric pipes and helical coil

CO3: assess the frictional loss coefficient for different valves and pipe fittings

CO4: appraise pressure drop through packed bed and estimate minimum fluidization velocity in fluidized bed

CO5: develop performance curves for centrifugal/ reciprocating pump

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14MAT41 NUMERICAL METHODS

(Common to Civil, EEE, EIE, ECE, CSE, IT, Chemical & Food Technology)

3 1 0 4

UNIT – I **9**

Solution to Algebraic and Transcendental Equations: Iteration method – Method of false position – Newton-Raphson method – Solution of linear system of equations – Direct methods: Gauss elimination method and Gauss - Jordan method – Iterative methods: Gauss Jacobi and Gauss – Seidel methods.

UNIT – II **9**

Interpolation: Interpolation with equal intervals: Newton's forward and backward difference formulae – Central difference interpolation formulae: Gauss forward and backward interpolation formulae – Interpolation with unequal intervals: Lagrange's interpolation formula – Newton's divided difference formula.

UNIT – III **9**

Numerical Differentiation and Integration: Differentiation using Newton's forward, backward and divided difference formulae – Numerical integration: Trapezoidal rule – Simpsons $1/3^{rd}$ rule – Double integrals using Trapezoidal and Simpson's rules.

UNIT – IV **9**

Numerical Solution of First order Ordinary Differential Equations: Single step methods**:** Taylor series method – Euler method – Modified Euler method – Fourth order Runge-Kutta method – Multi step methods: Milne's predictor corrector method – Adam's Bashforth method.

UNIT – V **9**

Solutions of Boundary Value Problems in PDE: Solution of one dimensional heat equation – Bender -Schmidt recurrence relation – Crank - Nicolson method – One dimensional wave equation – Solution of two dimensional Laplace equations – Solution of Poisson equation.

Lecture: 45, Tutorial: 15, TOTAL: 60

TEXT BOOKS:

1. Kandasamy P., Thilakavathy K. and Gunavathy K., "Numerical Methods", Reprint Edition, S.Chand & Co, New Delhi, 2014.
2. Veerarajan T., Ramachandran T., "Numerical Methods with Programming C", 2^{nd} Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2008.

REFERENCE BOOKS:

1. Balagurusamy E., "Numerical Methods", Reprint Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2007.
2. Jain M.K., Iyengar S.R.K. and Jain R.K., "Numerical Methods for Scientific and Engineering Computation", 6^{th} Reprint, New Age International Pvt. Ltd., New Delhi, 2014.
3. Sankara Rao K., "Numerical Methods for Scientists and Engineers", 3^{rd} Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
4. Gerald C.F. and Wheatley P.O., "Applied Numerical Analysis", 7^{th} Edition, Pearson Education, Asia, New Delhi, 2006.
5. Grewal B.S., "Numerical Methods in Engineering and Science", 9^{th} Edition, Khanna Publishers, 2007.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: know the various methods of solving algebraic and transcendental equations numerically

CO2: understand the concept of interpolation

CO3: gain knowledge on the concepts of numerical differentiation and integration

CO4: obtain the solution of ordinary differential equations numerically

CO5: apply various numerical techniques in solving complex partial differential equations

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT41 PROCESS ORGANIC SYNTHESIS

3 0 0 3

UNIT – I **9**

Nitration and Amination: Principle of Nitration-N-Nitro compounds and Nitration esters, industrial equipment and processes. Amination; methods – reduction and Ammonolysis. Catalytic reaction and manufacture of amino compounds.

UNIT – II **9**

Hydrogenation and Alkylation: Production and Properties of Hydrogen, Catalytic hydrogenation and Hydrogenolysis; Methanation and Fischer-Tropsch reactions. Types and Factors affecting alkylation, Industrial alkylation process.

UNIT – III **9**

Oxidation, Hydrolysis and Esterfication: Types of Oxidation reaction-Liquid-phase and Vapor-phase; Hydrolysis-processes and equipment. Esterification of organic and inorganic acids-applications in chemical industries.

UNIT – IV **9**

Halogenation, Sulfonation and Sulfation: Halogenation- Chlorination reaction; Sulfonation and sulfation; Desulfonation reactions.

UNIT – V **9**

Dye and Drug Synthesis: Synthesis of Dyes - Congo red. Triphenylmethane dyes -Malachite green, Para Rosaniline, Alizarin, Eosin; Drug Synthesis - Sulphanilamide, Sulphapyrindine, Chloroquinine, penicillin, erythromycin.

TOTAL: 45

TEXT BOOKS:

1. Groggins P.H., "Unit Processes in Organic Synthesis", 5th Edition (Reprint), McGraw Hill International Co., 2007.
2. Austin G.T., "Shreve's Chemical Process Industries" 5th Edition (Special Reprint Edition), McGraw Hill International Co., 2005.

REFERENCE BOOKS:

1. Tiwari K.S. and Vishnoi N.K., "A Textbook of Organic Chemistry ", 3rd Edition, Vikas Publishing House, New Delhi, 2007.
2. Graham Solomons T.W., Craig B. Fryhle and Scott A. Snyder, " Organic Chemistry ", 11th Edition, International Student Version, John Wiley & Sons Inc., New York, 2013.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand and apply nitration and animation processes in chemical process industries

CO2: comprehend the principles of hydrogenation and alkylation in chemical industries

CO3: analyze oxidation, hydrolysis and esterification processes in chemical engineering practices

CO4: appreciate the reaction mechanicsms of halogenation and sulfonation processes

CO5: understand the synthesis of important dyes and drugs

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT42 PROCESS HEAT TRANSFER

3 1 0 4

UNIT – I **9**

Conduction: Nature and Modes of heat transfer. Concept of heat conduction - Fourier's law, thermal conductivity of materials, one dimensional steady state heat conduction equation for flat plate, hollow cylinder, and hollow sphere, Heat conduction through a series of resistances. Relationship between Individual and overall heat transfer coefficients; critical thickness of insulation; fundamental concepts in extended surfaces heat transfer; Transient heat conduction.

UNIT – II **9**

Convection: Natural and forced convection – Application of dimensional analysis for convection and dimensionless numbers, Reynolds and Colburn analogy – jH factor, Equations for forced convection under laminar and turbulent flow conditions in pipes, Equations for natural convection in vertical plates and vertical and horizontal cylinders.

UNIT – III **9**

Radiation: Concept and nature of thermal radiations - Concept of Black and grey bodies; Stefan Boltzmann, Kirchhoff's, Planck's and Wien laws; Radiation between surfaces – configuration factor; radiation shield.

UNIT – IV **9**

Heat Transfer with Phase Change: Introduction to boiling and condensation, condensers-vertical and horizontal types, Evaporator- Types and method of feed - steam economy and surface area calculations for single effect evaporator.

UNIT – V **9**

Heat Exchangers: Types of heat exchangers; LMTD; use of correction factor charts; Fouling factors; surface area calculations for double pipe and shell and tube heat exchangers; effectiveness and number of transfer units - Wilson's plot.

Lecture:45, Tutorial:15, TOTAL: 60

TEXT BOOKS:

1. McCabe W.L., Smith J.C. and Harriot P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw Hill International Edition, New York, 2006.
2. Yunus A.Cengel., "Heat Transfer: A Practical Approach", 2nd Edition, McGraw Hill, 2003.

REFERENCE BOOKS:

1. Dutta Binay K., "Heat Transfer Principles and Applications", Prentice Hall of India, New Delhi, 2001.
2. Coulson J.M. and Richardson J.F., "Chemical Engineering", Volume I, 4th Edition, Asian Books Pvt. Ltd., 1998.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the principles of conduction heat transfer for different applications

CO2: demonstrate the knowledge of convective heat transfer for different applications in chemical industries

CO3: exhibit familiarity in radiation heat transfer

CO4: understand the boiling and condensation processes for thermal design of evaporators and condensers

CO5: design and assess the performance of various heat exchangers

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT43 MECHANICAL OPERATIONS

3 0 0 3

UNIT – I **9**

Characteristics and Handling of Particulate Solids: Particulate solids-characteristics and size analysis, agglomeration and segregation; Methods of handling, transportation and storage of solids.

UNIT – II **9**

Size Reduction: Laws, methods and equipment; Screening- equipment and effectiveness.

UNIT – III **9**

Mechanical Separations: Principles and equipment for gravity settling, sedimentation, thickening, and centrifugal separation; flotation, electrostatic and magnetic separators.

UNIT – IV **9**

Filtration: Theory of filtration, constant pressure and constant rate filtration, batch and continuous filters, centrifuges; Selection of filters.

UNIT – V **9**

Agitation and Mixing: Principles, types and equipment for mixing; Impellers, power requirement for mixing of Newtonian liquids; Mixers for powders and pastes.

TOTAL: 45

TEXT BOOKS:

1. McCabe W.L., Smith J.C. and Harriot P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw Hill International Edition, New York, 2006.
2. Coulson J.M. and Richardson J.F., "Chemical Engineering", Volume II, 5th Edition, Asian Books Pvt. Ltd., 2002.

REFERENCE BOOKS:

1. Alan S Foust, "Principles of Unit Operations", 2nd Edition, Wiley International Edition, 1965.
2. Badger Walter L. and Banchero Julius T., "Introduction to Chemical Engineering", Tata McGraw Hill Publishing Company, New Delhi, 21st Reprint 2008.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: demonstrate the knowledge of size analysis, handling and transportation of solids in chemical process industries

CO2: exhibit the knowledge of size reduction and screening operations

CO3: understanding the principles and applications of mechanical separation equipments

CO4: understand the principles of filtration and centrifugation

CO5: recognize mixing and agitation equipments

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT44 PROCESS THERMODYNAMICS

3 1 0 4

UNIT – I **9**

Laws of Thermodynamics: Basic concepts; Zeroth law; First Law - applications to non-flow and flow processes; Second Law - heat engines, Carnot cycle and theorem, Entropy calculations; Third Law of thermodynamics.

UNIT – II **9**

Properties of Real Gases and Thermodynamics Formulations: PVT behaviour of fluids - compressibility factor, two- and three-parameter theorems of corresponding states; Equation of states – Virial, van der Waals, Redlich-Kwong and Peng-Robinson equations; Basic energy relations; Maxwell relations.

UNIT – III **9**

Properties of Solutions: Partial molar properties; chemical potential; fugacity and activity coefficients; Gibbs-Duhem equation; enthalpy, entropy and Gibbs free energy changes in mixing of ideal solution.

UNIT – IV **9**

Phase Equilibria: Phase equilibrium and stability; criteria for equilibrium between phases in single and multi-component non-reacting systems; vapour-liquid equilibrium of binary ideal and non-ideal solutions; azeotropes; Raoult's law and Henry's law; P-x-y and T-x-y diagrams using Antoine equations.

UNIT – V **9**

Chemical Reaction Equilibria: Criteria of equilibrium; standard free energy change and reaction equilibrium constant; effect of temperature and pressure on reaction equilibrium constant; homogeneous chemical reactions - thermodynamic analysis and prediction of equilibrium compositions.

Lecture:45, Tutorial:15, TOTAL: 60

TEXT BOOKS:

1. Smith J.M., Van Ness H.C. and Abbot M.M., "Introduction to Chemical Engineering Thermodynamics", 7th Edition, McGraw Hill, 2005.
2. Narayanan K.V., "A Text Book of Chemical Engineering Thermodynamics", Prentice Hall of India Pvt. Ltd., New Delhi, 2011.

REFERENCE BOOKS:

1. Rao Y.V.C., "Chemical Engineering Thermodynamics", University Press (India) Ltd., Hyderabad (A.P), India, 2004.
2. Kyle B.G., "Chemical and Process Thermodynamics", 3rd Edition, Prentice Hall of India, New Delhi, 1999.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: apply laws of thermodynamics for various systems and processes

CO2: understand the PVT behavior of gases; Evaluate Energy and Maxwell relations

CO3: comprehend the properties of solutions for various applications

CO4: apply phase equilibria for different chemical systems; Comprehend the VLE for different applications

CO5: apply chemical reaction equilibria for homogeneous chemical reactions

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT45 MATERIALS OF CONSTRUCTION FOR PROCESS INDUSTRIES

3 0 0 3

UNIT – I **9**

Iron and its Alloys: Materials- types and properties; Iron carbide phase diagram. Pig, cast and wrought iron, steels - properties and application in chemical industries; deformation of metal- recovery and recrystallization.

UNIT – II **9**

Stainless Steels: Special steels and alloys-grades, general criterion of selection of material of construction in process industries and its applications.

UNIT – III **9**

Non Ferrous Metals: Nickel, Aluminium, Copper, Chromium, Lead, Titanium, Zinc, magnesium and their alloys; applications in process industries.

UNIT – IV **9**

Organics and Composites: Polymers, Resins, Composites, Refractories, Glass, Wood, Rubber, Silicones and Carbon as material of construction in chemical process industries.

UNIT – V **9**

Materials for Special Applications: Metallic glasses and oxides for high temperature applications; Bio materials- bio ceramics and polymers; materials for biomedical, space and cryogenics; Introduction to Sour service.

TOTAL: 45

TEXT BOOKS:

1. James A. Lee, " Materials of Construction for Chemical Process Industries", Mc Graw Hill, 1950.
2. Frank Rumford, "Chemical Engineering Materials", Nabu Press, 2013.

