RAJALAKSHMI ENGINEERING COLLEGE
DEPARTMENT OF CHEMICAL ENGINEERING
B. TECH. CHEMICAL ENGINEERING
REGULATIONS 2017
CURRICULUM

VISION

To be a center of excellence in chemical engineering to provide well prepared professionals to the industries and society.

MISSION

- To provide state of art environment to the students for better learning to cater for the chemical industries and pursue higher studies.
- To provide space to the students in research to think, create and innovate things.

PEOs'

1. To produce employable graduates with the knowledge and competency in Chemical Engineering complemented by the appropriate skills and attributes.
2. To produce creative and innovative graduates with design and soft skills to carry out various problem solving tasks.
3. To enable the students to work as teams on multidisciplinary projects with effective communication skills, individual, supportive and leadership qualities with the right attitudes and ethics.
4. To produce graduates who possess interest in research and lifelong learning, as well as continuously striving for the forefront of technology.

Program Outcomes (POs)

Engineering Graduates will be able to

1. Engineering Knowledge:

Apply the knowledge of mathematics, science, and engineering fundamentals, to solve the complex chemical engineering problems

2. Problem analysis:

Identify, formulate, review research literature, and analyze complex chemical engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

3. Design/development of solutions:

Design solutions for complex chemical engineering problems and design system components or process that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations.

4. 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 proceed valid conclusions.

5. Modern tool usage:

Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex chemical engineering activities with an understanding of the limitations.

6. 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 chemical engineering practice.

7.Environment and sustainability:

Understand the impact of the professional chemical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development.

8. Ethics:

Apply ethical principles and commit to professional ethics and responsibilities and norms of the chemical engineering practice.

9. Individual and team work:

Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication:

Communicate effectively on complex chemical 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.

11. 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.

12. Life-long learning:

Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological changes in chemical engineering.

PSO

1. Graduates will be able to apply chemical engineering principles to design equipment and a process plant.
2. They will be able to control and analyse chemical, physical and biological processes including the hazards associated with these processes.
3. Will be to able to develop mathematical models of real world industrial problems and compute solutions to dynamic processes.

SEMESTER I

S. No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	**HS17151**	Communicative English	HS	3	3	0	0	3
2	**MA17151**	Engineering Mathematics - I	BS	5	3	2	0	4
3	**PH17151**	Engineering Physics	BS	3	3	0	0	3
4	**CY17151**	Engineering Chemistry	BS	3	3	0	0	3
5	**GE17151**	Problem Solving and Python Programming	ES	3	3	0	0	3
6	**GE17152**	Engineering Graphics	ES	6	2	0	4	4
PRACTICALS								
7	**GE17161**	Problem Solving and Python Programming Laboratory	ES	4	0	0	4	2
8	**GE17162**	Physics and Chemistry Laboratory	BS	4	0	0	4	2
			TOTAL	**31**	**17**	**2**	**12**	**24**

SEMESTER II

S. No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	**HS17251/ HS17252**	Technical English/ Professional English Communication	HS	3	3	0	0	3
2	**MA17251**	Engineering Mathematics - II	BS	5	3	2	0	4
3	**PH17253**	Physics of Materials	BS	3	3	0	0	3
4	**CY17201**	Chemistry for Technologists	BS	3	3	0	0	3
5	**ME17252**	Basic Mechanical Engineering	ES	3	3	0	0	3
6	**CH17201**	Principles of Chemical Engineering	PC	3	3	0	0	3
PRACTICALS								
7	**GE17261**	Engineering Practices Laboratory	ES	4	0	0	4	2
8	**CY17211**	Chemical Analysis Laboratory	BS	4	0	0	4	2
			TOTAL	**28**	**18**	**2**	**8**	**23**

SEMESTER III

S. No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	**MA17353**	Probability and Statistics	BS	5	3	2	0	4
2	**CH 17301**	Chemical Process Calculations	PC	5	3	2	0	4
3	**CH17302**	Fluid Mechanics for Chemical Engineers	PC	4	2	2	0	3
4	**CH17303**	Solid Mechanics for Technologists	ES	3	3	0	0	3
5	**EE17301**	Principles of Electrical and Electronics Engineering	ES	3	3	0	0	3
6	**CY17301**	Organic Chemistry	BS	3	3	0	0	3
PRACTICALS								
7	**EE17362**	Electrical Engineering Laboratory	ES	4	0	0	4	2
8	**ME17361**	Mechanical Engineering Laboratory	ES	4	0	0	4	2
			TOTAL	**31**	**17**	**6**	**8**	**24**

SEMESTER IV

S. No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	**MA17451**	Numerical Methods	BS	5	3	2	0	4
2	**CY17251**	Environmental Science and Engineering	ES	3	3	0	0	3
3	**CH17401**	Chemical Engineering Thermodynamics I	PC	3	3	0	0	3
4	**CH17402**	Heat Transfer	PC	5	3	2	0	4
5	**CH17403**	Mechanical Operations	PC	3	3	0	0	3
6	**CY17401**	Physical Chemistry	BS	3	3	0	0	3
PRACTICALS								
7	**CH17411**	Fluid Mechanics Laboratory	PC	4	0	0	4	2
8	**CY17412**	Organic Chemistry Laboratory	BS	4	0	0	4	2
			TOTAL	**30**	**18**	**4**	**8**	**24**

SEMESTER V

S. No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	**CH17501**	Chemical Process Industries	PC	3	3	0	0	3
2	**CH17502**	Chemical Engineering Thermodynamics II	PC	3	3	0	0	3
3	**CH17503**	Mass Transfer I	PC	3	3	0	0	3
4	**CH17504**	Chemical Reaction Engineering I	PC	5	3	2	0	4
5		Professional Elective I	PE	3	3	0	0	3
6		Open Elective* I	OE	3	3	0	0	3
PRACTICALS								
7	**CH17511**	Mechanical Operations Laboratory	PC	4	0	0	4	2
8	**CH17512**	Heat Transfer Laboratory	PC	4	0	0	4	2
			TOTAL	**28**	**18**	**2**	**8**	**23**

* - Course from the curriculum of the other UG Programmes

SEMESTER VI

S. No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	**CH17601**	Chemical Reaction Engineering II	PC	5	3	2	0	4
2	**CH17602**	Mass Transfer II	PC	5	3	2	0	4
3	**CH17603**	Process Instrumentation Dynamics and Control	PC	3	3	0	0	3
4	**CH17604**	Process Engineering Economics	PC	3	3	0	0	3
5		Professional Elective II	PE	3	3	0	0	3
6		Open Elective* II	OE	3	3	0	0	3
PRACTICALS								
7	**CH17611**	Computational Programming Laboratory for Chemical Engineers	PC	4	0	0	4	2
8	**CH17612**	Chemical Reaction Engineering Laboratory	PC	4	0	0	4	2
			TOTAL	**30**	**18**	**4**	**8**	**24**

* - Course from the curriculum of the other UG Programmes

SEMESTER VII

S. No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	**CH17701**	Transport Phenomena	PC	3	3	0	0	3
2	**CH17702**	Process Equipment Design	PC	5	3	2	0	4
3	**CH17703**	Optimization of Chemical Processes	PC	3	3	0	0	3
4	**CH17704**	Comprehensive Chemical Engineering	PC	4	2	2	0	3
5		Professional Elective III	PE	3	3	0	0	3
6		Professional Elective IV	PE	3	3	0	0	3
PRACTICALS								
7	**CH17711**	Process Control Laboratory	PC	4	0	0	4	2
8	**CH17712**	Mass Transfer Laboratory	PC	4	0	0	4	2
9	**CH17713**	Mini Project	EEC	4	0	0	4	2
			TOTAL	**33**	**17**	**4**	**12**	**25**

SEMESTER VIII

S. No	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1		Professional Elective V	PE	3	3	0	0	3
PRACTICALS								
3	**CH17811**	Project Work	EEC	20	0	0	20	10
			TOTAL	**23**	**3**	**0**	**20**	**13**

TOTAL CREDITS : 180

PROFESSIONAL ELECTIVE – I

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	CH17E11	Enzyme Engineering	PE	3	3	0	0	3
2	CH17E12	Fluidization Engineering	PE	3	3	0	0	3
3	CH17E13	Food Technology	PE	3	3	0	0	3
4	CH17E14	Instrumental Methods of Chemical Analysis	PE	3	3	0	0	3
5	CH17E15	Computer Applications in Chemical Engineering	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – II

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	CH17E21	Air Pollution and Control	PE	3	3	0	0	3
2	CH17E22	Frontiers of Chemical Engineering	PE	3	3	0	0	3
3	CH17E23	Industrial Process Plant Safety	PE	3	3	0	0	3
4	CH17E24	Drugs and Pharmaceutical Technology	PE	3	3	0	0	3
5	GE17E25	Human values and Professional Ethics	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – III

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	CH17E31	Electrochemical Engineering	PE	3	3	0	0	3
2	CH17E32	Industrial Nanotechnology	PE	3	3	0	0	3
3	CH17E33	Waste water treatment	PE	3	3	0	0	3
4	CH17E34	Modern Separation Techniques	PE	3	3	0	0	3
5	CH17E35	Petroleum Technology	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – IV

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	CH17E41	Piping and Instrumentation	PE	3	3	0	0	3
2	CH17E42	Process Modeling and Simulation	PE	3	3	0	0	3
3	CH17E43	Process Plant Utilities	PE	3	3	0	0	3
4	CH17E44	Biochemical Engineering	PE	3	3	0	0	3
5	CH17E45	Energy Technology	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE – V

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	CH17E51	Fermentation Engineering	PE	3	3	0	0	3
2	CH17E52	Petroleum Refining and Petrochemicals	PE	3	3	0	0	3
3	CH17E53	Environmental Technology	PE	3	3	0	0	3
4	CH17E54	Polymer Technology	PE	3	3	0	0	3
5	CH17E55	Pulp and Paper Technology	PE	3	3	0	0	3

OPEN ELECTIVES FOR CHEMICAL ENGINEERING STUDENTS

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	OBT1703	Food and Nutrition	OE	3	3	0	0	3
2.	OBT1704	Medical Sciences for Engineers	OE	3	3	0	0	3
3.	OBT1705	Application of Biotechnology for Environmental protection	OE	3	3	0	0	3
4.	OBT1706	Fermentation Technology	OE	3	3	0	0	3
5.	OCE1704	Non Destructive Testing of Materials	OE	3	3	0	0	3
6.	OCE1706	Global Warming and Climate Change	OE	3	3	0	0	3
7.	OCS1705	IoT and its Applications	OE	3	3	0	0	3
8.	OCS1706	Programming in C	OE	4	2	0	2	3
9.	OCS1707	Programming in C++	OE	4	2	0	2	3
10.	OEE 1701	Renewable Power Generation Systems	OE	3	3	0	0	3
11.	OEC1701	MEMS and its applications	OE	3	3	0	0	3
12.	OEC1703	Digital Image Processing and its applications	OE	3	3	0	0	3
13.	OIT1702	Advanced Python Programming	OE	3	3	0	0	3
14.	OIT1706	Machine Learning and R Programming	OE	3	3	0	0	3
15.	OMT1701	Industrial Robotics	OE	3	3	0	0	3

16.	OME1701	Design of Experiments	OE	3	3	0	0	3
17.	OME1702	Industrial Safety	OE	3	3	0	0	3
18.	OME1705	Supply chain and Logistics Management	OE	3	3	0	0	3
19.	OMA1701	Computer based Numerical methods	OE	3	2	0	2	3
20.	OPH1701	Materials Synthesis and Characterization Techniques	OE	3	3	0	0	3
21.	OPH1702	Nanophysics	OE	3	3	0	0	3
22.	OCY1701	Green Chemistry in Energy and Environment	OE	3	3	0	0	3
23.	OCY1702	Interface Chemistry and Engineering	OE	3	3	0	0	3
24.	OGE1701	Human Rights	OE	3	3	0	0	3
25.	OGE1702	Foreign Language/Japanese	OE	3	3	0	0	3
26.	OGE1703	Foreign Language/German	OE	3	3	0	0	3
27.	OGE1704	Foreign Language/French	OE	3	3	0	0	3

SUMMARY

S. No	Subject Area	Credits Per Semester								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
1	HS	3	3	-	-	-	-	-	-	6
2	BS	12	12	7	12	-	-	-	-	43
3	ES	9	5	10	3	-	-	-	-	27
4	PC	-	3	7	9	17	18	17	-	71
5	PE	-	-	-	-	3	3	6	3	15
6	OE	-	-	-	-	3	3	-	-	6
7	EEC	-	-	-	-	-	-	2	10	12
Total		24	23	24	24	23	24	25	13	180

SYLLABUS

SEMESTER I

HS17151 COMMUNICATIVE ENGLISH

L T P C

Common to all branches of B.E. / B.Tech. programmes 3 0 0 3

OBJECTIVES:

- To develop the basic reading and writing skills of first year engineering and technology students.
- To help learners develop their listening skills, which will enable them listen to lectures and comprehend them by asking questions; seeking clarifications.
- To help learners develop their speaking skills and speak fluently in real contexts.
- To help learners develop vocabulary of a general kind by developing their reading skills

UNIT I SHARING INFORMATION RELATED TO ONESELF/FAMILY& FRIENDS 9

Reading- short comprehension passages, practice in skimming-scanning and predicting. Writing- completing sentences- developing hints. Listening- short texts- short formal and informal conversations. Speaking- introducing oneself - exchanging personal information- Language development- Wh Questions- asking and answering yes or no questions. Subject-Verb agreement – regular and irregular verbs. Vocabulary development- prefixes- suffixes- articles.

UNIT II GENERAL READING AND FREE WRITING 9

Reading - comprehension-pre-reading-post reading- comprehension questions (multiple choice questions and /or short questions/ open-ended questions)-inductive reading- short narratives and descriptions from newspapers including dialogues and conversations (also used as short Listening texts)- register. Writing – paragraph writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures. Listening- telephonic conversations. Speaking – sharing information of a personal kind—greeting – taking leave. Language development – prepositions, conjunctions. Vocabulary development- guessing meanings of words in context.

UNIT III GRAMMAR AND LANGUAGE DEVELOPMENT 9

Reading- short texts and longer passages (close reading). Writing- understanding text structure- use of reference words and discourse markers-coherence-jumbled sentences. Listening – listening to longer texts and filling up the table- product description- narratives from different sources. Speaking- asking about routine actions and expressing opinions. Language development- degrees of comparison-pronouns- direct vs indirect questions. Vocabulary development – single word substitutes- adverbs.

UNIT IV READING AND LANGUAGE DEVELOPMENT 9

Reading- comprehension-reading longer texts- reading different types of texts- magazines. Writing- letter writing, informal or personal letters-emails-conventions of personal email. Listening- listening to dialogues or conversations and completing exercises based on them. Speaking- speaking about oneself-speaking about one's friend. Language development- Tenses- simple present-simple past- present continuous and past continuous. Vocabulary development- synonyms-antonyms- phrasal verbs.

UNIT V EXTENDED WRITING 9

Reading- longer texts- close reading. Writing- brainstorming - writing short essays – developing an outline- identifying main and subordinate ideas- dialogue writing. Listening – listening to talks-conversations. Speaking – participating in conversations- short group conversations. Language

development-modal verbs- present/ past perfect tense. Vocabulary development-functional uses of tenses.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Read articles of a general kind in magazines and newspapers.
- Participate effectively in informal conversations; introduce themselves and their friends and express opinions.
- Comprehend conversations and short talks delivered in English
- Express ideas about oneself freely
- Write short essays of a general kind and personal letters and emails in English.

TEXT BOOKS:

1. Board of Editors. Using English A Coursebook for Undergraduate Engineers and Technologists. Orient BlackSwan Limited, Hyderabad: 2015.
2. Richards, C. Jack. Interchange Students' Book-2 New Delhi: CUP, 2015.

REFERENCES:

1. Bailey, Stephen. Academic Writing: A practical guide for students. New York: Rutledge,2011.
2. Means,L. Thomas and Elaine Langlois. English & Communication For Colleges. Cengage Learning ,USA: 2007
3. Redston, Chris &Gillies Cunningham Face2Face (Pre-intermediate Student's Book& Workbook) Cambridge University Press, New Delhi: 2005
4. Comfort, Jeremy, et al. Speaking Effectively: Developing Speaking Skills for Business English. Cambridge University Press, Cambridge: Reprint 2011
5. Dutt P. Kiranmai and RajeevanGeeta. Basic Communication Skills, Foundation Books: 2013

MA17151	ENGINEERING MATHEMATICS – I	L T P C
	Common to all branches of B.E. / B.Tech. programmes	**3 2 0 4**

OBJECTIVES:

- To learn the basics and concepts of traditional calculus.
- To provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions.
- To understand the concepts of single variable and multivariable calculus that plays an important role in the field of science, engineering & technology.

UNIT I MATRICES **15**

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II DIFFERENTIAL CALCULUS **15**

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules - Maxima and Minima of functions of one variable.