REFERENCE BOOKS:

1. Agrawal B.K., "Introduction to Engineering Materials", Tata McGraw Hill, 1988.
2. Donald Askeland and Wendelin Wright., "Essentials of Materials Science and Engineering, SI Edition", 3rd Edition, Cengage Learning, 2013.
3. Clauster Henry R., "Industrial and Engineering Materials", McGraw Hill, 1975.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the properties of Iron and its alloys for application in chemical industries

CO2: understand different grades of Stainless Steel; Develop criterion for selection of materials for process industries

CO3: gain an insight into the properties of non ferrous metals and their alloys for applications in chemical industries

CO4: appreciate the importance of organic and composite materials as materials of construction

CO5: demonstrate the knowledge of specialty and bio materials for High temperature, space and cryogenic applications

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

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHL41 APPLIED CHEMISTRY LABORATORY II

0 0 3 1

LIST OF EXPERIMENTS / EXERCISES:

1. Determination of carbohydrates from unknown organic compounds
2. Identification of acids from unknown organic compounds
3. Determination of ester from unknown organic compounds
4. Estimation of amine from unknown organic compounds
5. Determination of flash point and fire point of mineral oil
6. Estimate the amount of nitrogen in urea by Kjeldahls method
7. Estimate the ions present in given solution using UV-Visible Spectrophotometer
8. Determine the amount of sodium and potassium ions present in water using flame Photometer
9. Polarimetry-inversion of cane sugar
10. Turbidity and colour of wastewater
11. Separation of mixtures of organic compounds using column chromatography
12. Preparation of meta di-nitro benzene from nitro benzene
13. Preparation of benzoic acid from ethyl benzoate
14. Preparation of benzoic acid from benzaldehyde
15. Estimation of phenol by Winklers methods

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Lab Manual

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: estimate the turbidity of water using Nephelometer

CO2: determine the Nitrogen content of Urea

CO3: exhibit familiarity with UV Spectrophotometer and Flame Photometer to estimate the ions in solutions

CO4: prepare m-Dinitrobenzene and Benzoic Acid from organic chemicals

CO5: identify the nature and functional groups of organic compounds

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHL42 MECHANICAL OPERATIONS LABORATORY

0 0 3 1

LIST OF EXPERIMENTS / EXERCISES:

1. Determination of the crushing law constants using Jaw crusher
2. Determination of the Reduction ratio using crushing rolls
3. Determination of the critical speed of ball mill
4. Determination of the average particle size using size analysis and finding the effectiveness of Screen
5. Determination of the particle size distribution and the average particle size using Beaker decantation
6. Determination of the specific cake resistance and filter medium resistance using filter press
7. Determination of the specific cake resistance and filter medium resistance using leaf filter
8. Determination of the separation efficiency of cyclone separator
9. Carrying out the batch sedimentation test and to design a thickener
10. Determination of the specific surface area of the given powder using air elutriator
11. Determination of the specific cake resistance and filter medium resistance using rotary drum filter
12. Determination of power for liquid agitator
13. Determination of the specific cake resistance and filter medium resistance using Basket Centrifuge
14. Determination of the specific cake resistance and filter medium resistance using Froth flotation apparatus

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Lab Manual

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: analyze crushing characteristics, power requirements and constants of crushing laws using Jaw and Roll Crusher
CO2: determine the critical speed and assess work index by using Ball mill
CO3: estimate average particle size and specific surface area by conducting Sieve Analysis, Beaker Decantation and Air Permeability experiments
CO4: estimate specific cake and filter medium resistance using Filter press and Leaf filter
CO5: eevelop design for a thickener using batch sedimentation data and assess the efficiency of Cyclone separator

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT51 MASS TRANSFER I

3 1 0 4

UNIT – I **9**

Diffusion: Molecular and eddy diffusion in gases and liquids-steady state diffusion under stagnant and laminar flow conditions-Diffusivity measurement and prediction-multi component diffusion- diffusion in solids and its applications.

UNIT – II **9**

Interphase Mass Transfer: Individual mass transfer coefficients-Relationship between individual and overall mass transfer co-efficient - Theories of mass transfer-mass transfer in laminar and turbulent flow. Analogies: Reynolds, Chilton-Colburn and Taylor – Prandtl analogy. Co-current and counter-current operations-Equilibrium and operating line concept-Operating characteristics of stage wise and differential contactors-NTU and HTU concept.

UNIT – III **9**

Humidification: Basic concepts and terminologies-Adiabatic saturation process and theory of wet bulb temperature-psychometric chart for Humidification and dehumidification calculations-Cooling towers-Principle and design.

UNIT – IV **9**

Drying: Theory and mechanism of drying-drying characteristics of materials-batch and continuous drying-calculation for continuous drying-various drying equipments and their applications.

UNIT – V **9**

Crystallization: Principles of crystallization-super saturation-theory of homogeneous and heterogeneous nucleation-law of crystal growth and growth coefficients-Calculations involving material and energy balances-Methods of crystallization based on super saturation and industrial equipment.

Lecture:45, Tutorial:15, TOTAL: 60

TEXT BOOKS:

1. Treybal Robert E., "Mass Transfer Operations", 3rd Edition, McGraw-Hill Book Company, 1980.
2. McCabe W.L., Smith J.C. and Harriot P., "Unit Operations in Chemical Engineering", 7th Edition, McGraw-Hill International Edition, New York, 2006.

REFERENCE BOOKS:

1. Anantharaman N. and Meera Sheriffa Begum K.M., "Mass Transfer: Theory and Practice", Prentice Hall of India, New Delhi, 2011.
2. Welty J.R., Wilson R.E. and Wicks C.E., "Fundamentals of Momentum Heat and Mass Transfer", 5th Edition, John Wiley, 2007.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend diffusional operations and theories of mass transfer

CO2: exhibit knowledge of analogy and characteristics of stage wise and differential contactors

CO3: grasp the principles of humidification/dehumidification and design cooling towers

CO4: gain an insight into the theory of drying and apply it to different drying equipments

CO5: appreciate the principles of crystallization and understand its industrial applications

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT52 CHEMICAL PROCESS INDUSTRIES

3 0 0 3

UNIT – I **9**

Introduction: The role of a Chemical Engineers in process industries-importance of block diagrams and flow charts-unit operations-unit processes-process utilities and economics.

UNIT – II **9**

Inorganic Chemical Industries: Manufacture of Sodium chloride, Soda ash, Sodium bicarbonate, Chlorine and Caustic soda, Bleaching powder-Hydrochloric, Sulfuric and Phosphoric acid-Ammonia and Nitric acid.

UNIT – III **9**

Fertilizer Industries: Plant nutrients, growth elements and regulators-Manufacture of ammonia based fertilizers, single and triple super phosphate, ammonium phosphate-Chloride, nitrate and phosphate of Potassium-Compound and bio-fertilizers.

UNIT – IV **9**

Starch, Oil and Detergent Industries: Manufacture of pulp and paper-Raw and refined sugar- Starch, Cellulose and their derivatives-Oil, fats and their extraction methods-Hydrogenation of oils- Soaps and detergents.

UNIT – V **9**

Petroleum and Allied Industries: Petroleum refining-Physical and chemical conversion products- Polymerization processes-Manufacture of Nylons, ABS, Viscose Rayon, Cellulose Acetate, PVC, Polyesters-Natural and Synthetic rubbers.

TOTAL: 45

TEXT BOOKS:

1. Austin G.T., "Shreve's Chemical Process Industries", 5th Edition, McGraw-Hill International Book Company, Singapore, 2012.
2. Gopala Rao M. and Marshall Sittig, " Dryden's Outlines of Chemical Technology", 3rd Edition, East-West Press, New Delhi, 2008.

REFERENCE BOOKS:

1. Mark W.V. and Bhatia S.C., "Chemical Process Industries", Volume - I and II, 2nd Edition, CBS Publishers and Distributors, New Delhi, 2007.
2. Kent J.A., "Riggel's Hand Book of Industrial Chemistry", Van Nostrant Reinhold, 1974.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: appreciate the role of chemical engineers in process industries and develop block diagrams and flow charts for manufacture of different chemicals

CO2: comprehend the unit operations/ processes in chloroalkalies, nitrogen, sulphur and phosphorous industries

CO3: gain knowledge about fertilizer and bio-fertilizer industries

CO4: develop familiarity with the chemical technology aspects of wood chemicals, oils, fats/ soap manufacturing units

CO5: gain insight into the manufacturing principles of petroleum/ petrochemical products, fibers, plastics and rubber industries

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT53 CHEMICAL REACTION ENGINEERING

3 1 0 4

UNIT – I **9**

Elements of Reaction Kinetics: Classification of chemical reactions, rate equation, Reaction Mechanism –elementary and non- elementary reaction; Temperature dependency- Arrhenius law, collision theory and transition theory. Analysis of experimental reactor data: Integral and differential method, constant and variable volume batch reactor, Integral rate equation for different order reactions.

UNIT – II **9**

Ideal Reactors: Performance equations for Batch, Semi-batch and steady state flow reactors.

UNIT – III **9**

Design for Single and Multiple Reactions: Size comparison of Single reactors, multiple reactor system, Reactions in Parallel and Series, Yield and Selectivity. Recycle reactor, Autocatalytic reactions

UNIT – IV **9**

Non Ideal Flow: Residence time distribution studies; models for non-ideal flow- dispersion and tanks-in-series; conversion in non-ideal reactors.

UNIT – V **9**

Introduction to Heterogeneous Reactions (Qualitative treatment only): Catalysts- types, preparation and deactivation; Industrial reactors-fixed, fluidized, trickle bed and air lift reactors.

Lecture: 45, Tutorial: 15, TOTAL: 60

TEXT BOOKS:

1. Levenspiel O., "Chemical Reaction Engineering", 4th Edition, Wiley India Pvt. Ltd., New Delhi, 2009**.**
2. Fogler H.S., "Elements of Chemical Reaction Engineering", 4th Edition, Prentice Hall of India, New Delhi, 2008.

REFERENCE BOOKS:

1. Smith J.M., "Chemical Engineering Kinetics", 3rd Edition, McGraw-Hill, New York, 1981.
2. Scott Fogler H., "Essentials of Chemical Reaction Engineering", 1st Edition, Prentice Hall of India, 2010.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: gain insight into reaction kinetics, formulate rate equation and analyze batch reactor data

CO2: understand the ideal reactor concepts and to develop the performance equation to evaluate conversion and space time

CO3: design reactor systems for single and multiple reactions and compute their yield and selectivity

CO4: comprehend different models of non ideal reactors; Perform RTD analysis to calculate conversion

CO5: understand the principles of catalysis and industrial catalytic reactors

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT54 CHEMICAL PROCESS PLANT SAFETY AND HAZARD ANALYSIS

3 0 0 3

UNIT – I **9**

Safety Principles: Need for safety, Safety programs, Training & Education, Design for ventilation; Personal protective Equipments. Safety codes: NFPA, IS and OSHA standards; colour codes for pipe lines. Materials Safety Data sheets; safety in storage and handling of chemicals.

UNIT – II **9**

Hazards: Hazards- fire, explosion and radiation; Designs to prevent fires and explosions; relief and relief sizing. Occupational diseases - effects.

UNIT – III **9**

Safety in Operations and Processes: Safety in operations and processes. Runaway reactions, unstable products; Safety Studies – HAZOPS, HAZANS, Fault tree, Event tree and risk analysis.

UNIT – IV **9**

Industrial Accidents: Industrial accidents –types, nature/effects, causes, costs, prevention, investigation and analysis, accident proneness, case studies.

UNIT – V **9**

Legal Aspects: Factories act, ESI act and Workmen's compensation act, Role of Government, safety organizations, management and trade unions in promoting industrial safety. Emergency response systems for hazardous goods basic rules and requirements which govern the chemical industries.

TOTAL: 45

TEXT BOOKS:

1. Fawcett H.H. and Wood W.S., "Safety and Accident Prevention in Chemical Operation", 2nd Edition, Interscience, 1982.
2. Gupta A.K., "Industrial Safety and Environment", 2nd Edition Reprint 2009.

REFERENCE BOOKS:

1. William H., "Industrial Safety Handbook", 2nd Edition, McGraw Hill, 1968.
2. "Loss Prevention and Safety Promotion in Chemical Process Industries", Vol. I, II, III Published by Institution of Chemical Engineers U.K., 1983.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: demonstrate the applications of plant safety standards, codes and MSDS in handling and storage of chemicals

CO2: analyze chemical, fire, explosion hazards and to understand the causes of occupational diseases

CO3: perform safety studies like HAZOP, HAZAN, Fault Tree analyses for different process and equipments

CO4: elucidate the causes, costs and prevention techniques for accidents

CO5: gain the knowledge of legal aspects of safety and the role of different agencies in promoting safety

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT55 CHEMICAL EQUIPMENT DESIGN I

3 1 0 4

UNIT – I **9**

Basic Design: Basic design and drawing considerations of machine elements (bolts, nuts), PFD- Flow sheet presentation- computer aided flow sheets, PID-Mechanical design of piping systems and piping design

UNIT – II **9**

Heat Exchangers: Design of Heat Exchangers (Shell and tube & Double pipe) - Construction details- mean temperature difference-fouling factors. Heat transfer coefficient -individual and overall coefficient. Pressure drop – shell side and tube side.

UNIT – III **9**

Evaporators: Design of single effect Evaporators- Introduction- selection of evaporators- capacity and steam economy- downtake design- tube sheet area- diameter, length and area of evaporator.

UNIT – IV **9**

Crystallizers and Centrifuge: Design of Crystallizers- Introduction – classification – yield of crystals – wash liquor requirement – length of crystallizer. Design of centrifuge – Classification of centrifuges- separating power- capacity factor- critical speed of rotation- minimum wall thickness of bowl.

UNIT – V **9**

Pressure Vessel, Storage Vessel and Tall Columns: Pressure vessel-Introduction – codes and standards- theories of failure- design of thin walled vessels under internal pressure- design of vessels under combined loading; Design of storage vessel and tall columns

Lecture:45, Tutorial:15, TOTAL: 60

TEXT BOOKS:

1. Towler C. Gavin and Sinnott Ray, "Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design", 2nd Edition, Elsevier, 2008
2. Thakore S.B. and Bhatt B.I., "Introduction to Process Engineering and Design", 2nd Reprint, Tata McGraw-Hill Publishing Company Ltd., 2009.