UNIT III FUNCTIONS OF SEVERAL VARIABLES **15**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT IV INTEGRAL CALCULUS **15**

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts – Bernoulli's formula, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

UNIT V MULTIPLE INTEGRALS **15**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

TOTAL : 75 PERIODS

OUTCOMES :

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

- Apply the concept of Eigenvalues and eigenvectors, diagonalization of a matrix, Symmetric matrices, Positive definite matrices and similar matrices for solving problems
- Use the techniques of differentiation to differentiate functions and to apply the concept of differentiation to solve maxima and minima problems.
- To apply the concept of Partial differentiation for functions two or more variables and use different techniques for solving problems.
- Solve problems involving integration using different methods such as substitution, partial fractions, by parts .
- Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to change of order and change of variables.

TEXT BOOKS :

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015.

REFERENCES :

1. Anton, H, Bivens, I and Davis, S, "Calculus", Wiley, 10th Edition, 2016.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
3. Narayanan, S. and Manicavachagom Pillai, T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2007.
4. Srimantha Pal and Bhunia, S.C, "Engineering Mathematics" Oxford University Press, 2015.
5. Weir, M.D and Joel Hass, "Thomas Calculus", 12th Edition, Pearson India, 2016.
6. Veerarajan T, Engineering Mathematics I & II, McGraw Hill Education, 3rd Edition, 2012.

PH 17151 ENGINEERING PHYSICS L T P C
Common to all branches of B.E. / B.Tech. programmes 3 0 0 3

OBJECTIVE:

- To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

UNIT I PROPERTIES OF MATTER 9

Elasticity – Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment - bending of beams –area moment of inertia - bending moment – cantilever - applications – uniform and non-uniform bending- I-shaped girders - stress due to bending in beams.

UNIT II WAVES AND OPTICS 9

Oscillatory motion – forced and damped oscillations: differential equation and its solution – plane progressive waves – wave equation. Lasers: population of energy levels, Einstein's A and B coefficients derivation – resonant cavity, optical amplification (qualitative) –CO_2 laser - Semiconductor lasers: homojunction and heterojunction – Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibers (material, refractive index and mode) – losses associated with optical fibers - fiber optic sensors: pressure and displacement.

UNIT III THERMAL PHYSICS 9

Transfer of heat energy – thermal expansion of solids and liquids – expansion joints - bimetallic strips - thermal conduction, convection and radiation –rectilinear heat flow – thermal conductivity - Forbe's and Lee's disc method: theory and experiment - conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.

UNIT IV QUANTUM PHYSICS 9

Black body radiation – Planck's theory (derivation) – Compton effect: theory and experimental verification – wave particle duality – electron diffraction – concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations – particle in a one-dimensional rigid box – tunnelling (qualitative) – electron microscope – scanningtunnelling microscope.

UNIT V CRYSTAL PHYSICS 9

Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances -reciprocal lattice - coordination number and packing factor for SC, BCC, FCC, and HCP –Polymorphism and allotropy: diamond and graphite structures - crystal imperfections: point defects, line defects – Burger vectors, stacking faults – role of imperfections in plastic deformation - growth of single crystals: solution and melt growth techniques.

TOTAL :45 PERIODS

OUTCOMES:

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

- Apply the knowledge of basic properties of matter and its applications in Engineering and Technology.
- Use the concepts of waves and optical devices and their applications in fiber optics.

- Use the concepts of thermal properties of materials and their applications in heat exchangers.
- Use the advanced physics concepts of quantum theory and its applications in electron microscope and material sciences.
- Apply the basic knowledge of crystallography in materials preparation and device fabrication.

TEXT BOOKS:

1. Bhattacharya, D.K. & Poonam, T. "Engineering Physics". Oxford University Press, 2015.
2. Gaur, R.K. & Gupta, S.L. "Engineering Physics". Dhanpat Rai Publishers, 2012.
3. Pandey, B.K. &Chaturvedi, S. "Engineering Physics". Cengage Learning India, 2012.

REFERENCES:

1. Halliday, D., Resnick, R. & Walker, J. "Principles of Physics". Wiley, 2015.
2. Serway, R.A. & Jewett, J.W. "Physics for Scientists and Engineers". Cengage Learning, 2010.
3. Tipler, P.A. & Mosca, G. "Physics for Scientists and Engineers with Modern Physics'. W.H. Freeman, 2007.
4. Arthur Besier and S. RaiChoudhury, Concepts of Modern Physics (SIE), 7th edition, McGraw-Hill Education, 1994.
5. Murugeshan R and Kiruthiga Sivaprasath, Modern Physics, S.Chand, 2015.

CY17151 ENGINEERING CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

- To acquire knowledge on characteristics of boiler feed water and water treatment techniques.
- To develop an understanding on surface chemistry and its applications
- To develop an understanding of the basic concepts of phase rule and its applications towards alloying
- To acquire knowledge on different types of fuels and its characteristics.
- To obtain knowledge on batteries and fuel cell.

UNIT I WATER AND ITS TREATMENT 9

Hardness of water – types – expression of hardness – units– boiler troubles (scale and sludge) – treatment of boiler feed water – Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) - External treatment – ion exchange process, zeolite process – potable water treatment – break point chlorination - desalination of brackish water - Reverse Osmosis – UASB process (Upflow Anaerobic Sludge Blanket).

UNIT II SURFACE CHEMISTRY AND CATALYSIS 9

Adsorption - types of adsorption – adsorption of gases on solids – adsorption of solute from solutions – adsorption isotherms – Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – contact theory – Preparation and applications of activated carbon (up flow and down flow process) - applications of adsorption on pollution abatement.

Catalysis – types of catalysis – criteria – autocatalysis – catalytic poisoning and catalytic promoters - acid base catalysis – applications (catalytic convertor) – enzyme catalysis – Michaelis – Menten equation.

UNIT III PHASE RULE, ALLOYS AND COMPOSITES 9

Phase rule - introduction, definition of terms with examples, one component system -water system - reduced phase rule - thermal analysis and cooling curves - two component systems - lead-silver system - Pattinson process.

Alloys - definition- properties of alloys- significance of alloying- functions and effect of alloying elements- nichrome and stainless steel (18/8) – heat treatment of steel.

Composites- polymer matrix composites -metal matrix composites-ceramic matrix composites.

UNIT IV FUELS AND COMBUSTION 9

Fuels - classification of fuels - coal - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum - manufacture of synthetic petrol (Bergius process) - knocking - octane number - diesel oil - cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gas (LPG) - power alcohol and biodiesel.

Combustion of fuels - introduction - calorific value - higher and lower calorific values- theoretical calculation of calorific value - ignition temperature - spontaneous ignition temperature - explosive range.

UNIT V ENERGY SOURCES AND STORAGE DEVICES 9

Batteries - components – Characteristics – voltage , current , capacity, electrical storage density, energy density, discharge rate – types of batteries – primary battery (dry cell)- secondary battery (lead acid battery, Ni- Cd battery, lithium-ion-battery) .Fuel cells – H_2-O_2 fuel cell, methanol oxygen fuel cell, Proton exchange membrane fuel cell – SOFC and Biofuel cells.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Get familiarized on water treatment techniques.
- Apply adsorption phenomena on various fields.
- Analyse alloying composition based on phase rule concept.
- Apply the role of fuels in day today applications.
- Design batteries and fuel cells.

TEXT BOOKS:

1. Jain P C and Monika Jain, "Engineering Chemistry" 17th Edition, DhanpatRai Publishing Company (P) LTD, New Delhi, 2015
2. Vairam S, Kalyani P and Suba Ramesh, "Engineering Chemistry", Wiley India PVT, LTD, New Delhi, 2013.

REFERENCES:

1. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
2. Prasanta Rath, "Engineering Chemistry", Cengage Learning India PVT, LTD, Delhi, 2015.
3. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2015.
4. Dara S S and Umare S S, "A Textbook of Engineering Chemistry", 12thedition, S. Chand & Company LTD, New Delhi, 2015.

GE17151 PROBLEM SOLVING AND PYTHON PROGRAMMING L T P C
3 0 0 3

OBJECTIVES
The student should be able to:

- Develop an understanding of algorithmic problem solving
- Develop Python programs with conditionals and loops.
- Define Python functions and call them.
- Use Python data structures –- lists, tuples, dictionaries.
- Do input/output with files in Python.

UNIT I ALGORITHMIC PROBLEM SOLVING 9

Introduction to computers - characteristics - basic organization of a computer – algorithms - building blocks of algorithms (instructions/statements, state, control flow, functions) - notation (pseudo code, flow chart, programming language) - algorithmic problem solving - simple strategies for developing algorithms (iteration, recursion).