REFERENCE BOOKS:

1. Sinnot R.K., "Chemical Equipment Design: Chemical Engineering", Volume - 6, 4th Edition, Elsevier- Butterworth, 2005.
2. Joshi M.V. and Mahajan V.V., "Process Equipment Design", 3rd Edition, Macmillan India Ltd., 1996.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: design machine elements ; Develop Process Flow Diagrams and Piping Instrumentation Diagrams

CO2: undertake thermal design of heat exchangers

CO3: perform the process design of evaporators

CO4: perform design calculations of crystallizers and centrifuges

CO5: understand the concepts involved in design of pressure vessel, storage vessel and tall columns

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHL51 PROCESS HEAT TRANSFER LABORATORY

0 0 3 1

LIST OF EXPERIMENTS:

1. Estimation of individual and overall heat transfer coefficient for heat transfer in Packed Column
2. Determination of Stefan Boltzmann constant using Stefan Boltzmann experiment
3. Estimation of unsteady state temperature values using transient heat conduction experiment- constant flux and constant temperature
4. Estimation of individual heat transfer coefficient under forced convection heat transfer
5. Estimation of individual heat transfer coefficient under natural convection heat transfer
6. Studies on radiation heat transfer
7. Estimation of individual and overall heat transfer coefficient for heat transfer in shell and tube heat exchanger
8. Estimation of individual and overall heat transfer coefficient for heat transfer in double pipe heat exchanger
9. Estimation of individual heat transfer coefficient and fin efficiency for heat transfer through extended surface
10. Estimation of steam economy and efficiency of an evaporator
11. Heat transfer studies in pool boiling
12. Estimation of individual heat transfer coefficient for heat transfer through horizontal and vertical condenser
13. Estimation of individual and overall heat transfer coefficient for heat transfer in jacketed vessel
14. Estimation of thermal conductivity of a material

TOTAL: 45

REFERENCES / MANUALS / SOFTWARE:

1. Lab Manual

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: determine Stefan Boltzmann constant at different temperatures

CO2: assess the heat transfer coefficient for natural and forced convection systems, double pipe heat Exchanger, shell and tube heat exchanger, condensers and jacketed vessel

CO3: develop temperature profile for transient heat conduction system

CO4: evaluate the convective and radiative heat transfer coefficients

CO5: appraise the fin efficiency and estimate the steam economy in an evaporator

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHL52 CHEMICAL REACTION ENGINEERING LABORATORY

0 0 3 1

LIST OF EXPERIMENTS:

1. Kinetic Studies in a Batch reactor
2. Kinetic Studies in a Plug flow reactor
3. Kinetic studies in a Mixed flow reactor
4. Kinetic Studies in a PFR followed by CSTR
5. Kinetic studies in an Adiabatic reactor
6. Determination of conversion in Semi batch reactor
7. Determination of effect of Temperature on reaction rate constant
8. RTD studies in a Plug flow Reactor
9. RTD studies in a Mixed flow Reactor
10. RTD Studies in CSTR in Series
11. RTD studies in a Packed bed reactor
12. RTD studies in a Fluidized bed reactor
13. Determination of Surface Area by BET method

TOTAL: 45

REFERENCES / MANUALS / SOFTWARE:

1. Lab Manual

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: determine the order, rate constant and conversion in batch semi batch reactors

CO2: estimate the order, rate constant and conversion in plug flow, mixed flow and combined reactors

CO3: determine the effect of temperature on rate of reaction to validate Arrhenius equation

CO4: perform RTD studies in plug flow, mixed flow and combination of reactors

CO5: assess the flow characteristics in Packed/ Fluidized bed reactors

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14EGL41 COMMUNICATION SKILLS LABORATORY

(Common to all Engineering and Technology branches)

0 0 3 1

LIST OF EXPERIMENTS:

1. Listening Skills: Listening activity using software package in the communication laboratory - Listening to native speakers - Developing oral communication by imitating the model dialogues. Listening for specific information – Listening to improve pronunciation – Listening and typing – Filling the blanks–TV programmes and News.

Audio Visual Lab: Activity based learning

2. Activity based Reading Skills: Reading for getting information and understanding; scanning, skimming and identifying topic sentences – Reading for gaining knowledge-Group activity.

3. Activity based Writing Skills: Preparing a draft – Word editing features, editing and proof reading; Writing a short essay using the draft prepared - Group activity.

4. Speaking Skills: Verbal and Non-Verbal Communication; Introducing oneself -Describing a place, Expressing views and opinions; Giving a presentation on a Topic - eye contact, speaking audibly, clearly and with confidence; Group discussion.Conversations – Face-to-Face conversation – Simulated Telephonic Conversation.

Career Lab

5. Interview Skills: Introducing oneself – Answering other FAQ's. Presentation Skills: Elements and structure of effective presentation – Presentation Tools – Voice modulation – Body language –Video samples. Group Discussion: Structure of Group Discussion – Strategies in group discussion - Team work – Video Samples. Soft Skills: Fundamentals of Soft Skills – Work Place Culture and Inter-Personal Relationships.

TOTAL : 45

REFERENCES / MANUALS / SOFTWARE:

1. Orell Digital Language Lab Software

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: communicate efficiently in English in real life and career related situations

CO2: demonstrate good presentation and team skills

CO3: familiarize in using modern communication software packages to enhance their soft skills

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14GET61 ECONOMICS AND MANAGEMENT FOR ENGINEERS

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Economics – Basics Concepts and Principles – Demand and Supply – Law of demand and Supply – Determinants – Market Equilibrium – Circular Flow of Economic activities and Income.

UNIT – II **9**

National Income and its measurement techniques. Inflation - Causes of Inflation – Controlling Inflation – Business Cycle. Forms of business – Management Functions: Planning, Organizing, Staffing, Leading and Controlling - Managerial Skills - Levels of Management - Roles of manager.

UNIT – III **9**

Marketing - Core Concepts of Marketing - Four P's of Marketing - New product development - Product Life Cycle - Pricing Strategies and Decisions.

UNIT – IV **9**

Operations Management - Resources - Types of Production system - Site selection, Plant Layout, Steps in Production Planning and Control - Inventory - EOQ Determination.

UNIT – V **9**

Accounting Principles – Financial Statements and its uses – Depreciation: Straight Line and Diminishing Balance Method – Break Even Analysis – Capital Budgeting: Meaning – Types of decisions – Methods (Theory).

TOTAL : 45

TEXT BOOK:

1. "Economics and Management for Engineers", Complied by Department of Management Studies, Kongu Engineering College, McGraw-Hill Education, India, 2013.

REFERENCE BOOKS:

1. Geetika, Piyali Ghosh and Purba Roy Choudhury, "Managerial Economics", 1st Edition, Tata McGraw-Hill, New Delhi, 2008.
2. Jeff Madura, "Fundamentals of Business", Cengage Learning Inc., India, 2007.
3. Stanley L. Brue and Campbell R. Mcconnell, "Essentials of Economics", Tata McGraw-Hill, New Delhi, 2007.
4. Jain S.P., Narang K.L. and Simi Agrawal, "Accounting for Management", 1st Edition, Tata McGraw-Hill, New Delhi, 2009.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: estimate market equilibrium and interpret national income calculation and inflation issues

CO2: categorize the forms of business and analyse the functions of management

CO3: appraise marketing management decisions

CO4: apply appropriate operation management concept in business situations

CO5: interpret financial and accounting statements

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT61 MASS TRANSFER II

3 1 0 4

UNIT – I **9**

Absorption: Choice of solvent, Co-current and counter-current operations, Kresmer Equation for plate tower, overall volumetric mass transfer coefficients; Equipment for gas absorption: Mechanically agitated vessels, Packed column and plate columns.

UNIT – II **9**

Distillation: Vapour-liquid equilibria, Raoult's law and deviations from ideality. Methods of distillation: Batch distillation-calculations using Rayleigh equation, Flash vaporization, Continuous fractionation- Fenske equation; fractionation of binary system.

UNIT – III **9**

Fractionation Analysis and other Methods of Distillation: Design calculations by McCabe-Thiele and Ponchon-Savarit methods; continuous contact distillation tower (packed tower) design. Steam, azeotropic, extractive and low pressure distillation.

UNIT – IV **9**

Adsorption: Characteristics and choice of adsorbents. Theories of adsorption of gases and liquids. Adsorption isotherms and breakthrough curve. Single and multiple cross current and counter current operation. Adsorption equipment for batch and continuous operation, Industrial applications.

UNIT – V **9**

Extraction and Leaching: Equilibrium in ternary systems; Solvent selection criteria; Single stage operation, Multistage operation for partially miscible and immiscible systems. Extraction equipment - spray, packed and mechanically agitated contactors, Pulsed extractors, centrifugal extractors. Solid-liquid equilibria; calculations in single stage, multi stage cross flow and counter current leaching, Leaching equipment-batch and continuous.

Lecture:45, Tutorial:15, TOTAL: 60

TEXT BOOKS:

1. Treybal Robert E., "Mass Transfer Operations", 3rd Edition, McGraw-Hill Book Company Ltd., 1980.
2. Wankat Philip C., "Equilibrium Staged Operations", Prentice Hall of India, 1988.

REFERENCE BOOKS:

1. Coulson J.M. and Richardson J.F., "Chemical Engineering", Volume I, Pergamon Press, 1977.
2. Geankopolis C.J., "Transport Processes and Separation Process Principles", 4th Edition, Prentice Hall of India, 2004.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: determine HTU and NTU for absorption column

CO2: explain the methods and perform the design of distillation equipment

CO3: analyze design parameters of distillation column

CO4: determine the adsorbent quantity for adsorption process and describe ion exchange concepts

CO5: calculate extraction efficiency for the extraction and leaching processes

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT62 PROCESS DYNAMICS AND CONTROL

3 1 0 4

UNIT – I **9**

Open Loop Control Systems: Introduction to process control. Review of Laplace transforms principles. Standard input functions, Open loop systems - transient response of first and second order systems. Transfer function for chemical reactors and dynamics. Linearization of nonlinear systems

UNIT – II **9**

Controllers and Final Control Elements: Controllers – Types and Transfer functions, final control elements, Principles of pneumatic and electronic controllers; Transportation lag; Feed-back control systems – concept and development of block diagrams.

UNIT – III **9**

Transient Response of Closed Loops: Transient response - Servo and regulator problems, offset calculations; criteria for stability – Routh test and root locus diagrams.

UNIT – IV **9**

Frequency Response Analysis of Closed Loops: Introduction to frequency response and control system design. Bode and Nyquist diagrams; Stability criterion, Phase and gain margin

UNIT – V **9**

Controller Tuning and Advance Control Systems: Tuning of controller settings – Ziegler-Nichols and Cohen-Coon methods; Advanced control systems: principle and applications - cascade, split-range, feed forward and ratio controls.

Lecture:45, Tutorial:15, TOTAL: 60

TEXT BOOKS:

1. Donald R. Coughanowr, Steven E. LeBlanc, "Process Systems Analysis and Control", 3rd Edition, Tata McGraw Hill Company Ltd., New Delhi, 2013.
2. Seborg D.E., Edgar D.F., Mellichamp D.A. and Doyle III F.J., "Process Dynamics and Control", 3rd Edition, Prentice Hall of India, 2011.

REFERENCE BOOKS:

1. Stephanopoulos S.G., "Chemical Process Control: An Introduction to Theory and Practice", Prentice Hall of India, New Delhi, 2011.
2. Bhagade Sudheer S. and Nageshwar Govind Das, "Process Dynamics and Control", Prentice Hall of India, New Delhi, 2011.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: gain knowledge of Open loop control systems and their responses to different input methods

CO2: comprehend the principles of controllers and control elements for different applications

CO3: gain familiarity with transient response of closed loops

CO4: understand frequency response and stability analyses

CO5: exhibit familiarity with controller timing procedures and advanced control strategies

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT63 CHEMICAL EQUIPMENT DESIGN II

3 1 0 4

UNIT – I **9**

Condensers and Reboilers: Design of Condensers- Different configuration – condensation outside horizontal tubes- condensation inside and outside vertical tubes- Heat transfer coefficient and pressure drop. Design of Reboilers- Choice of type- boiling heat transfer coefficient- Design of thermosyphon reboiler.

UNIT – II **9**

Reactors: Introduction to reactors- design of ideal reactors- ideal batch reactor, plug flow reactor and continuous stirred tank reactor. Design of commercial reactor- packed bed reactor design- calculation of pressure drop and weight of catalyst for the reaction.

UNIT – III **9**

Distillation Column: Introduction – continuous distillation – design variables- design methods for binary systems- Mc-cabe thiele method- column sizing.

UNIT – IV **9**

Absorption Column: Introduction – Height of packing required- prediction of height of transfer units- column diameter- absorption factor- number of plates.

UNIT – V **9**

Dryers: Introduction – rate of drying- time for drying- selection of dryers; Rotary dryer- length and diameter; Fluid bed dryer – area and diameter of disengagement zone and distributor grid.

Lecture:45, Tutorial:15, TOTAL: 60

TEXT BOOKS:

1. Walas, Stanley M., "Chemical Process Equipment Selection and Design", 3rd Edition, Butterworth - Heinemann, Boston, 2012.
2. Lloyd E. Brownell and Edwin H. Young, " Process Equipment Design", John Wiley and Sons

REFERENCE BOOKS:

1. Nicholas P. Cherimisinoff., "Handbook of Chemical Processing Equipment", Butterworth, 2000.
2. Uzimann, "Principles of Chemical Reactor Analysis and Design", 2nd Edition, John Wiley and Sons, 2009.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: develop thermal design of condensers and reboilers

CO2: perform design calculations for ideal and industrial reactors

CO3: perform the process design of distillation column

CO4: exhibit proficiency in design of absorption column

CO5: understand the concepts involved in design of dryers

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHL61 MASS TRANSFER LABORATORY

0 0 3 1

LIST OF EXPERIMENTS:

1. Determination of the diffusivity of the given liquid to air
2. Estimation of Mass transfer co-efficient using Wetted wall column
3. Conduction of batch drying test and estimation of the mass transfer coefficient and psychometric Ratio
4. Verifying the Raleigh's equation for the given system using simple distillation setup
5. Determination of the activity coefficients & Van Laar constant for the given system by performing VLE experiments
6. Determination of vaporization efficiency (E_v) and Thermal efficiency (E_t) of the given system using steam distillation apparatus
7. Estimation of Height Equivalent to a Theoretical Plate and find out % recovery of the overhead and bottom products of given system under total reflux conditions
8. Conduction of Simple /Co-current /Counter – current Leaching studies
9. Conduction of liquid liquid extraction studies and plot binodal curve for the given ternary system /Conduction of Liquid-liquid extraction studies in Rotating Disc Contactor
10. Studying the concept of Surface Evaporation and finding the constants of Himus Equation
11. Verifying adsorption isotherms by Batch Adsorption tests
12. Conduction of drying experiments using Vacuum Dryer
13. Mass transfer studies in Membrane Separations

TOTAL: 45

REFERENCES / MANUALS / SOFTWARE:

1. Lab Manual

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: determine diffusivity and mass transfer co-efficient for different systems like wetted wall column

CO2: generate vapour liquid equilibrium and liquid liquid equilibrium data for different systems by experimentation

CO3: evaluate the performance of Simple /Packed / Steam distillation units

CO4: appraise the performance of a simple leaching process

CO5: assess the performance of a batch drier; Estimate the Himus constant using surface evaporation apparatus

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHL62 PROCESS COMPUTATION LABORATORY

0 0 3 1

LIST OF EXPERIMENTS:

1. Estimation of the following by using spread sheet
   (a) Molecular weight, density, enthalpy of the reaction
   (b) Volume of a Van der Waals gas as a function of pressure and temperature
   (c) Behavior of ideal gas volume based on temperature and pressure changes
2. Estimation of the following by using spread sheet
   (a) Cell potential
   (b) H^+ ion for a given acid by successive approximation
3. Computing the following by using Newton- Raphson technique
   (a) Concentrations of all species
   (b) Solubility of solute in aqueous solution
4. Computing the free energy changes and equilibrium constant for the given reaction
5. Error calculation for given graphical representation using spread sheet
6. Linearization of given graphical data using spread sheet chart
7. Identification of the kinetics and rate of the given reaction
8. Identification of the total heat transfer area by using composite curve
9. Drawing of PFD and PID using CAD / MS office (Visio)
10. Design of Shell and Tube heat exchanger using MATLAB / C program
11. Design of Double pipe heat exchanger using MATLAB / C program
12. Design of Condenser using MATLAB / C program
13. Design of Single effect evaporator using MATLAB / C program
14. Estimation of WBT and DBT
15. Mass transfer studies using breakthrough curve

TOTAL: 45

REFERENCES / MANUALS / SOFTWARE:

1. Lab Manual

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: estimate the molecular weight, density, enthalpy of the reaction and cell potential using spread sheets
CO2: predict the concentration of species and solubility of solute in aqueous solutions using Newton Raphson method
CO3: determine the free energy changes and equilibrium constant for a given reaction
CO4: study the kinetics and rate of a reaction; Estimate heat transfer area using composite curve
CO5: apply MATLAB/ C program for design of shell and tube/ double pipe heat exchangers/ evaporators/ condensers

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14GET71 TOTAL QUALITY MANAGEMENT

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Quality (Basic concepts and principles) : Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs, Basic concepts of Total Quality Management, Historical Review. Principles of TQM, Leadership – Concepts, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

UNIT – II **9**

TQM Principles and strategies : Customer satisfaction – Customer Perception of Quality, Customer Complaints, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits. Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development

UNIT – III **9**

TQM Tools (Process Control): The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

UNIT – IV **9**

TQM Tools: Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA, Poka Yoke.

UNIT – V **9**

Quality Systems -Need for ISO 9000 and Other Quality Systems, ISO 9000:2008 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, Introduction to TS 16949, QS 9000, ISO 14000, ISO 18000, ISO 20000, ISO 22000.

TOTAL : 45

TEXT BOOKS:

1. Besterfield, Dale H. et al., "Total Quality Management", 3rd Edition (Revised), Pearson Education, 2011.
2. Subburaj Ramasamy, "Total Quality Management", Tata McGraw Hill, New Delhi, 2008.

REFERENCE BOOKS:

1. Feigenbaum A.V., "Total Quality Management", 4th Edition, Tata McGraw Hill, New Delhi, 2004.
2. Suganthi L. and Samuel A. Anand, "Total Quality Management", PHI Learning, New Delhi, 2011.
3. Evans James R. and Lindsay William M., "The Management and Control of Quality", 7th Edition, South-Western (Thomson Learning), 2011.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the meaning of quality and its importance

CO2: know the principles of total quality management and peculiarities of their implementation

CO3: develop in-depth knowledge on various tools and techniques of quality management

CO4: learn the applications of quality tools and techniques in both manufacturing and service industry

CO5: develop analytical skills for investigating and analyzing quality management issues in the industry and suggest implement able solutions to those

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT71 TRANSPORT PHENOMENA

3 1 0 4

UNIT – I **9**

Fundamentals of Transport Phenomena: Importance of Transport Phenomena; Analogous nature of transfer processes; Conservation laws; Newtonian and Non-Newtonian fluids- Rheological models; Transport properties of gases and liquids- theories, pressure and temperature effects.

UNIT – II **9**

Shell Momentum Balances and Velocity Distribution in Laminar Flow: Shell balance and boundary conditions; Momentum flux and velocity distribution in falling film, circular tube, annulus and two adjacent immiscible fluids; creeping flow around a Sphere. Equations of Continuity and Motion- solutions to flow problems.

UNIT – III **9**

Shell Energy Balances and Temperature Distributions in Solids and Laminar Flow: Heat Conduction with Electrical, Nuclear and Viscous Heat Sources; Heat Conduction - Composite Walls and Cooling Fin; Forced and Free Convection; Use of equations of change to solve heat transfer problems- tangential flow in an annulus with viscous Heat Generation and Transpiration cooling.

UNIT – IV **9**

Shell Mass Balance and Concentration Distributions in Solids and Laminar Flow: Diffusion - Stagnant Gas Film, Heterogeneous and Homogeneous Chemical Reactions, Falling Liquid Film (Gas Absorption); Diffusion and Chemical Reaction inside a Porous Catalyst.

UNIT – V **9**

Analogies of Transport Process: Development and applications of analogies between momentum, heat and mass transfer- Reynolds, Prandtl, Von Karman and Chilton-Colburn analogies.

Lecture: 45, Tutorial: 15, TOTAL: 60

TEXT BOOKS:

1. Bird R.B., Stewart W.E. and Lightfoot E.N., "Transport Phenomena", 2nd Edition, John Wiley & Sons, 2002.
2. Brodkey Robert S. and Hershey Harry C., "Transport Phenomena - A united approach", McGraw-Hill, 1988.

REFERENCE BOOKS:

1. Welty J.R., Wicks C. E. and Wilson R. E., "Fundamentals of Momentum, Heat and Mass Transfer", 5th Edition, John Wiley and Sons, 2007.
2. Fahien R.W., "Elementary Transport Phenomena", McGraw-Hill, New York, 1983.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the analogous nature of Transport processes; Gain insight about different rheological models and transport properties of fluids

CO2: apply the shell momentum balance approach to determine momentum flux and velocity distribution; understand equations of continuity and motion

CO3: use equations of change to solve heat transfer problems; Develop shell balance approach fo condensation and convection

CO4: develop solutions for homogeneous and heterogeneous chemical reactors by applying shell mass balance

CO5: analyze the analogy between the transport processes

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHT72 PROCESS MODELING AND SIMULATION

3 0 0 3

UNIT – I **9**

Introduction to Modeling: Physical, Mathematical and Chemical Systems Modeling; Principles of model Formulation; Representation of Model; Fundamental Laws; Types of Modeling Equations; Boundary Condition; Black Box Principles; Validation of Model and Application of Modeling and Simulation in Industries.

UNIT – II **9**

Models in Fluid Flow Operations: Laminar flow in a Pipe, Narrow Slit and Gravity Flow Tank, Flow of the film on the Outside of a Circular Tube, Annular flow with Inner Cylinder Moving Axially, Flow between Coaxial Cylinders and Concentric Spheres, Creeping Flow Between Two Concentric Spheres, Parallel Disc Viscometer

UNIT – III **9**

Models in Heat Transfer Operations: Steady state Heat Conduction Through a Hollow Cylindrical Pipe; Unsteady state Steam Heating of a Liquid; Two Heated Tanks; Counter Current Cooling of Tanks, Single-Component Vaporizer; Multicomponent Flash Drum; Double Pipe Heat Exchanger; Triple Effect Evaporator; Heat Transfer through extended surfaces(spine fin); Unsteady State Heat Transfer in a Tubular Gas Preheater.

UNIT – IV **9**

Models in Mass Transfer Operations: Multistage Absorption; Compartmental Distillation Model; Ideal Binary Distillation Column; Multicomponent Non Ideal Distillation Column; Batch Distillation with Holdup; Binary Continuous Distillation Column; Steady State Single and Multistage Extraction.

UNIT – V **9**

Models in Reaction Engineering and Introduction to Process Simulators: Batch Reactor; Chemical Reaction with Diffusion in a Tubular Reactor; Series of Isothermal, Constant-Holdup CSTRs; CSTRs with Variable Holdups; Gas-Phase Pressurized CSTR; Non Isothermal CSTR; Reactor with Mass Transfer; Gas Absorption Accompanied by Chemical Reaction. Introduction to Process Simulators like ASPEN PLUS and HYSYS.

TOTAL : 45

TEXT BOOKS:

1. Babu B.V., "Process Plant Simulation", Oxford University Press, New Delhi, 2004.
2. Luyben W.L., "Process Modeling, Simulation and Control for Chemical Engineers", 2nd Edition, McGraw Hill Book Company, New York, 1990.

REFERENCE BOOKS:

1. Gaikwad R.W. and Dhirendra, "Process Modeling and Simulation", 2nd Edition, Denett and Company, Nagpur, 2006.
2. Amiya K. Jana, "Chemical Process Modeling and Computer Simulation", Prentice Hall of India, 2014.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand modeling principles and applications of modeling and simulation in process industries

CO2: comprehend mathematical models for fluid flow operations

CO3: acclimatize with different models for heat transfer systems

CO4: gain knowledge of different models for mass transfer operations

CO5: gain insight into the models for reaction engineering; Exhibit familiarity about the process simulators like ASPEN PLUS and ASPEN HYSIS

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHL71 PROCESS SIMULATION LABORATORY

0 0 3 1

LIST OF EXPERIMENTS:

1. Estimation of physical property for a non data bank component
2. Analysis of physical properties and generation of T-x-y and P-x-y diagram for different systems
3. Calculation of Bubble Point and Dew Point Temperature/Pressure
4. Simulation of mixer and flash separator
5. Simulation of heat exchanger
6. Simulation of distillation column
7. Simulation of batch and flow reactors
8. Simulation and analysis of absorption/extraction column
9. Sensitivity analysis and optimization of parameters
10. Simulation and analysis of simple flow sheets problems
11. Simulation of drying of solids
12. Design of heat exchangers and air cooler

TOTAL: 45

REFERENCES / MANUALS / SOFTWARE:

1. Aspen Plus Software
2. HTRI Software

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: estimate the physical properties of chemicals using ASPEN software

CO2: calculate Bubble / Dew points of gas mixtures and generate T-x-y / P-x-y diagrams using ASPEN software

CO3: simulate the performance of mixers, flash separators, reactors, distillation/extraction/absorption colums

CO4: develop and analyze flow sheets for simple chemical processes

CO5: design and simulation of heat exchangers using ASPEN and HTRI softwares

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHL72 PROCESS DYNAMICS AND CONTROL LABORATORY

0 0 3 1

LIST OF EXPERIMENTS:

1. ON-OFF control of thermal, level, pressure and flow process
2. Study the servo problem with PI controller on thermal process
3. Performance comparison of P, PI, and PID controllers on flow control loop
4. Effectiveness study of P, PI, and PID controllers on level process
5. Behavioural evaluation of P, PI and PID Controllers on pressure control loop
6. Estimation of optimum controller settings
7. Verification of the flow coefficient and performance characteristics of various control valves
8. Study the response of interacting and non-interacting level systems
9. Simulation study on the characteristic behaviours of higher order systems using MAT LAB
10. Optimum controller tuning for shell and tube heat exchanger
11. Time constant evaluation of dynamic CSTR/thermometer/ manometer
12. Evaluation of Level/Flow/Pressure using DCS(Demonstration only)

TOTAL: 45

REFERENCES / MANUALS / SOFTWARE:

1. Lab Manual

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: study the response of On –Off, P, PI and PID controllers for level, pressure and flow process systems

CO2: evaluate the performance of P, PI and PID controllers in flow, pressure and thermal control loops

CO3: evaluate the response of simple first and second order system

CO4: assess the characteristics of different control valves

CO5: optimise controller settings for Shell and Tube heat exchanger; apply MATLAB simulation for higher order systems

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14GET81 PROFESSIONAL ETHICS AND HUMAN VALUES

(Common to all Engineering and Technology branches)

3 0 0 3

UNIT – I **9**

Understanding: Morals – Values-Ethics– Honesty – Integrity – Work Ethic – Service Learning – Civic Virtue – caring – Sharing – Courage – Valuing Time – Co-operation – Commitment – Empathy –Self-Confidence – Character – Spirituality- Senses of 'Engineering Ethics' - variety of moral issues - types of inquiry.