UNIT II DATA, EXPRESSIONS, STATEMENTS AND CONTROL FLOW 9

Python interpreter and interactive mode - values and types - data types – variables – keywords - expressions and statements - python I/O - operators - precedence of operators – comments. Conditionals: conditional (if) - alternative (if-else) - chained conditional (if-elif-else) – nested conditional. Iteration: while – for - break – continue – pass. Illustrative programs: exchange the values of two variables - circulate the values of n variables - test for leap year.

UNIT III FUNCTIONS 9

Function calls – type conversion – math function – composition - definition and use - flow of execution - parameters and arguments. Fruitful functions: return values – parameters - scope: local and global - recursion. Strings: string slices – immutability - string functions and methods - string comparison. Illustrative programs: square root – GCD – exponentiation - sum the array of numbers - linear search - binary search.

UNIT IV COMPOUND DATA: LISTS, TUPLES AND DICTIONARIES 9

Lists - list operations - list slices - list methods - list loop – mutability – aliasing - cloning lists - list parameters. Tuples – immutable - tuple assignment - tuple as return value. Dictionaries: operations and methods – dictionaries and tuples – dictionaries and lists. Advanced list processing - list comprehension. Illustrative programs: Sorting.

UNIT V FILES, MODULES AND PACKAGES 9

Files and exception: file operation - text files - reading and writing files - format operator- command line arguments - errors and exceptions - handling exceptions – writing modules – packages. Illustrative programs: word count - copy file – case

TOTAL: 45 PERIODS

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

- Develop algorithmic solutions to simple computational problems.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.

- Represent compound data using Python lists, tuples and dictionaries.
- Read and write data from/to files in Python programs.

TEXT BOOK:

1. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, Second edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)

REFERENCES:

1. Anita Goel, Ajay Mittal, Computer Fundamentals and programming in C, Pearson India Publisher, First edition, 2013.
2. John V Guttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press, 2013
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
4. Timothy A. Budd, Exploring Python, Mc-Graw Hill Education (India) Private Ltd. 2015.
5. Kenneth A. Lambert, Fundamentals of Python: First Programs, CENGAGE Learning, 2012.
6. Charles Dierbach, Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
7. The Python Tutorial, https://docs.python.org/2.7/tutorial/

GE17152 ENGINEERING GRAPHICS

(Common to all B.E and B.Tech Programmes)

L	T	P	C
2	0	4	4

OBJECTIVE:

- To develop in students, graphic skills for communication of concepts, ideas and design of Engineering products.
- To expose them to existing national standards related to technical drawings.
- To study different type of projections and practice him on free hand sketching.

CONCEPTS AND CONVENTIONS (Not for Examination) **1**

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREEHAND SKETCHING 7+12

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves- Construction of helical curve.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes -

Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS 5+12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 5 **+12**

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6 + 12

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

TOTAL: 90 PERIODS

OUTCOMES:

On completion of the course, the student will be able to:

- Drawbasic geometrical constructions of plane curvesand freehand sketching of multiple views of objects.
- Drawthe orthographic projection of lines and plane surfaces.
- Draw the projections solids.
- Draw the true shape of the sectioned solid and development of surfaces.
- Drawthe isometric and perspective sections of simple solids.

TEXT BOOK:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2009.

REFERENCES:

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
3. Luzzader, Warren.J. and Duff,John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.
5. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson, 2nd Edition, 2009.

PUBLICATION OF BUREAU OF INDIAN STANDARDS:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

SPECIAL POINTS APPLICABLE TO END SEMESTER EXAMINATIONS ON ENGINEERING GRAPHICS:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

GE17161 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

The student should be able to:

- Be familiar with the use of office package, exposed to presentation and visualization tools.
- Implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples and dictionaries.
- Read and write data from/to files in Python.

LIST OF PROGRAMS

1. Search, generate, manipulate data using Open Office
2. Presentation and Visualization – graphs, charts, 2D, 3D
3. Problem Solving using Algorithms and Flowcharts
4. Compute the GCD of two numbers.
5. Find the square root of a number (Newton's method)
6. Exponentiation (power of a number)
7. Linear search and Binary search
8. First n prime numbers
9. Find the maximum of a list of numbers
10. Sorting
11. Removing all the duplicate elements in a list
12. Multiply matrices
13. Programs that take command line arguments (word count)
14. Find the most frequent words in a text read from a file
15. Mini Project

TOTAL: 60 PERIODS

PLATFORM NEEDED:

Hardware: PC with 8 GB RAM, i3 Processor

Software: Python 3 interpreter for Windows/Linux

OUTCOMES:

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

- Develop documentation, presentation and visualization charts.
- Implement Python programs with conditionals and loops.
- Develop Python programs stepwise by defining functions and calling them.
- Use Python lists, tuples and dictionaries for representing compound data.
- Read and write data from/to files in Python

OBJECTIVE:

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics, and properties of matter.
- To impart practical skills in water quality parameter analysis, spectrophotometry, flame photometry and corrosion rate determination.

GE17162	**PHYSICS AND CHEMISTRY LABORATORY**	**L T P C**
	Common to all branches of B.E. / B.Tech. programmes	**0 0 4 2**

LIST OF EXPERIMENTS: PHYSICS LABORATORY (Any 5 Experiments)

1. Determination of rigidity modulus – Torsion pendulum
2. Determination of Young's modulus by non-uniform bending method
3. (a) Determination of wavelength, and particle size using Laser
   (b) Determination of acceptance angle in an optical fiber.
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
6. Determination of wavelength of mercury spectrum – spectrometer grating
7. Determination of thickness of a thin wire – Air wedge method

TOTAL: 30 PERIODS

LIST OF EXPERIMENTS: CHEMISTRY LABORATORY (Any 7 Experiments)

1. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler's method.
4. Determination of chloride content of water sample by argentometric method.
5. Determination of strength of given hydrochloric acid using pH meter.
6. Estimation of iron content of the given solution using potentiometer.
7. Conductometric titration of strong acid vs strong base.
8. Determination of strength of acids in a mixture of acids using conductivity meter.
9. Estimation of copper content of the given solution by Iodometry.
10. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline / thiocyanate method).
11. Estimation of sodium and potassium present in water using flame photometer.
12. Corrosion experiment-weight loss method.

OUTCOMES:

On completion of the course students will be able to

- Calculate elastic properties of materials, such as Young's modulus & Rigidity modulus (of solids) and Bulk modulus (through compressibility of liquids).
- Measure various optical and thermal properties of materials (such as wavelengths of spectral lines & Laser source, acceptance angle &numerical aperture of fiber optical cable and thermal conductivity of media).
- Analyse water quality parameters.
- Be familiar in the use of instruments for chemical analysis.
- Measure the corrosion rate in metals.

TOTAL: 30 PERIODS

TEXTBOOKS:

- Vogel's Textbook of Quantitative Chemical Analysis (8^{TH} edition, 2014)

SEMESTER II

HS17251 TECHNICAL ENGLISH L T P C
3 0 0 3

Common to all branches of B.E. /B. Tech. Programmes

OBJECTIVES:

- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Foster their ability to write convincing job applications and effective reports.
- Develop their speaking skills to make technical presentations, participate in group discussions.
- Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialisation.

UNIT I INTRODUCTION TO TECHNICAL ENGLISH 9

Listening- listening to talks mostly of a scientific/technical nature and completing information-gap exercises. Speaking – asking for and giving directions. Reading – reading short technical texts from journals- newspapers. Writing- purpose statements – extended definitions – issue- writing instructions – checklists-recommendations. Vocabulary Development- technical vocabulary. Language Development –subject verb agreement - compound words.

UNIT II READING AND STUDY SKILLS 9

Listening- listening to longer technical talks and completing exercises based on them. Speaking – describing a process. Reading – reading longer technical texts- identifying the various transitions in a text- paragraphing. Writing- interpreting charts, graphs. Vocabulary Development-vocabularyused in formal letters/emails and reports. Language Development- impersonal passive voice, numerical adjectives.

UNIT III TECHNICAL WRITING AND GRAMMAR 9

Listening- listening to classroom lectures/ talks on engineering/technology. Speaking – introduction to technical presentations. Reading – longer texts both general and technical, practice in speed reading. Writing-Describing a process, use of sequence words. Vocabulary Development- sequence words. Misspelled words. Language Development- embedded sentences

UNIT IV REPORT WRITING 9

Listening- listening to documentaries and making notes. Speaking – mechanics of presentations. Reading – reading for detailed comprehension. Writing- email etiquette- job application – cover letter. Résumé preparation(via email and hard copy)- analytical essays and issue based essays. Vocabulary Development- finding suitable synonyms-paraphrasing. Language Development- clauses- if conditionals.

UNIT V GROUP DISCUSSION AND JOB APPLICATIONS 9

Listening- TED talks; Speaking –participating in a group discussion. Reading– reading and understanding technical articles. Writing– writing reports- minutes of a meeting- accident and survey. Vocabulary Development- verbal analogies, foreign words and phrases Language Development- reported speech, common errors in English.

TOTAL :45 PERIODS

OUTCOMES:

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

- Read technical texts and write area- specific texts effortlessly.
- Listen and comprehend lectures and talks in their area of specialisation successfully.
- Speak appropriately and effectively in varied formal and informal contexts.
- Write reports and winning job applications.
- Write error free language.

TEXT BOOKS:

1. Board of editors. Fluency in English A Course book for Engineering and Technology. Orient Blackswan, Hyderabad: 2016
2. Sudharshana.N.P and Saveetha. C. English for Technical Communication. Cambridge University Press: New Delhi, 2016.

REFERENCES

1. Raman, Meenakshi and Sharma, Sangeetha- Technical Communication Principles and Practice.Oxford University Press: New Delhi,2014.
2. Kumar, Suresh. E. Engineering English. Orient Blackswan: Hyderabad,2015
3. Booth-L. Diana, Project Work, Oxford University Press, Oxford: 2014.
4. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007
5. Means, L. Thomas and Elaine Langlois, English & Communication For Colleges. Cengage Learning, USA: 2007

Students can be asked to read Tagore and Chetan Bhagat for supplementary reading.

HS17252 PROFESSIONAL ENGLISH COMMUNICATION L T P C

Common to all branches of B.E./B.Tech. programmes **3 0 0 3**

OBJECTIVES

- To prepare students to be competent in a global business environment.
- To think accurately, clearly and deeply in communicative contexts.
- To improve career opportunities – get English language skills that are needed to be successful.

UNIT-I CRITICAL/ INFORMATIONAL LISTENING 9

Short conversations or Monologues – Listening for specific information- Conversations or Monologues with factual information- listen to fill up missing information- business related discussions or interview (two or more speakers).

UNIT-II CONVERSATIONAL/ PRESENTATION SKILLS 9

Speak about oneself - Face-to-face speaking for real-life context – pick and talk - personal opinion on business related topics- mini presentations on a business theme- discussion with another candidate on business related topics.

UNIT-III INTENSIVE/ EXTENSIVE READING AND INTERPRETING 9

Short texts (signs, messages, emails, labels and notes) -Short descriptions-graph or chart. Reading to find factual information- decision making from a written text- a leaflet or a newspaper- magazine or

article- reading to understand correct grammar, contextually- reading to understand the structure of a text-read and transfer information from memos, advertisements,notices.

UNIT-IV FORMAL COMMUNICATION 9

Business Correspondence - writing business letters to people outside the company. Internal Company Communication- a note, a message, a memo or an email.

UNIT – V VERBAL ABILITY/ FUNCTIONAL GRAMMAR 9

Grammar – tenses – concord- prepositions – articles- punctuations. Vocabulary – advanced vocabulary – synonyms and antonyms. Sentence correction – sentence completion - cloze passage - verbal reasoning: analogies, meaning-usage match.

TOTAL:45 PERIODS

OUTCOMES:

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

- Listen to, understand and give opinions in meetings.
- Apply for new jobs and develop their career.
- Write short business messages and reports.
- Use language in both official and unofficial contexts.
- Speak effectively in business communication

TEXT BOOK:

1. Board of Editors. Sure Outcomes. A Communication Skills Course for Undergraduate Engineers and Technologists. Orient Black Swan Limited, Hyderabad, 2013.

REFERENCE BOOKS:

1. Hartley, Mary. "The Power of Listening," Jaico Publishing House; First Edition (2015).
2. Chambers, Harry. "Effective Communication Skills for Scientific and Technical Professionals," Persues Publishing, Cambridge, Massachusetts, 2000.
3. Lesikar V. Raymond, Flatley E. Marie, Rentz, Kathryn and Pande, Neerja. "Business Communication," Eleventh Edition, Tata McGraw Hill Education Private Limited.

MA17251 ENGINEERING MATHEMATICS – II **L T P C**

Common to all branches of B.E.B.Tech. programmes **3 2 0 4**

OBJECTIVES :

- To handle practical problems arising in the field of engineering and technology.
- To solve problems using the concept of Differential Equation, Vectors calculus, Complex analysis, Laplace transforms.

UNIT I DIFFERENTIAL EQUATIONS **15**

Higher order linear differential equations with constant coefficients - Method of variation of parameters – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients - Method of undetermined coefficients.

UNIT II VECTOR CALCULUS **15**

Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface

- Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals (cubes and parallelepipeds).

UNIT III ANALYTIC FUNCTIONS 15

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions $w = z + c, cz, \frac{1}{z}, z^2$ - Bilinear transformation.

UNIT IV COMPLEX INTEGRATION 15

Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour.

UNIT V LAPLACE TRANSFORMS 15

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

TOTAL: 75 PERIODS

OUTCOMES:

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

- Apply various techniques in solving differential equations.
- Use the concept of Gradient, divergence and curl of a vector point function and related identities in different areas of Engineering.
- Evaluate line, surface and volume integrals using Gauss, Stokes and Green's theorems and their verification.
- Use the concept of Analytic functions, conformal mapping and complex integration for solving problems.
- Use Laplace transform and inverse transform techniques in solving differential equations.

TEXT BOOKS :

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.

REFERENCES :

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
2. Jain R.K. and Iyengar S.R.K., " Advanced Engineering Mathematics ", Narosa Publications, New Delhi , 3rd Edition, 2007.
3. O'Neil, P.V. "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.
4. Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014.

5. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.
6. Veerarajan T, Engineering Mathematics I & II, McGraw Hill Education, 3rd Edition, 2012.

PH 17253 PHYSICS OF MATERIALS L T P C
Common to B.Tech. Chemical Engineering and Biotechnology 3 0 0 3

OBJECTIVES

- To introduce and study of synthesis and characterization of materials.
- To study the properties of conducting materials, superconductors, insulators, magnetic materials, ceramics and new materials.

UNIT I PREPARATION AND PROCESSING OF MATERIALS 9

Phases - Phase rule – binary systems – tie line rule – lever rule – phase diagram – invariant reactions – diffusion Fick's law - Nucleation – homogeneous and heterogeneous nucleation – Free energy of formation of a critical nucleus – Thin films – preparation: PVD method - Sol-gel method – heat treatment and hardening processes.

UNIT II PROPERTIES OF CONDUCTING AND SUPER CONDUCTING MATERIALS 9

Classical free electron theory of metals – expression for electrical conductivity – thermal conductivity, - Wiedemann - Franz law - electrons in a metal: particle in a box (in three dimension) - Density of energy states – effect of temperature on Fermi energy – carrier concentration in metals - Superconducting Phenomena, Properties of superconductors – Meissner effect and Isotope effect. Type I and Type II superconductors, High Tc superconductors – Magnetic levitation and SQUIDS.

UNIT III ELECTRONIC MATERIALS 9

Elemental and compound semiconductors - Origin of band gap in solids (qualitative) - Concept of effective mass of electron and hole – carrier concentration in an intrinsic semiconductor (derivation) – Fermi level – Variation of Fermi level with temperature – electrical conductivity – band gap determination – carrier concentration in n-type and p-type semiconductors (derivation) – variation of Fermi level with temperature and impurity concentration – Compound semiconductors – Hall effect – Determination of Hall coefficient – LED and Solar cells.

UNIT IV INSULATING AND MAGNETIC MATERIALS 9

Dielectric, paraelectric and ferroelectric materials - Electronic, Ionic, Orientation and Space Charge polarization – Internal field and deduction of Clausius - Mossotti equation – dielectric loss – different types of dielectric breakdown – classification of insulating materials and their applications - Ferroelectric materials - Introduction to magnetic materials - Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic materials – Ferrites, Giant Magneto Resistance materials. Magnetic bubbles.

UNIT V CERAMIC AND NEW MATERIALS 9

Introduction to Ceramics and its applications - Ceramic Fibres – role of matrix and reinforcement - Fibre reinforced Plastics – Fibre reinforced Metal – Metallic glasses – Shape memory alloys – Copper base alloys – Nickel – Titanium alloys – Relaxor- Ferroelectric materials – Electro and magneto

rheological fluids - Sensors and Actuators – polymer semiconductors – photoconducting polymers – Bio-sensors - Bio materials – hydroxyapatite – PMMA – Silicone.