UNIT – II **9**

Moral dilemmas – moral autonomy – Kohlberg's theory – Gilligan's theory – consensus and controversy – Models of Professional Roles – theories about right action – Self-interest – customs and religion- uses of ethical theories. Meaning of Engineering experimentation - engineers as responsible experimenters.

UNIT – III **9**

Codes of ethics for engineers - a balanced outlook on law - the challenger case study. Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk, Bhobal Gas Tragedy and Chernobyl case studies.

UNIT – IV **9**

Collegiality and loyalty – respect for authority – collective bargaining – confidentiality – conflicts of interest – occupational crime – professional rights – employee rights – discrimination – Intellectual Property Rights (IPR) – Multinational corporations.

UNIT – V **9**

Environmental ethics - Computer ethics – weapons development-engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership-sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of Electronics and Telecommunication Engineers(IETE).

TOTAL : 45

TEXT BOOKS:

1. Martin Mike and Schinzinger Roland, "Ethics in Engineering", 4th Edtion, Tata McGraw-Hill, New Delhi, 2014.
2. Govindarajan M., Natarajan S., and Senthil Kumar V.S., "Engineering Ethics", Prentice Hall of India, New Delhi, Reprint 2013.

REFERENCE BOOKS:

1. Fleddermann Charles D., "Engineering Ethics", 4th Edition, Pearson Education/Prentice Hall, New Jersey, 2014.
2. Harris Charles E., Protchard Michael S. and Rabins Michael J., "Engineering Ethics: Concepts and Cases", 4th Edition Wadsworth Thompson Learning, United States, 2008.
3. Seebauer Edmund G. and Barry Robert L., "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2008.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the components of ethics and values

CO2: acquire knowledge on ethical theories and attain moral autonomy

CO3: highlight ethical issues in risky situation

CO4: understand the knowledge of interpersonal and organizational issues in ethics

CO5: understand the role of professional bodies as well to identify global issues concerned to ethics

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE01 OIL AND NATURAL GAS ENGINEERING

3 0 0 3

UNIT – I **9**

Occurrence and Exploration: Occurrence of petroleum: types of reservoirs; Exploration –Methods. Drilling and Production of crude and natural gas; types of rigs and platforms.

UNIT – II **9**

Natural Gas: Composition and properties, compression and liquefaction of natural gas; purification methods; Shale gas: occurrence, extraction and purification.

UNIT – III **9**

Storage and Transport: Storage and transportation of Natural gas; application in Chemical Process, Power generation, domestic, Industrial and transportation sectors.

UNIT – IV **9**

Applied Hydrodynamics in Oil Wells: Hydrodynamic equations for flow of fluids through porous media; PVT properties for oil gas systems; Multiphase flow correlations to determine flow ratio and pressure traverse in flowing oil wells

UNIT – V **9**

Regulatory Problems: Safety, environmental and economic aspects of oil and gas exploration, Oil Spill Management-Alaska and Gulf of Mexico case studies.

TOTAL: 45

TEXT BOOKS:

1. Katz Donald L. and Lee Robert L., "Natural Gas Engineering", McGraw Hill Publishing Company, New York, 1990.
2. Medici M.,"The Natural Gas Industry", Newnes-Butterworths, London, 1974.

REFERENCE BOOKS:

1. Econonides M.J. and Daniel A. "Petroleum Production Systems", Prentice Hall Petroleum Engineering Series, 2012.
2. William C Lyons, Gary C Plisga, "Standard Hand Book of Petroleum and Natural Gas Engineering", 2nd Edition, Gulf Professional Publishing, 2004.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the occurrence of petroleum, exploration and production techniques, types of rigs and platforms

CO2: comprehend natural/ shale gas occurrence, extraction and purification methods.

CO3: gain insight into storage, transportation and application of natural gas

CO4: examine the hydrodynamic equations for flow through porous media, PVT properties of gas and multiphase flow correlations

CO5: recognize safety, environment and economic aspects of oil/ gas exploration

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE02 BIOCHEMICAL ENGINEERING

3 0 0 3

UNIT – I **9**

Microbes and Microbial Kinetics: Classification of Microbes**;** Typical growth characteristics of microbial cells; immobilization techniques; Factors affecting growth; Monod model; Immobilized whole cells and their characteristics.

UNIT – II **9**

Enzymes and Enzyme Kinetics: Classification of Enzymes; Mechanism of enzymatic reactions; Michaelis-Menten kinetics; Enzyme Inhibition; Industrial Applications of Enzymes.

UNIT – III **9**

Fermentation and Sterilization: Requirements of fermentation process; Aerobic and Anaerobic fermentation Processes; Solid state and Submerged fermentation; Batch and Continuous Sterilization; Sterilization of Air; Effect of Sterilization on Quality of Nutrients.

UNIT – IV **9**

Transport in Microbial Systems: Theories of Diffusional Mass Transfer; Mass Transfer by Convection Measurement of KLa; Oxygen Transfer Methodology; Factors affecting Oxygen Transfer Rate.

UNIT – V **9**

Bioreactors: Classification based on feeding Mechanism- batch, continuous, fed batch reactors; Fluidized bed reactor, Immobilized cell rector, Air-Lift reactor. Downstream Processes: Suspended solids removal; Filtration; Sedimentation; Centrifugation; Cell disruption; Extraction; Membrane Separation; Chromatography; Crystallization and Drying

TOTAL: 45

TEXT BOOKS:

1. Bailey J.E., and Ollis D.F., "Biochemical Engineering Fundamentals", 2nd Edition, McGraw-Hill, International Edition, New York, 1986.
2. Blanch Harvey W., and Clark Douglas S., "Biochemical Engineering", 1st Edition, Marcel Dekker, Inc. New York, 1997.

REFERENCE BOOKS:

1. Aiba S., Humphrey A.E., and Millis N.F., "Biochemical Engineering", 2nd Edition, Academic Press, 1973.
2. Lee James M., "Biochemical Engineering", Prentice Hall, 1992.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend microbes and microbial kinetics and immobilization techniques

CO2: understand enzymes and enzyme kinetics for application in batch and continuous process

CO3: understand the sterilization and fermentation process

CO4: apply theories of mass transfer to microbial systems

CO5: gain knowledge of industrial bio reactors and downstream processing

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE03 INSTRUMENTAL METHODS OF ANALYSIS

3 0 0 3

UNIT – I **9**

Electromagnetic Radiation: Various ranges, Dual properties, Various energy levels, Interaction of photons with matter, absorbance& transmittance and their relationship, Permitted energy levels for the electrons of an atom and simple molecules, classification of instrumental methods based on physical properties.

UNIT – II **9**

Molecular Spectroscopy: Various electronic transitions in organic and inorganic compounds effected by UV, visible and infra-red radiations, various energy level diagrams of saturated, unsaturated and carbonyl compounds, excitation by UV and Visible radiations, Woodward-Fischer rules for the calculation of absorption maxima (dienes and carbonyl compounds), Effects of auxochromes and effects of conjugation on the absorption maxima; Instrumentation for UV, VISIBLE and IR spectroscopies (source, Optical parts and Detectors), Photometric titration (Experimental set-up and various types of titrations), Applications of UV, VISIBLE and IR spectroscopies.

UNIT – III **9**

AAS, NMR Spectroscopy: Atomic Absorption Spectrophotometry: Principle instrumentation and applications. Nuclear Magnetic Resonance: Introduction to NMR, principle and instrumentation (Proton NMR only). Relaxation, Chemical shift and its causes, reference compounds.

UNIT – IV **9**

Thermal Methods: Thermogravimetry: Instrumentation, factors affecting shapes of thermo grams, and applications. Thermogram of important compounds ($CaSO_4.5H_2O$; $CaC_2O_4.2H_2O$) Differential Thermal Analysis: Principle, instrumentation and applications. Differences between DSC & DTA. Application of DSC (Inorganic & Polymer samples). TGA - Principle, instrumentation and applications.

UNIT – V **9**

Chromatographic Methods: Classification of chromatographic methods; Column, Thin layer, Paper, Gas, High Performance Liquid Chromatography (principle, mode of separation and technique). Separation of organic compounds by Column and Thin Layer, Mixture of Cu, Co and Ni by Paper Chromatography. Separation of amino acids by Paper Chromatography. Estimation of organic compounds by GC and HPLC.

TOTAL: 45

TEXT BOOKS:

1. Willard H.H., Merritt I., Dean J.A. and Settle F.A., "Instrumental Methods of Analysis", 7th Edition, CBS Publishers, New Delhi, 1986.
2. Ewing, Galen W., "Instrumental Methods of Chemical Analysis", 7th Edition, McGraw-Hill Company, New Delhi, 1985.

REFERENCE BOOKS:

1. Skoog D.A. and West D.M., "Fundamentals of Analytical Chemistry", 7th Edition, Saunders College Publishing, New York,1996.
2. Banwell. G. C., "Fundamentals of Molecular Spectroscopy", Tata McGraw-Hill, New Delhi, 2006.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the principles of electromagnetic radiation and classification of instrumental methods

CO2: grasp the principles and applications of UV, Visible, IR Spectroscopy and Photometric methods

CO3: appreciate the importance of AAS and NMR spectroscopy in chemical analysis

CO4: gain knowledge about TG and DTA instruments and their applications

CO5: understand the principles and applications of chromatographic methods

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE04 FOOD TECHNOLOGY

3 0 0 3

UNIT – I **9**

Constituents of Food: Carbohydrates – proteins, Lipids, Vitamins, Additives, Preservatives, Solvents, Flavors, Agents, Food Engineering Operations, Food Sorting, Cleaning, Grading – Harvesting –Drying storage –Prime processing.

UNIT – II **9**

Food Process Engineering Operations: Materials and Energy Balances – Fluid flow applications, Heat transfer applications, Drying, Evaporation, Equilibrium stage process, leaching and Extractions, Applications, Application of Mechanical separations and Mixing, in Diary, Meat Industry, Oil and Flat Industry, Cereal processing.

UNIT – III **9**

Preservation Operations and Plant Hygiene: Preservation methods & strategies, Thermal Methods, Nabla Factor Sterilization, Pasteurization, Dehydro freezing, Irradiation, Dosimetry, Transport of food & Preservation Strategies.Plant Hygiene:Plant Hygiene, Design of sterilization Process, Water Quality Upkeep, waste disposal, Material handling, Packaging, Packing of solid Liquid foods, Food storage, Special case Studies.

UNIT – IV **9**

Developments in Food Processing: Food Constituents and processing, Food emulsions, Food Rheology, Advances in thermal Operation, Extrusion, cooking Spray dryer design, Energy expenditure & Saving Food for developing countries, Food Detoxification, Production of Sweeteners, Starch, Microbial Polysaccharides, Amino acid, Rice bran Tocopherols.

UNIT – V **9**

Food Safety and Quality Control: Quality Control in Food Industry, Dose Response Relationship, Health Problem, Chemical and Micro biological aspects, Food analysis, Instruments & Enzymatic Analysis, Food Safety. Food laws and standards PFA, FPO, ISI/BIS and AGMARK. GMP's, SSOP's HACCP and ISO9000 programs.

TOTAL: 45

TEXT BOOKS:

1. Jowitt R., "Hygienic Design and Operation of Food Plant", AVI Pvt. Co., West Port, 1980.
2. Head man D.R. and Singh R.P., "Food Processing Technology", AVI Pvt. Co., West Port, 1981.

REFERENCE BOOKS:

1. Brennan J., Butters G.J.R., Cowell, N.D. and AEV Lilly, "Food Engineering Operations", 3rd Edition, Applied Scientific Publishers, London, 1990.
2. Ronald H. Schmidt and Gary E. Rodrick, "Food Safety Handbook", John Wiley and Sons, New Jersey, 2005.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the constituents of food and prime food processing operations

CO2: gain knowledge of the food process engineering operations and their applications to various food industries

CO3: familiarize the food preservation, plant hygine and packaging operations

CO4: acquaint with plant hygiene in food processing industries

CO5: understand the advanced food processing operations; comprehend the energy conservation

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE05 FLUID MOVERS

3 0 0 3

UNIT – I **9**

Pumps-I: Classification of and selection of pumps. Centrifugal pump- Theory, analysis, performance and construction. Displacement pump-Theory, design and construction. Diaphragm pump, screw pump –construction and working, performance, installation and diagnostics. Jet pump- theory and applications. Solid Pumping - Hydraulic transport of solids. Application, construction and working of centrifugal solid handling pump.

UNIT – II **9**

Pump-II: Pump drives and power transmission-pump drives and speed varying devices. Pump sealing- Centrifugal pump packing, mechanical seal and injection type shaft seals .Pump noise measurement- Noise measurement techniques, estimating pump noise level and noise control techniques. Pump testing- Classification of testing, test procedure and measurement.

UNIT – III **9**

Compressor: Compressor Theory - Compressed air and air usage. Compressor- Types and selection. Effect of operating conditions .Thermodynamic compression. Real gas effects. Description and control of surge in centrifugal and axial compressor. Multistage and intercooling Performance analysis of compressor. Compressor values.

UNIT – IV **9**

Blower: Theory and types of Blowers. Working Principle of a Centrifugal Blower. Cross flow blowers –Flow pattern and performance. Vortex Blowers – Flow pattern, performance. Velocity Triangle and Parametric Calculations: Work, Efficiency, and Number of Blades and Impeller sizes.

UNIT – V **9**

Fans: Types of Fans -Fan law- Conversion of fan performance, speed and size. Fan selection- Axial and centrifugal. Specific speed. Fan Performance and efficiency. Drives for Fans. Fanless air movers. Ventilation and duct system Performance testing of fan. Case study- VSD application and Cooling towers and Humidification plant. Vacuum cleaners-construction and testing Performance.