TOTAL : 45 PERIODS

OUTCOMES

On completion of the course, students will be able to

- Prepare and characterize the structure of various crystals.
- Analyze conducting properties of metals and superconductors.
- Analyze physical properties of semiconductors in electronic devices.
- Analyze the properties of insulating and magnetic materials.
- Analyze the usage of new engineering materials.

TEXT BOOKS

1. Raghavan. V. Materials Science and Engineering, Prentice Hall of India, 2002.
2. Palanisamy.. P.K., Materials Science, Scitech., 2003.

REFERENCES

1. Kumar J., MoorthyBabu. S and Vasudevan. S., Engineering Physics, Vijay Nicole Imprints, 2006
2. Calister W.D., Materials Science and Engineering an Introduction, John Wiley, 2003.
3. Raghavan V., Physical Metallurgy, Prentice Hall of India, 2002
4. Pillai S. O, Solid state physics, New Age International, 2015.
5. Charles Kittel, Introduction to Solid State Physics, 8th Edition, Willey India Pvt.Ltd, 2005.

CY17201 CHEMISTRY FOR TECHNOLOGISTS L T P C

3 0 0 3

OBJECTIVES:

- To acquire knowledge on different types of organic reactions.
- To understand the basic concepts of reaction mechanisms.
- To study the types, properties and applications of oils, fats, soaps and lubricants.
- To acquire knowledge on various bleaching agents.
- To study the basic concepts of dyes and its applications.

UNIT I UNIT PROCESSES 9

Nitration, Sulphonation, Halogenation, Esterification, Amination, Saponification and Hydrogenation – role of the above unit processes in such industries as petroleum, drugs, Pharmaceuticals and organic synthesis.

UNIT II REACTION MECHANISMS 9

Free radical substitutions, electrophilic addition, aromatic electrophilic substitutions, nucleophilic additions, condensation reactions, nucleophilic substitutions in aliphatic and aromatic compounds, cyclo – additions – rearrangements - Beckmann and Fries rearrangement reactions.

UNIT III OILS, FATS, SOAPS & LUBRICANTS 9

Chemical constitution, chemical analysis of oils and fats – acid, saponification and iodine values - definitions, determination and significance. Definition, mechanism of lubrication - preparation of

petrolubes - desirable characteristics – viscosity, viscosity index, carbon residue, oxidation stability, flash and fire points, cloud and pour points, aniline point - semisolid lubricants – greases, preparation of sodium, lithium, calcium and axle greases - uses, consistency test and drop point test - solid lubricants – graphite and molybdenum disulphide.

UNIT IV CHEMICALS AND AUXILIARIES 9

Preparation, properties and uses of bleaching powder, sodium hypochlorite, hydrogen peroxide, chlorine dioxide - estimation of available chlorine in hypochlorite bleach liquor - determination of strength of hydrogen peroxide.

UNIT V COLORANTS 9

Theory of color and constitution - Witt's theory - chromophore and auxochrome - classification of dyes based on application – chemistry and synthesis of azo dye (methyl red, methyl orange, and congo red) - triphenyl methane dyes (malachite green) - textile dyeing process.

TOTAL: 45 PERIODS

OUTCOMES:

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

- Develop potential organic compounds.
- Interpret and control the organic reactions.
- Analyse the characteristics of oil.
- Measure the quality of bleaching agent.
- Develop new types of dyes.

TEXTBOOKS:

1. Dhara S. S., "A Text Book of Engineering Chemistry", 12th Ed., S. Chand & Co. Ltd., New Delhi, 2016.
2. Jain. P.C. and Monica Jain, "Engineering Chemistry", 17thedition, Dhanpet Rai & Sons, New Delhi, 2015.
3. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2015.

REFERENCES:

1. Sharma B.K, "Industrial chemistry", 27th edition, KrishnaPrakashan Media (P) Ltd, Meerut, 2012.
2. Shore J., "Colourants and Auxiliaries: Volume II Auxiliaries", Wood head Publishing Ltd., 2002.
3. Trotman E. R., "Dyeing and Chemical Technology of Textile Fibres", B.I Publishing Pvt. Ltd., New Delhi, 1994.
4. Shenai V. A., "Chemistry of Dyes and Principles of Dyeing", Sevak Publications, Mumbai, 1995.

ME17252 BASIC MECHANICAL ENGINEERING L T P C

3 0 0 3

OBJECTIVE

- To impart knowledge on thermodynamics

- To impart knowledge on thermal engineering power generating units such as engines and steam turbines.
- To impart overview of theory of machines.

UNIT I LAWS OF THERMODYNAMICS 10

Basic concepts and hints; Zeroth law; First Law of Thermodynamics - Statement andapplication; Steady flow energy equation-problems- Second law of Thermodynamics – Kelvin -Plank statement and Clausius statement- problems; Limitations; Heat Engine, Refrigerator andHeat Pump, Available energy, Third law of Thermodynamics - Statement.

UNIT II HEATING AND EXPANSION OF GASES 6

Expressions for work done, Internal energy and heat transfer for Constant Pressure, ConstantVolume, Isothermal, Adiabatic and Polytropic processes-Derivations and problems; Freeexpansion and Throttling process.

UNIT III AIR STANDARD CYCLES 6

Carnot cycle; Sterling's cycle; Joule cycle; Otto cycle; Diesel cycle; Dual combustion Cycle-Derivations and problems.

UNIT IV I.C. ENGINES, STEAM AND ITS PROPERTIES AND STEAM TURBINE 12

Engine nomenclature and classification; SI Engine; CI Engine; Four Stroke cycle, Two strokecycle; Performance of I.C.Engine; Brake thermal efficiency; Indicated Thermal Efficiency,Specific fuel consumption. Steam - Properties of steam; Dryness fraction; latent heat; Total heat of wet steam; Dry steam;Superheated steam. Use of steam tables; volume of wet steam, volume of superheated steam;External work of evaporation; Internal energy; Entropy of vapour, Expansion of vapour, Rankinecycle. Steam turbines – Impulse and Reaction types - Principles of operation.

UNIT V SIMPLE MECHANISM, FLY WHEEL, DRIVES AND BALANCING 11

Definition of Kinematic Links, Pairs and Kinematic Chains; Flywheel-Turning moment Diagram; Fluctuation of Energy. Belt and rope drives; Velocity ratio; slip; Creep; Ratio of tensions; Length of belt; Power Transmitted; gear trains-types. Balancing of rotating masses in same plane;Balancing of masses rotating in different planes.

TOTAL: 45 PERIODS

OUTCOME:

At the end of the course, Students learn and understand:

- The laws of thermodynamics
- Various unsteady flow heat cycles
- Various standard air cycles
- Working of I.C.Engine and steam properties.
- Designingof simple mechanisms.

TEXT BOOKS

1. Nag, P.K., "Engineering Thermodynamics ", II Edition, Tata McGraw Hill Publishing Co.,Ltd., 2013.

2. Rajput, R .K, "Thermal Engineering", Laxmi Publications (P) Ltd, 2017.

3. Rattan S S, " Theory of Machines" ,Mc Graw hill Education,2017.

REFERENCES

1. Smith J M, "Chemical Engineering Thermodynamics" Mc Graw hill Education,2004.
2. Thomas Bevan, "Theory of Machines", III Edition, Pearson Education Limited, 2010.
3. Kothandaraman and Dhomkundwar,": A course in Thermal Engineering (SI Units)", Dhanpat Rai and Sons, Delhi ,2001.

CH17201 PRINCIPLES OF CHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES

- To understand the overall view of the chemical engineering and chemical engineering subjects

UNIT I History and Role of Chemical Engineers 5

Chemistry, Chemical engineering and Chemical technology. Chemical process industries: History and their role in society - Role of Chemical engineer. History and personalities of Chemical engineering - greatest achievements of Chemical engineering.

UNIT II Courses in Chemical Engineering 12

Components of Chemical engineering - Role of mathematics, physics, chemistry and biology; thermodynamics, transport phenomena, chemical kinetics, process dynamics, design and control.

UNIT III Unit Process and Unit Operations 12

Concept of unit Processes and unit operations - description of different unit processes and unit operations – introduction to design of equipments - flowsheet representation of process plants - evolution of an industry – sulphuric acid and soda ash manufacture. Simple chemical engineering experiments.

UNIT IV Frontiers of Chemical Engineering 12

Role of computer in Chemical engineering - Chemical engineering software - relation between Chemical engineering and other engineering disciplines - traditional vs. modern Chemical engineering - versatility of Chemical engineering - role of Chemical engineers in the area of food, medical, energy, environmental, biochemical and electronics.