TOTAL: 45

TEXT BOOKS:

1. Igor J. Karassik, Joseph P. Messina, Paul Cooper, Charles C. Heald he "Pump Handbook", 4th Edition, McGraw-Hill Company, New York, 2008.
2. Giampaolo Tony "Compressor Handbook - Principles and Practices" Fairmount Press Incorporation, 2010.

REFERENCE BOOK:

1. Frank P. Bleier, "Fan Handbook – Selection, Application and Design", 2nd Edition, Mc-Graw Hill Companies Inc., 1997.
2. Christie J. Geankoplis, "Transport Processes and Unit Operations", Prentice Hall of India, 1993.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the types , characteristics and performance of pumps

CO2: familiarize with drives and power transmission of pumps; testing of pumps

CO3: gain knowledge about types, characteristics and performance of compressors

CO4: exhibit familiarity with the types, theory and performance of blowers; calculate the power requirement and efficiency of blowers

CO5: gain insight into the selection, working, performance and application of fans

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE06 PETROLEUM REFINING ENGINEERING

3 0 0 3

UNIT – I **9**

Formation and Composition of Petroleum: Origin and formation of petroleum; composition; types and classification; Petroleum reserves.

UNIT – II **9**

Properties and Testing Methods: Physical properties and testing methods – crude and petroleum products;

UNIT– III **9**

Treatment Techniques: Desalting of crudes, dehydration and fractionation methods; Thermal and catalytic cracking processes – vis-breaking, Dubbs two coil process, coking, FCC, Hydro cracking processes.

UNIT– IV **9**

Upgrading Processes: Solvent extraction; hydro treatment processes; Reforming and Alkylation; Isomerization; polymerization; finishing and purification processes.

UNIT – V **9**

Material and Energy Balances: Material and Energy balances calculation; controlling hydrocarbon losses in refinery; application of pollution control techniques.

TOTAL: 45

TEXT BOOKS:

1. BhaskaraRao B.K., "Modern Petroleum Refining Processes", 5th Edition, Oxford and IBH Publishing Company, New Delhi, 2008.
2. Nelson W.L., "Petroleum Refinery Engineering", 4th Edition, McGraw Hill Publishing Company Limited, 1958.

REFERENCE BOOKS:

1. Watkins R.N., "Petroleum Refinery Distillation", 2nd Edition, Gulf Publishing Company, Texas, 1979.
2. Hobson G. D., "Modern Petroleum Technology", Part 1&2, 5th Edition, Wiley Publishers, 1984.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the formation and composition of petroleum

CO2: familiarize with properties and testing methods for crude and petroleum products

CO3: understand the various treatment techniques of petroleum

CO4: familiarize with upgrading process of petroleum products

CO5: understand the material, energy balance and pollution control techniques for refineries

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE07 DRUGS AND PHARMACEUTICALS TECHNOLOGY

3 0 0 3

UNIT – I **9**

Principles and Kinetics: Introduction to drugs and pharmaceutical, application of organic therapeutic agents; Drug metabolism; physico chemical principles; pharmaco kinetics.

UNIT – II **9**

Process Synthesis: Chemical Conversion process- alkylation, carboxylation, condensation and cyclisation, dehydration, esterification, halogenation, oxidation and sulfonation reactions.

UNIT – III **9**

Drug Delivery Systems: Tablets and capsules -Formulation and Manufacturing; parential solutions; oral liquids; injections and ointments.

UNIT – IV **9**

Pharmaceutical Products: Vitamins; cold remedies; laxatives; analgesics; antacids and antiseptics

UNIT – V **9**

Quality Control: Concept of quality control, Quality analysis - raw materials, process and finished products. Good Manufacturing Practices.

TOTAL: 45

TEXT BOOKS:

1. Brahmankar D.M. and Sunil B. Jaiswal, "Biopharmaceutics and Pharmacokinetics: A Treatise", Vallabah Prakashan, 1995.
2. Arthur Owen Bentley, "Text book of Pharmaceutics", 8th Edition, Bailliere Tindall, London, 1977.

REFERENCE BOOKS:

1. Yalkonsky S.H. and Swarbick J., "Drug and Pharmaceutical Sciences", Vol. I, II, III, IV, V, VI and VII, Marcel Dekkar Inc., New York, 1975.
2. Banker G.S. and Rhodes C.T., "Modern Pharmaceutics", 4th Edition, Marcel Dekker Inc., 2002.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the Drug Metabolism and pharmaco–kinetic Principles

CO2: understand different chemical conversion processes in pharmaceutical industries

CO3: comprehend the formulation and manufacturing of drug delivery systems

CO4: exhibit familiarity with the manufacturing processes of different types of pharmaceutical products

CO5: understand the importance of good manufacturing practices and quality control procedures

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE08 COMPUTATIONAL FLUID DYNAMICS FOR PROCESS ENGINEERS

3 0 0 3

UNIT – I **9**

Conservation Laws of Fluid Motion and Boundary Conditions: Governing equations of fluid flow and heat transfer, equations of state, Navier-Stokes equations for Newtonian fluid, conservative form of governing equations of flow, differential and integral forms of general transport equations, classification of physical behavior.

UNIT – II **9**

Finite Volume Method for Diffusion and Convective-Diffusion Problems: Finite volume method for one-dimensional, two-dimensional and three-dimensional steady state diffusion, steady one-dimensional convection and diffusion, the central differencing scheme. Properties of discretization schemes, assessment of the central differencing scheme for convection-diffusion problems, the upwind differencing scheme, the hybrid differencing scheme, the power-law scheme and QUICK schemes for convection-diffusion problems.

UNIT – III **9**

Solution Algorithms for Pressure-Velocity Coupling in Steady Flows: Staggered grid, momentum equations, SIMPLE algorithm, assembly of a complete method, SIMPLER, SIMPLEC, and PISO algorithms; Solution of discretized equations: tri-diagonal matrix algorithm, application TDMA to two-dimensional and three-dimensional problems.

UNIT – IV **9**

Finite Volume Method for Unsteady Flows: One-dimensional unsteady heat conduction, implicit method for two-and three-dimensional problems, discretization of transient convection-diffusion equation, transient convection-diffusion using QUICK differencing, solution procedures for unsteady flow calculations, steady state calculations using pseudo-transient approach.

UNIT – V **9**

Turbulence and its Modeling: Transition from laminar to turbulent flow, characteristics of simple turbulent flows, effect of turbulence on properties of the mean flow, turbulent flow calculations, Reynolds-averaged Navier-Stokes equations and classical turbulence models – Mixing Length Model; K-ε Model; Reynolds Stress Equation Model; Algebraic Stress Equation Model.

TOTAL: 45

TEXT BOOKS:

1. Versteeg H.K. and Malalasekara W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", 2nd Edition, Pearson Education Ltd., 2007.
2. Anderson John D., "Computational Fluid Dynamics-The Basics with Applications", 1st Edition, Tata-McGraw Hill Publisher, 2012.

REFERENCE BOOKS:

1. Muralidhar K. and Sundarajan T., "Computational Fluid Flow and Heat Transfer", 2nd Edition, Alpha Science International, 2003
2. Fletcher C.A.J., "Computational Techniques for Fluid Dynamics", Volume I & II, Springer Series, Springer-Verlag, Berlin, 2003.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the governing equations / models for fluid flow and heat transfer

CO2: apply finite volume method for developing solution of steady state diffusion and convection diffusion problems

CO3: gain knowledge about solution algorithms for Pressure – velocity coupling in steady flows

CO4: apply the knowledge of algorithms in solving unsteady flow heat conduction and transient convection diffusion problems

CO5: comprehend the nature and different models for turbulence

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE09 CHEMICAL PROCESS UTILITIES

3 0 0 3

UNIT – I **9**

Water and Steam: Source and characteristics of water; soft and Demineralised water. Treatment of water for boiler and cooling towers. Properties of steam; waste heat boilers. Thermic fluid System for process applications. Steam trap - classification, selection and applications. Efficient use of steam in process plants.

UNIT – II **9**

Air and Humidification: Air, Compressed air, Types and characteristics of fans, blowers and compressors. Air drying systems. Humidification and dehumidification of air. Production of oxygen and nitrogen by PSA systems.

UNIT – III **9**

Refrigeration: Principles, compression and absorption refrigeration systems. Types and properties of refrigerants, eco-friendly refrigerants.

UNIT – IV **9**

Vacuum System: Selection of vacuum systems; types and characteristics of vacuum pumps, steam jet ejectors and auxiliaries. Process equipment under vacuum – Separation columns, Reactors Evaporators and Dryers.

UNIT – V **9**

Insulation and Inert Gas: Importance of insulation. Insulation materials for high, intermediate, low and very low temperatures. Calculation of critical thickness of insulation. Properties of inert gases and their uses

TOTAL: 45

TEXT BOOKS:

1. Jack Broughton, "Process Utility System- Introduction to Design Operation and Maintenance", Institution of Chemical Engineers, UK, 1994.
2. Lyle O., "Efficient use of steam", HMSO Publishers, 2000.

REFERENCE BOOKS:

1. Eskel Nordell, "Water treatment for industrial and other uses", Reinhold Publishing Corporation, New York, 1961.
2. Mcquiston F.C and Parker J., "Heating, Ventilating & Air Conditioning – Analysis and Design", 3rd Edition, John Wiley, New York, 1988.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the water treatment and steam utilization practices in process industries

CO2: perceive the importance of compressed air, psychometry and PSA systems

CO3: grasp the principles of refrigeration process for application in chemical process industries

CO4: select suitable vacuum systems for different chemical processes

CO5: understand the importance of insulation and calculate critical thickness of insulation; Gain an insight into the characteristics of inert gases

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE10 MODERN SEPARATION PROCESSES

3 0 0 3

UNIT – I **9**

Fundamentals and Filtration: Basic Concepts – Characteristics and Mechanism of Separation, Feasibility of Separation Processes. Theory and Selection of Equipment for Filtration Process - Cross Flow, Electro, Dual Functional Filters.

UNIT – II **9**

Membrane Process: Theory of Membranes Process, Types and Choice of Membranes, Types and Relative Merits of Membrane Modules.

UNIT – III **9**

Applications of Membrane Process: Principle and Applications of Micro filtration, Ultra filtration, Nano Filtration and Reverse Osmosis; Dialysis and Electro Dialysis; Pervaporation.

UNIT – IV **9**

Other Separation Process: Principle and Applications of Ion Exchange, Chromatography, Electrophoresis, Dielectrophoresis, Lyophilisation, Supercritical Fluid Extraction.

UNIT – V **9**

Current Trends: Principles and Applications of Zone melting, Adductive Crystallization, Foam Separation, Thermal Diffusion, Cryoseperations

TOTAL : 45

TEXT BOOKS:

1. Seader, J.D., Ernest J.Henley, Keith Roper D., "Separation Process Principles", 3rd Edition, Wiley,. 2010.
2. Coulson, J.M., and Richardson, J.F., "Chemical Engineering", 4th Edition, Butterworth- Heinemann, 1996.

REFERENCE BOOKS:

1. Schoen H.M., "New Chemical Engineering Separation Techniques", Interscience Publishers, 1972.
2. Scott K. and Hughes R., "Industrial Membrane Separation Technology", Blackie Academic and Professional Publications, 1996.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the principles and mechanisms of separation processes; Understand the theory and applications of filtration

CO2: analyze the theories and types of membranes

CO3: understand the applications of different membrane processes in chemical industries

CO4: exhibit familiarity with principles and applications of special separation processes

CO5: gain knowledge in the current trens and advancements in separation processes

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE11 AIR POLLUTION AND CONTROL

3 0 0 3

UNIT - I **9**

Air Pollution Regulatory Framework: Air pollution Regulatory framework - History – Regulator system – Laws and Regulations – Clean air act – Provisions for recent developments

UNIT – II **9**

Fundamentals of Gases and Incinerators: Measurement fundamentals – Chemicals and Physical properties – Phase equilibrium- Conservation laws, Incinerators- Design and performance – Operation and maintenance

UNIT - III **9**

Absorber Design and Fundamentals of Particulates: Absorbers – Design operation and improving performances of absorbers, Particle collection mechanisms– Fluid particle dynamics – Particle size distribution – Collection efficiency

UNIT – IV **9**

Design of Equipment: Gravity settling chambers, Electrostatic precipitators, Bag houses – Design and Performance equations- Operation and maintenance

UNIT – V **9**

Hybrid Systems: Hybrid systems - Wet electrostatic precipitators - Dry scrubbers –Electrostatically augmented fabric filtration, Air pollution control equipment: Introduction – Installation – Cost Model.

TOTAL: 45

TEXT BOOKS:

1. Louis Theodore, "Air Pollution Control Equipment", Springer, 2011.
2. Cooper C.D. and Alley F.C. "Air Pollution Control-A Design Approach", 4th Edition, Waveland Pr Inc., 2010.

REFERENCE BOOKS:

1. Noel de Nevers, "Air Pollution Control Engineering", 2nd Edition, Waveland Pr Inc., 2010.
2. Rao M.N. and Rao H.V.N., "Air Pollution", 1st Edition, McGraw Hill Education India Pvt. Ltd., 2001.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the evolution of air pollution regulation and different laws related to air pollution and control

CO2: comprehend the chemical and physical properties of gases; Gain knowledge about the design and performance of incinerators

CO3: get acquainted with absorber design and fundamentals of particulates

CO4: perform the design of air cleaning equipments and evaluate their performance

CO5: exhibit the concepts involved in hybrid systems for air pollution control; Evaluate air pollution control costs

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE12 EMPLOYABILITY SKILLS

3 0 0 3

UNIT -I **9**

Communication Skills: Verbal Communication: oral, telephone TV/internet, self-introduction, delivering talks in seminars, non-verbal communications: body language, gestures. Written communication: Ability to prepare CV, write formal business letters. Writing technical articles for journals and magazines. Ability to describe technical problems and situations occurring in chemical industries. Presentation Skills: Power point presentation and interaction with audience. Listening skills: listening to technical lectures and conversations and ability to comprehend. News documentary new product development.