UNIT V Opportunities for Chemical Engineering 4

Paradigm shifts in Chemical engineering - range of scales in Chemical engineering. Opportunities for Chemical engineers - future of Chemical engineering.

TOTAL : 45 PERIODS

OUTCOMES

On completion of the course, students will be able

- To realize what is chemical engineering?
- To understand the importance of various subjects of chemical engineering
- To get an overview of process industries
- To get an overview of various computing methods available for chemical engineering
- To get an awareness of scope of a chemical engineer

TEXT BOOKS

1. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", 6th Edition, Tata McGraw Hill, 1997.
2. Dryden, C.E., "Outlines of Chemicals Technology", Edited and Revised by Gopala Rao, M. and M.Sittig, 2nd Edition, Affiliated East-West press, 1993.

3. Randolph Norris Shreve, George T. Austin, "Shreve'e Chemical Process Industries", 5th edition, McGraw Hill, 1984

REFERENCE BOOKS

1. McCabe, W.L., Smith, J. C. and Harriot, P. "Unit operations in Chemical Engineering", McGraw Hill, 7th Edition, 2001
2. Finlayson, B. A., Introduction to Chemical Engineering Computing, John Wiley & Sons, New Jersey, 2006.

GE17261 ENGINEERING PRACTICES LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE 13

Buildings:

(a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
(b) Study of pipe connections requirements for pumps and turbines.
(c) Preparation of plumbing line sketches for water supply and sewage works.
(d) Hands-on-exercise:

Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

(e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:

(a) Study of the joints in roofs, doors, windows and furniture.
(b) Hands-on-exercise:
Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE 18

Welding:

(a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
(b) Gas welding practice

Basic Machining:

(a) Simple Turning and Taper turning
(b) Drilling Practice

Sheet Metal Work:

(a) Forming & Bending:
(b) Model making – Trays and funnels.
(c) Different type of joints.

Machine assembly practice:

(a) Study of centrifugal pump
(b) Study of air conditioner

Demonstration on:

(a) Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.
(b) Foundry operations like mould preparation for gear and step cone pulley.
(c) Fitting – Exercises – Preparation of square fitting and V – fitting models.

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE 13

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of an electrical equipment.

IV ELECTRONICS ENGINEERING PRACTICE 16

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EX-OR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL: 60 PERIODS

OUTCOMES:

- ability to fabricate carpentry components and pipe connections including plumbing works.
- ability to use welding equipments to join the structures.
- ability to fabricate electrical and electronics circuits.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	15 Sets.
2. Carpentry vice (fitted to work bench)	15 Nos.
3. Standard woodworking tools	15 Sets.
4. Models of industrial trusses, door joints, furniture joints	5 each
5. Power Tools: (a) Rotary Hammer	2 Nos
(b) Demolition Hammer	2 Nos
(c) Circular Saw	2 Nos
(d) Planer	2 Nos
(e) Hand Drilling Machine	2 Nos

(f) Jigsaw	2 Nos

MECHANICAL

1. Arc welding transformer with cables and holders	5 Nos.
2. Welding booth with exhaust facility	5 Nos.
3. Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets.
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 Nos.
5. Centre lathe	2 Nos.
6. Hearth furnace, anvil and smithy tools	2 Sets.
7. Moulding table, foundry tools	2 Sets.
8. Power Tool: Angle Grinder	2 Nos
9. Study-purpose items: centrifugal pump, air-conditioner	One each.

ELECTRICAL

1. Assorted electrical components for house wiring	15 Sets
2. Electrical measuring instruments	10 Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp 1 each	
4. Megger (250V/500V)	1 No.
5. Power Tools: (a) Range Finder	2 Nos
(b) Digital Live-wire detector	2 Nos

ELECTRONICS

1. Soldering guns	10 Nos.
2. Assorted electronic components for making circuits	50 Nos.
3. Small PCBs	10 Nos.
4. Multimeters	10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply	

CY17211 CHEMICAL ANALYSIS LABORATORY L T P C

B.Tech. Chemical Engineering 0 0 4 2

OBJECTIVE

- To acquire practical skills in the analysis of oils and lubricants.
- To acquire knowledge on grading of coal.
- To understand quality of cements.
- To understand quantitative estimation of nitrite in water, cement, oil, coal and Phenol.

LIST OF EXPERIMENTS

1. Determination of Redwood / Saybolt numbers, kinematic viscosity and viscosity index of Lubricating oils
2. Determination of flash point, fire point, cloud and pour point of oils
3. Determination of acid value and iodine value of oils
4. Determination of COD of water samples
5. Cement Analysis a. Estimation of silica content b. Estimation of mixed oxide content c. Estimation of calcium oxide content d. Estimation of calcium oxide by rapid method
6. Coal Analysis a. Estimation of sulphur present in coal b. Ultimate analysis of coal c. Proximate analysis of coal
7. Soap Analysis a. Estimation of total fatty acid b. Estimation of percentage alkali content
8. Flue gas analysis by Orsat's apparatus
9. Estimation of phenol.

10. Determination of calorific value using bomb calorimeter
11. Determination of nitrite in water.

TOTAL: 60 PERIODS

OUTCOME

On completion of the course students will be able to

- Get familiarized with equipment like viscometers, flash and fire point apparatus.
- Analyse different chemical parameters in water.
- Get familiarized of a few simple synthetic techniques for soap.
- Analyse the quality of cement.
- Analyse the grade of coals

REFERENCE BOOKS

1. Environmental pollution analysis, S.M.Khopkar, New age international. 2011
2. Manual of environmental analysis, N.C Aery, Ane books. 2010
3. Text book of quantitative chemical analysis, J.Mendham, Pearson education 2008

SEMESTER III

MA17353 PROBABILITY AND STATISTICS L T P C

3 2 0 4

OBJECTIVES

- To provide the required skill to apply the statistical tools in Engineering problems.

UNIT I ONE – DIMENSIONAL RANDOM VARIABLE 15

Discrete and continuous random variables – Moments – Moment generating functions –Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Weibull and Normal distributions – Functions of Random Variable.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES 15

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression – Transformation of random variables – Applications of Central Limit Theorem.

UNIT III TESTING OF HYPOTHESIS 15

Statistical hypothesis - Large sample test based on Normal distribution for single mean and difference of means -Tests based on t, F and Chi-square test for single sample standard deviation. Chi-square tests for independence of attributes and goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS 15

One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design.

UNIT V STATISTICAL QUALITY CONTROL 15

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

TOTAL :75 PERIODS

OUTCOMES

On completion of the course, students will be able to

- Characterize standard probability distribution by employing basic techniques and methods of probability mass function and probability density function for discrete and continuous random variables
- Develop skills to solve problems on correlation and regression
- Obtain statistical data from experiments and able to analyze the same using statistical test.
- Design experiments using suitable ANOVA techniques and draw conclusions.
- Use control charts to study, analyze and interpret problems in statistical quality control.

TEXT BOOKS:

1. Veerarajan T., 'Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks' , Mc Graw Hill, 2016.

2. Johnson R.A. and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition, 2007.

REFERENCES:

1. Devore J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2012.

2. Walpole R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia , 8th Edition, 2007.
3. Ross S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
4. Spiegel M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.

CH 17301 CHEMICAL PROCESS CALCULATIONS L T P C
3 2 0 4

OBJECTIVE:

- To impart knowledge on units and its conversions
- To teach concept of degree of freedom and its application
- To understand and apply the basics of calculations related to material and energy flow in the processes without and with reactions
- To impart the knowledge of various process simulation software

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UNIT I UNITS , DIMENSIONS AND BASIC CALCULATIONS 13

Units, dimensions and conversion; Process variables and properties; Stoichiometric Equations, Degrees of freedom.

UNIT II MATERIAL BALANCE CALCULATIONS 21

Introduction to material balances. Material balance problems for single units; Stoichiometry and Chemical reaction equations; material balance for processes involving reaction bypass, purging, recycle operations.

UNIT III GAS CALCULATIONS 13

Ideal gases, Real gases, Single component two phase systems, Multiple component phase systems, Phase rule, Phase equilbria, Combustion processes.

UNIT IV ENERGY BALANCE CALCULATIONS 15

Energy balances, Conservation of Energy processes without reaction, Heat capacity, Energy balances with chemical reaction, Efficiency applications.

UNIT V UNSTEADY STATE AND PROCESS SIMULATORS 13

Application of energy balances. Unsteady state material and energy balances. Solving material and energy balances using process simulators.