UNIT - II **9**

Interpersonal Skills: Negotiation: stages of negotiation, formal and informal negotiation, interests/positions in negotiation. Attributes of successful negotiation. Team work and collaboration skills: Definition of team, Roles of team members, Elements of successful team work, group exercises. Discipline and communication in teams. Building Rapport, Rapport behavior. Tact and diplomacy: Strategies for Tact and diplomacy Decision making: definition, stages of decision making, strategies for making sound decision.Time management: Importance, principles and Prioritization of jobs-Exercises

UNIT – III **9**

Critical Thinking and Problem Solving: Principles of Critical examination, brain storming Delphi's method. Stages and methods of solving problem, problem solving tools, divergent, lateral and strategies thinking examples from process industries. Stress: causes stress and awarding

UNIT – IV **9**

Leadership Skills: Definition of leader/leadership, styles of leadership, steps in developing leadership. Delegation organization, emotional intelligence, charisma. Assertiveness skills: types of human behavior self-esteem, self-confidence. Techniques of assertiveness, dealing with non-assertiveness, criticisms. Complaining effectively.

UNIT – V **9**

I.T. Skills: Computer literacy: ability to use desktop, PC, laptop and tablet. Intelligent mobile phone and android applications. Word processing and spread sheet applications in chemical engineering. Elementary awareness about C, C++ and chemical engineering software like Aspen, HYSIS, MAT lab and HTRI.

TOTAL: 45

TEXT BOOKS:

1. Hariharan S.I., Sundarajan N. and Shanmugapriya S.P., "Soft Skills", Mjp Publishers, 2011.
2. Rao M.S.,"Soft Skills - Enhancing Employability: Connecting Campus with Corporate", 2011.

REFERENCE BOOKS:

1. Barun K. Mitra, "Personality Development and Soft Skills", 2011.
2. David W.G. Hind and Stuart Moss, "Employability Skills", Business Education Publishers 2005.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: develop verbal, non verbal, written and communication skills

CO2: understand the importance of team work and collaboration skills and develop decision making ability

CO3: improve their level of critical thinking to solve problems in chemical industries

CO4: develop their leadership and assertiveness skills

CO5: upgrade their computer literacy with emphasis on solving problems through chemical engineering software/simulation

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE13 POLYMER TECHNOLOGY

3 0 0 3

UNIT – I **9**

Introduction to Polymerization: Monomer; functionality and degree of polymerizations; polymers and their classification; Types of polymerization and mechanisms: addition; condensation and copolymerization, bulk, solution, emulsion and suspension polymerizations.

UNIT – II **9**

Structure and Properties of Polymers: Structure of polymers: linear, branched and cross linked; Characterization of polymers: molecular weight, crystallinity, glass transition and mechanical propertiesUltrasonic waves; Photodegradation, High energy radiation, Oxidative and hydrolytic.

UNIT – III **9**

Plastics and Methods: Introduction to plastics: Anti-oxidants and stabilizers, polymer additives; fillers, plasticizers; colorants. Moulding methods: Injection; compression transfer and Blow moulding, Processing techniques: Calendaring; casting; extrusion; thermoforming; foaming.

UNIT – IV **9**

Characterization Techniques: Chemical analysis of polymer; X-ray diffraction, Microscopic technique: Light scattering, SEM; Spectroscopic methods: IR, NMR. Thermal analysis: DSC, DTA and TGA.

UNIT – V **9**

Preparation, Properties and Industrial Uses of Polymers: Polyethylene; poly propylene; polystyrene, polymethylmethacrylate; polyvinyl chloride; polytetrafluoroethylene; polyacrylate; nylon 6, nylon 6,6 and polyesters; Phenol formaldehyde, urea formaldehyde, and melamine formaldehyde; epoxy; urethanes and silicones, ion exchange polymers.

TOTAL: 45

TEXT BOOKS:

1. Gowarikar V.R., Viswanathan N.V., and Jayadev Sreedhar, "Polymer Science", 9th Reprint, New Age International Pvt. Ltd., India, 1996.
2. Rodriguez. F., Cohen, C., Ober, C, Archer, L.A., "Principles of Polymer Systems", 5th Edition, Taylor and Francis, Great Britain, London, 2003.

REFERENCE BOOKS:

1. Williams D.J., "Polymer Science and Engineering", Prentice Hall, New York, 1971.
2. Arora M.G. and Singh M., "Polymer Chemistry", Anmol Publications Pvt. Limited, 2003.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the principles and types of polymerization processes

CO2: gain insight into the structure and properties of polymers

CO3: grasp the principles and methods of moulding plastics

CO4: comprehend the characterization techniques for polymers using microscopic and spectroscopic instruments

CO5: comprehend the properties and manufacturing processes of polymers

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE14 PILOT PLANT AND SCALE UP METHODS

3 0 0 3

UNIT – I **9**

Fundamentals of Scale up, Dimensional Analysis and Scale-up Criterion: Principles of Similarity, Pilot Plants and Models, Introduction to Scale-up Methods, Dimensional Analysis, Regime Concept, Similarity Criterion and Scale up Methods used in Chemical Engineering.

UNIT – II **9**

Scale-Up of Heat Transfer Equipment: Typical Problems in Scale-up of Mixing Equipment and Heat Transfer Equipment

UNIT – III **9**

Scaling up of Reactors: Scale-up Techniques available for Tubular Reactor, CSTR and Catalytic Reactors.

UNIT – IV **9**

Scale-Up of Mass Transfer Equipment: Distillation Column and Packed Towers: Scale-up of Distillation Columns and Packed Towers for Continuous and Batch Processes and Dryers

UNIT – V **9**

Scale up of Miscellaneous Equipment and Limitations: Scaling up of Ball Mill, Pressure Jet Nozzle and Centrifugal Disk Atomizers and Screw Extruders, Furnaces and Kilns, Analogue Models, Limitations of Scale up Techniques.

TOTAL : 45

TEXT BOOKS:

1. Johnstone R.E. and Thring M.W., "Pilot Plants Models and Scale-up methods in Chemical Engineering", McGraw Hill, New York, 1962.
2. Marko Zlokarnik, "Scale-up in Chemical Engineering.", Wiley-VCH, Germany, 2002.

REFERENCE BOOKS:

1. Marko Zlokarnik, "Dimensional Analysis and Scale-up in Chemical Engineering", Springer - Verlag, Berlin, Germany, 1986.
2. Donald G. Jordan, "Chemical Process Development", Part-1 and 2, Intersciences Publishers, 1988.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the principles of pilot plants, models, similarity and scale up methods

CO2: solve the problems in scale-up of mixing and heat transfer equipment

CO3: understand the scale-up of different types of reactors

CO4: understand the scale-up of columns and dryers

CO5: get insight into the scale-up of ball mills, furnaces, screw extruders, etc.

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE15 POWER PLANT MANAGEMENT

3 0 0 3

UNIT – I **9**

Introduction to Power Plants and Boilers: Layout of Steam , Hydel , Diesel , MHD, Nuclear and Gas turbine Combined Power cycles , Co Generation Systems , Load duration Curves Steam boilers and cycles – High pressure Super Critical and – Fluidized Bed Boilers

UNIT – II **9**

Steam Power Plant Components: Fuel preparation and ash handling ,Combustion Equipment for coal oil and gas, Draught- Different Types, Pollution Control Equipment , Surface Condenser types, Cooling Towers

UNIT – III **9**

Nuclear and Hydel Power Plants: Nuclear Energy-Fission, Fusion Reaction, Types of Reactors, Waste disposal and Safety. Hydel Power plant- Essential elements, Selection of turbines, governing of Turbines- Micro hydel plants

UNIT – IV **9**

Diesel and Gas Turbine Power Plant: Types of Diesel plants, components , Selection of Engine type, applications-Gas turbine power plant- Fuels, open and closed Cycles- Reheating, Regeneration and inter cooling . Combined cycle plants

UNIT – V **9**

Alternate Energy Sources and Economics: Solar Geo thermal- OTEC- Tidel, Wind, Pumped storage systems,Cost of Electric Energy- Fixed and operating costs - Types tariffs- Economics of load sharing, Energy Conservation opportunities in power plants .

TOTAL: 45

TEXT BOOKS:

1. Rajput R.K.,"Power Plant Engineering", 4th Edition, Laxmi Publications, New Delhi, 2007.
2. Nag P.K ,"Power Plant Engineering", 3rd Edition, Tata McGraw-Hill Company, New Delhi, 2007.

REFERENCE BOOKS:

1. Ramalingam K.K., "Power Plant Engineering", Scitech Publications, 2002.
2. Rai G.D., "Introduction to Power Plant Technology", Khanna Publishers, 1995.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the principles of power plant operations and boilers

CO2: grasp the significance of power plant components

CO3: get familiarized with the nuclear and hydel power plants; Understands the waste disposal and safety procedures followed

CO4: perceive the principles of selection operation and design features of diesel and gas turbine power systems

CO5: gain an insight into the importance of technical and economic viability of alternate energy sources; comprehend energy conservation opportunities in power plants

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE16 PULP AND PAPER TECHNOLOGY

3 0 0 3

UNIT – I **9**

Wood Preparation and Pulping: Basics of pulp and paper technology- Wood as raw material- Pulpwood harvesting, handling and storage- Mechanical pulping, Chemical pulping and Semi-chemical pulping- Chemical recovery.

UNIT – II **9**

Processing and Bleaching of Pulp: Processing of pulp- Cooking, Defibering, Deknotting ,Washing, Screening and Thickening- Bleaching- Oxygen bleaching, Chlorine-dioxide bleaching, Hydrosulfite bleaching, Peroxide bleaching, Ozone bleaching - Stock preparation**.**

UNIT – III **9**

Paper Manufacture Operations: Secondary Fiber Processing- Paper making process- Wet and Dry end operations- Surface treatments andfinishing operations -Specific paper and Board grades.

UNIT – IV **9**

Properties and Testing of Pulp and Paper: Properties of pulp and paper- Testing of pulp and paper –Paper end uses- Process control- Quality assurance.

UNIT – V **9**

Emissions and Pollution Control: Emissions from pulp and paper industry – Solid, liquid & gaseous wastes- Water pollution control- Air pollution control.

TOTAL: 45

TEXT BOOKS:

1. Kenneth W. Brittt, "Handbook of Pulp and Paper Technology", 2nd Revised Edition, John Wiley & Sons, 1971.
2. Smook G.A., "Handbook for Pulp & Paper Technologists", 3rd Edition, Angus Wilde Publications, Incorporation, 2003.

REFERENCE BOOKS:

1. Austin, G.T., "Shreve's Chemical Process Industries", 5th Edition, McGraw-Hill International Book Company, Singapore, 1984.
2. Kent J.A., "Riggel's Hand Book of Industrial Chemistry", Van Nostrant Reinhold, 1974.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand various methods for wood preparation and pulping

CO2: get acquainted with the processing and bleaching of pulp

CO3: comprehend the finishing and surface treatment of various grades of paper

CO4: exhibit familiarity with various methods for testing of pulp and paper

CO5: get an insight into various mitigation measures for solid , liquid and gaseous pollution from pulp and paper mills

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE17 HETEROGENEOUS CATALYTIC REACTIONS

3 0 0 3

Pre-requisites: Basic Knowledge in Chemical Reaction Engineering

UNIT – I **9**

Catalytic Reaction: Catalysis, Types, Nature of catalysis, catalyst preparation and characterization, catalyst deactivation; surface area and pore-volume distribution.

UNIT – II **9**

Adsorption: Adsorption isotherm and rates of adsorption, desorption and surface reaction; analysis of rate equation and rate controlling steps.

UNIT – III **9**

Diffusion and Reaction in Porous Catalysts: Diffusion within catalyst particle, effective thermal conductivity, mass and heat transfer within catalyst pellets; effectiveness factor.

UNIT – IV **9**

Fluid-Solid Non Catalytic Reactions: Models for explaining the kinetics; shrinking core model; controlling resistances and rate controlling steps; time for complete conversion for single and mixed sizes particle.

UNIT – V **9**

Catalytic Reactors: Fixed bed, Fluidized bed, Slurry and Trickle bed Reactors.

TOTAL: 45

TEXT BOOKS:

1. Fogler H.S., "Elements of Chemical Reaction Engineering", 4th Edition, Prentice Hall of India, New Delhi, 2008.
2. Smith J.M., "Chemical Engineering Kinetics", 3rd Edition, McGraw-Hill Company, New York,1981.

REFERENCE BOOKS:

1. Gilbert F. Froment and Kenneth B. Bischoff, "Chemical Reactor Analysis and Design", 2nd Edition, Wiley Publications, 1990.
2. James J. Carberry, "Chemical and Catalytic Reaction Engineering", McGraw Hill, 2004.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the basics of catalysis and catalyst preparation and characterization

CO2: comprehend the principles of adsorption for catalysis

CO3: estimate the rate of mass and heat transfer within catalyst pellets

CO4: get acquainted with different models for fluid solid non catalytic reactions

CO5: understand the working concepts of multi-phase reactors

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHE18 PROCESS OPTIMIZATION

3 0 0 3

UNIT – I **9**

Developing Models for Optimization: Scope and hierarchy of optimization, Essential features of Optimization problems, Classification of Models, Building a model, Factorial experimental designs, Degree of freedom

UNIT – II **9**

Basic Concepts: Formation of objective function, continuity of functions, NLP problem statement, convexity and applications, Interpretation of objective function based on its Quadratic approximation

UNIT – III **9**

Optimization of Unconstrained Functions: Methods for one dimensional search, Newton's method and Quasi – Newton methods for uni-dimensional search. Polynomial approximation methods

UNIT – IV **9**

Unconstrained Multivariable Optimization: Methods using function value only, methods using first derivative, Newton's method, Quasi – Newton methods.

UNIT – V **9**

Linear Programming: Simplex method, Barrier method, sensitivity analysis, Linear mixed integer programs, Examples

TOTAL: 45

TEXT BOOKS:

1. Edgar T.F., Himmelblau D.M., and Ladson L.S., "Optimization of Chemical Practice", 2nd Edition, McGraw Hill International Company, New York, 2003.
2. Kalyanmoy Deb, "Optimization for Engineering Design: Algorithms and Examples", Prentice Hall of India, New Delhi, 2005.

REFERENCE BOOKS:

1. Joshi M.C., and Kannan M. Moudgalya, "Optimization, Theory and Practice", Narsoa Publication, New Delhi, 2004.
2. Urmila M. Diwaker, "Introduction to Applied Optimization", Kluwer Academic Publication, 2003.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: design experiments and formulate optimization models of chemical processes/equipment

CO2: gain knowledge of the basic concepts of process optimization techniques

CO3: gain insight into optimization of unconstrained uni-variable functions

CO4: understand and apply the principles of unconstrained multivariable Optimization techniques

CO5: familiarize the methods of linear programming

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHO01 WASTE WATER TREATMENT

3 0 0 3

UNIT – I **9**

Introduction to Waste Water Treatment: Wastewater Sources and Flow rates- Constituents in waste water – Impact of Regulations -Health and Environment Concerns in waste water- Wastewater treatment methods- Wastewater Reclamation and reuse

UNIT – II **9**

Physical and Chemical Treatment Processes: Physical Unit Operations –Screening, Equalization, Flocculation, sedimentation, Clarification, Filtration, Flotation and Aeration Systems. Chemical Unit Process – Chemical Coagulation, Precipitation, Oxidation and Neutralization.

UNIT – III **9**

Biological Treatment Process: Microbial metabolism – Bacterial growth and energatus – Aerobic and Anaerobic biological oxidation – Activated Sludge process – Trickling filters – Rotating biological contactors – Combined aerobic treatment processes.

UNIT – IV **9**

Advanced Treatment Process: Need for Advanced Wastewater Treatment - Technologies used in advanced treatment – Depth Filtration – Surface Filtration – Membrane Separation Process- Absorption – Ion Exchange – Advanced oxidation process – ZLD Concept

UNIT – V **9**

Process Analysis and Selection: Components of waste water flows – Analysis of Data – Reactors used in waste water treatment – Mass Balance Analysis – Modeling of ideal and non ideal flow in Reactors – Process Selection.

TOTAL: 45

TEXT BOOKS:

1. Metcalf, Eddy and Tchobanoglous G., "Waste Water Engineering Treatment and Reuse", 2nd Edition, Tata McGraw Hill Company, NewYork, 2002.
2. "Industrial Waste Water Management, Treatment and Disposal-MOP FD-3", 3rd Edition, Tata McGraw Hill Professional Publishing Company, New York, 2008.

REFERENCE BOOKS:

1. Eckenfelder W.W., "Industrial Water Pollution Control", 2nd Edition, McGraw-Hill, 1999.
2. Arceivala S.J., "Wastewater Treatment for Pollution Control", 3rd Edition, McGraw-Hill, 2006.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: get familiarized with sources, constituents and environmental concerns of waste water and treatment methods

CO2: comprehend various physical and chemical treatment processes

CO3: understand various biological treatment processes

CO4: get acquainted with various advanced treatment process and Zero Liquid Discharge systems

CO5: understand the process of selection and modelling of reactors used in waste water treatment

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHO02 ENERGY TECHNOLOGY

3 0 0 3

UNIT – I **9**

Fossil Fuels: Coal -types and classification –Conversion technologies, Petroleum- products and properties, shale oil and gas, Oil and tar sand, Natural gas-CNG and LNG.

UNIT – II **9**

Nuclear and Biomass Energy: Nuclear energy-Fission and fusion-Types of nuclear reactors. Biomass energy-Resources and conversion processes.

UNIT – III **9**

Renewable Energy Sources-I: Fundamentals of Power generation systems-Hydro, Wind and solar energy.

UNIT – IV **9**

Renewable Energy Sources-II: Fundamentals of Power generation systems –Geothermal and ocean energy; fuel cells.

UNIT – V **9**

Energy Conservation and Management: Energy forecasting and planning; Energy conservation: Waste heat recovery and heat pipes, Energy Audit in Chemical process industries; Cogeneration practices in industries.

TOTAL: 45

TEXT BOOKS:

1. Twidell John and Weir Tony, "Renewable Energy Sources", 2nd Edition, Taylor and Francis, New York, 2006.
2. Rao S. and Dr. B.B. Parulekar, "Energy Technology", 4th Edition, Khanna Publishers, 2005.

REFERENCE BOOKS:

1. Beggs Clive, "Energy: Management Supply and Conservation", Butterworth-Heinemann, Oxford, 2002.
2. Fay James A. and Golomb Dan S., "Energy and the Environment", Oxford University Press Inc., New York, 2002.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the sources, applications and conversion technologies of fossil fuels

CO2: gain knowledge on the relevance and applications of nuclear and biomass energy

CO3: comprehend the principles of power generation using hydro, wind and solar energy

CO4: grasp the principles and applications of geothermal, ocean energy and fuel cells

CO5: appreciate the importance of energy conservation and management and conduct energy audit in chemical process industries

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHO03 PIPING ENGINEERING

3 0 0 3

UNIT – I **9**

Piping Fundamentals: Equations of flow for Newtonian and Non-Newtonian fluids; losses in pipes and fittings; Types of pipes and fittings.Piping standards and codes. .

UNIT – II **9**

Piping Generic Design: Piping layout- series and parallel pipes - Pipe network. Stress analysis and design of pipe supports.

UNIT – III **9**

Piping Design-I: Design of pipeline system – Air, Water, Steam and Oil.

UNIT – IV **9**

Piping Design- II: Design of pipeline system – Gases, Refrigeration and Slurry.

UNIT – V **9**

Operation and Maintenance: Coating, cleaning; freeze prevention, leak detection, corrosion and protection. Pipeline failures - Piping insulation and heat tracing, repair techniques; Pipeline economics.

TOTAL: 45

TEXT BOOKS:

1. John J Mcketta, " Piping Handbook", 3rd Edition, Marcel Dekker Publication, 1992.
2. Henry Liu, "Pipeline Engineering", 2nd Edition, Lewis Publishers, 2003.

REFERENCE BOOKS:

1. Mohinder L. Nayyar, "Piping Handbook", 7th Edition, McGraw Hill, 2000.
2. George A. Antaki, "Piping and Pipeline Engineering: Design, Construction, Maintenance, Integrity and Repair", Marcel Dekker Publications, 2003.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: get familiarized with the fundamental principles of fluid flow phenomena

CO2: understand the concept of generic design of piping systems

CO3: perform the design of pipeline systems for air, water and oil systems

CO4: perform the design of pipeline system for gas, refrigeration and slurry systems

CO5: apply operation and maintenance techniques to ensure safety and reliability

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHO04 PROCESS AUTOMATION

3 0 0 3

UNIT – I **9**

Introduction: Principles of measurement and classification of process control instruments; temperature, pressure, fluid flow, liquid level, velocity, fluid density, viscosity. Instrument scaling; sensors; transmitters and control valves; instrumentation symbols and labels

UNIT – II **9**

Process Automation: Basic concepts; terminology and techniques for process control; control modes; Tuning process controllers

UNIT – III **9**

Advanced Control: Advanced control techniques, feed forward and ratio control; controller design; adaptive control system; statistical process control; expert system; multivariable control techniques; supervisory control.

UNIT – IV **9**

Digital Control: Digital control techniques; z transforms; sampling and filtering; response of discrete time systems; sampled data control systems; design of digital controllers.

UNIT – V **9**

Optimal Control: Optimization and simulation; optimization techniques; single and multivariable constrained optimization; dynamic simulation of distillation columns and reactors.

TOTAL : 45

TEXT BOOKS:

1. Nakara B.C. and Choudary K.K., "Instrumentation and Analysis", Tata McGraw-Hill, New Delhi, 1993.
2. Stephanopoulos G., "Chemical Process Control", Tata McGraw-Hill, New Delhi, 1993.

REFERENCE BOOKS:

1. Chidambaram M., "Computer Control of Processes", Alpha Science International Ltd, India, 2002.
2. Chemical Engineering Refresher Series on "Process Automation", McGraw-Hill Publications, New York, 1991.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the principles of measurement techniques in process industries

CO2: understand the concepts of process control techniques

CO3: gain insight into advanced control techniques used in process control

CO4: get familiarized with digital control approaches and digital controllers

CO5: comprehend the optimal control strategies and simulation of process equipments

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHO05 PROCESS INSTRUMENTATION

3 0 0 3

UNIT – I **9**

Principles of Measurements: Qualities of measurements; Static and dynamic characteristics. Measurement of force, strain, and torques. Transducers-resistive, capacitive, inductive and piezoelectric devices; Applications in chemical process industries.

UNIT – II **9**

Temperature Measurement: Thermometer: Liquid and gas- filled,vapour pressure, Bimetallic and resistance types. Thermocouples and thermistors; Radiation pyrometery. Infrared thermometry, Special types- paint and crayons, pellets, strips and seger cones. Calibration of instrument.

UNIT – III **9**

Pressure and Vacuum Measurements: Manometers, bourdon gauge and bellows gauge, vacuum measurement-mechanical, thermal and ionization gauges.

UNIT – IV **9**

Flow and Level Measurements: Variable head and area flow meters. Mass and quantity flow meters, Magnetic, Vortex and Coreolis meter. Level measurements-direct and indirect methods.

UNIT – V **9**

Miscellaneous Measurements: Measurement of density, specific gravity, Viscosity, Humidity, pH, Thermal conductivity and electrical conductivity; Gas analyzers-CO/CO_2,SOx and NOx.

TOTAL: 45

TEXT BOOKS:

1. Patranabis D., "Principles of Industrial Instrumentation", Tata-McGraw Hill, New Delhi, 2009.
2. Eckmen D.P., "Industrial instrumentation", Wiley Eastern, New Delhi, 2004.

REFERENCE BOOKS:

1. Perry R.H. and Green D.W., "Perry's Chemical Engineers' Hand Book", McGraw Hill, New Delhi, 2009.
2. Singh S.K., "Industrial Instrumentation and Control", 2nd Edition, Tata McGraw-Hill Publishing Company, New Delhi, 2006.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: understand the basic principles of measurements for application in chemical process industries

CO2: comprehend the different temperature measurement techniques in process industries

CO3: get familiarized with the pressure and vacuum measurement techniques

CO4: comprehend the flow and level measurement instruments

CO5: gain insight into measurement of miscellaneous variables like pH, humidity, etc

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHO06 CORROSION TECHNOLOGY

3 0 0 3

UNIT – I **9**

Types of Corrosion and Testing Methods: Basic principles of corrosion and its control – Forms of corrosion, uniform, Galvanic, Crevis, pitting, selective leaching, erosion, stress - corrosion, cracking Cavitation phenomena and their effects – Corrosion testing – Field testing – Electrochemical techniques for measurement of corrosion rates, corrosion detection and components examination – Accelerated salt - spray testing.

UNIT – II **9**

Corrosion Protection Methods: Corrosion inhibitors, electroplated coatings, conversion coatings, anodizing, hot dipping, spray metal coatings, zinc coating by alloying, electrophoteric coatings and electro painting, powder coating, electrical methods of corrosion protection, composite materials in corrosion minimization – Cathodic and Anodic protections.

UNIT – III **9**

Corrosion in Specific Environments: Corrosion damage to concrete in industrial and marine environments and its protection; biological corrosion, halogen corrosion of metals, environmental degradation of materials, corrosion and inspection managements in chemical processing and petrochemical industries.

UNIT – IV **9**

Corrosion in Specific Cases and Control : Corrosion in structure – corrosion of stainless steels – corrosion in power equipments, corrosion in electrical and electronic industry – corrosion and selection of materials of pulp and paper plants – corrosion aspects in nuclear power plants – corrosion of surgical implants and prosthetic devices.

UNIT – V **9**

Corrosion and Country's Economy: Corrosion protection management – process maintenance procedures under corrosion Environments.

TOTAL: 45

TEXT BOOKS:

1. Fontana M.G., "Corrosion Engineering", Tata McGraw Hill, 2005.
2. Jones D.A., "Principal and Protection of Corrosion", Prentice-Hall, 1996.

REFERENCE BOOKS:

1. Pierre R. Roberge, "Corrosion Engineering: Principles and Practice", McGraw-Hill, 2008.
2. Sastri V.S., Ghali E. And Elboujdaini M., "Corrosion Prevention and Protection: Practical Solutions", John Wiley and Sons, 2007.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: comprehend the different types of corrosion and their testing methods

CO2: understand corrosion protection methods for applications in chemical process industries

CO3: get acquainted with corrosion inspection and management practices in different environments in industries

CO4: understand corrosion control methods and select suitable materials for different applications

CO5: comprehend the impact of corrosion in nations economy and environment

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial

14CHP81 – PROJECT WORK

0	**0**	**12**	**12**
			6

COURSE OUTCOMES

On completion of the course the students will be able to

CO1: identify and define the problems that need to be solved

CO2: select appropriate literature and frame the objectives

CO3: develop/ design value added products equipment using research tools and methods

CO4: analyze the experimental data and device the valid conclusion

CO5: elaborate the project in the form of oral presentation, report and technical paper publication

Mapping of COs with POs and PSOs

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

1 – Slight, 2 – Moderate, 3 – Substantial