TOTAL: 75 PERIODS

OUTCOME:

- Will be able to understand degrees of freedom analysis and its significance
- Ability to make material balances on unit operations and processes and solve them
- Will be able to solve combustion related problems
- Ability to perform energy balance calculations
- Ability to solve material and energy balances in process simulators

TEXT BOOKS:

1. Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes", 3rd Edn., John Wiley & Sons, New York, 2000.
2. Bhatt, B.L., Thakore, S.B., "Stoichiometry ", 4th Edition, McGraw-Hill (2010)
3. K.V.Narayanan,B.Lakshmikutty," Stochiometry and Process Calculation", PHI Learning Ltd.(2013).

REFERENCES:
1. Hougen O A, Watson K M and Ragatz R A, "Chemical process principles" Part I, CBS publishers (1973).
2. Himmelblau, D.M., "Basic Principles and Calculations in Chemical Engineering", EEE Sixth Edition, Prentice Hall Inc., 2003

CH17302 FLUID MECHANICS FOR CHEMICAL ENGINEERS

L T P C
2 2 0 3

OBJECTIVE:

- To impart the knowledge on fluid properties
- To explain the concepts of fluid static characteristics and its applications
- To explain the concepts of fluid at motion and its applications
- To explain the principles of dimensional analysis and its application
- To explain the principle of various instruments used to measure fluid properties

UNIT I BASICS OF FULID MECHANICS 9

Methods of analysis and description - fluid as a continuum – Velocity and stress field - Newtonian and non-Newtonian fluids – Classification of fluid motion

UNIT II FLUID STATICS, KINEMATICS AND DYNAMICS 12

Fluid statics – basic equation - equilibrium of fluid element – pressure variation in a static fluid - application to manometry – Differential analysis of fluid motion– continuity, equation of motions, Bernoulli equation and Navier- Stokes equation.

UNIT III DIMENSIONAL ANALYSIS 12

The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi-theorem - non-dimensional action of the basic equations -similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies

UNIT IV FLOW THROUGH PIPES 15

Reynolds number regimes, internal flow - flow through pipes – pressure drop under laminar and turbulent flow conditions – major and minor losses; Line sizing; External flows - boundary layer concepts, boundary layer thickness under laminar and turbulent flow conditions- Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds.

UNIT V FLOW MEASUREMENT, VALVES AND PUMPS 12

Flow measurement - Constant and variable head meters; Velocity measurement techniques; Types, characteristics and sizing of valves; Classification, performance characteristics and sizing of pumps, compressors and fans

TOTAL : 60 PERIODS

OUTCOME:

On completion of this course, the students

- will have knowledge on basic principles of fluid mechanics and fluid properties
- will be able to apply the concepts of fluid statics and solve the problems
- will be able to apply the concepts of fluid kinetics and dynamics and solve the problems with single and two phase systems
- will be able to do dimensional analysis and scaling

- will be able to understand the principle of various instruments, valves and pumps

TEXT BOOKS:

1. Noel de Nevers, "Fluid Mechanics for Chemical Engineers ", 3rd Edition, McGraw-Hill, (2011).
2. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, 2005
3. Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 5th Edition", John Wiley, 2006

REFERENCES:

1. White, F.M., "Fluid Mechanics ", IV Edition, McGraw-Hill Inc., 1999.
2. James O Wilkes and Stacy G Bike, "Fluid Mechanics for Chemical Engineers' Prentice Hall PTR (International series in Chemical Engineering) (1999)

CH17303 SOLID MECHANICS FOR TECHNOLOGISTS

L	T	P	C
3	0	0	3

OBJECTIVE:

- To understand the theory of elasticity including strain/displacement and Hooke's law relationships
- T solve for stresses and deflections of beams under unsymmetrical loading
- To obtain stresses and deflections of beams on elastic foundations.
- To locate the shear center of thin wall beams
- To obtain solutions to column buckling and plate problems
- To solve torsion problems in bars thin walled members

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – forces on solids and supports – equilibrium and stability – strength and stiffness – tension, compression and shear stresses – Hooke's law and simple problems – compound bars – thermal stresses – elastic constants and poission's ratio – welded joints – design.

UNIT II TRANSVERSE LOADING ON BEAMS 9

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

UNIT III DEFLECTIONS OF BEAMS 9

Double integration method – Macaulay's method – Area – moment theorems for computation of slopes and deflections in beams – conjugate beam method

UNIT IV STRESSES IN BEAMS 9

Theory of simple bending – assumptions and derivation of bending equation (M/I = F/Y = E/R) – analysis of stresses in beams – loads carrying capacity of beams – proportioning beam sections – leaf springs – flitched beams – shear stress distribution in beams – determination of shear stress in flanged beams.

UNIT V TORSION AND COLUMNS 9

Torsion of circular shafts – derivation of torsion equation (T/J = C/R = G0/L) – stress and deformation in circular and hollow shafts – stresses and deformation in circular and hollow shafts – stepped shafts – shafts fixed at both ends – stresses in helical springs – deflection of springs – spring constant- Axially loaded short columns – columns of unsymmetrical sections – Euler's theory of long columns – critical loads for prismatic columns with different end conditions – effect of eccentricity.

TOTAL : 45 PERIODS

OUTCOMES:
On completion of this course, the students
- Will be able to determine stress, strain and elasticity with all its prerequisites.
- Will be able to design of beams
- Will be able to design pipelines and storage tanks
- Ability to develop skills on designing reaction colums
- Will be able to perform the design analysis of support column.

TEXT BOOKS:
1. Junarkar, S.B., Mechanics of Structure Vol. 1, 21st Edition, Character Publishing House, Anand, Indian, (1995)
2. William A.Nash, Theory and Problems of Strength of Materials, Schaum's Outline Series. McGraw Hill International Editions, Third Edition, 1994.

REFERENCE:
1. Elangovan, A., ThinmaVisaiIyal (Mechanics of Solids in Tamil), Anna University, Madras, 1995.

EE17301 PRINCIPLES OF ELECTRICAL AND ELECTRONICS ENGINEERING

L T P C
3 0 0 3

OBJECTIVES:
- To impart knowledge on DC Circuits, AC Circuits and operating principles of basic measuring instruments.
- To study the working principle, basic equations and applications of Electrical Machines.
- To understand the construction, operation and applications of various electronic devices.
- To provide knowledge on basic digital electronic circuits and data conversion techniques.
- To impart knowledge on working of various communication systems.

UNIT I ELECTRICAL CIRCUITS & BASIC MEASURING INSTRUMENTS 9
Ohm's law - Kirchhoff's Laws - Introduction to DC Circuits - Introduction to AC Circuits – Waveforms and RMS Value – Power and Power factor – Single Phase and Three Phase Balanced Circuits. Operating Principles of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters), Dynamometer type Watt meters and Energy meters.

UNIT II ELECTRICAL MACHINES 9
Construction, Principle of operation, Basic Equations and Applications of DC Generators, DC Motors, Single Phase Transformer, Single Phase induction Motors.

UNIT III BASIC SEMICONDUCTOR DEVICES AND ITS APPLICATIONS 9
Characteristics of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers – Voltage Regulation. Bipolar Junction Transistor – CB, CE, CC Configurations and Characteristics.

UNIT IV BASIC DIGITAL ELECTRONICS CIRCUITS AND DATA CONVERSION TECHNIQUES 9
Binary Number System – Logic Gates – Boolean Algebra – Half and Full Adders– Flip-Flops –

Registers and Counters – A/D and D/A Conversions

UNIT V COMMUNICATION ENGINEERING 9

Types of Signals: Analog and Digital Signals – Modulation and Demodulation: Principles of Amplitude and Frequency Modulations. Communication Systems: Radio, TV, Fax, Microwave, Satellite and Optical Fibre (Block Diagram approach only).

TOTAL: 45 PERIODS

OUTCOMES:

On completion of this course, the student will be able to:

- Understand the basics of electrical circuits and measuring instruments.
- Realize the working principle, basic equations and applications of of electrical machines
- Realize the working principle, operation and applications of basic electronic devices.
- Analyse the different Digital Electronic Circuits.
- Understand working principles of various communication systems.

TEXT BOOKS:

1. D P Kothari and I.J Nagarath, ”Electrical Machines “Basic Electrical and Electronics Engineering”, McGraw Hill Education(India) Private Limited, Third Reprint ,2016
2. S.K.Bhattacharya “Basic Electrical and Electronics Engineering”, Pearson India, 2011
3. Sedha R.S., “Applied Electronics”, S. Chand & Co., 2006

REFERENCES:

1. Muthusubramanian R, Salivahanan S and Muraleedharan K A, “Basic Electrical, Electronics and Computer Engineering”, Tata McGraw Hill, Second Edition, 2006.
2. Nagsarkar T K and Sukhija M S, “Basics of Electrical Engineering”, Oxford press 2005.
3. Mehta V K, “Principles of Electronics”, S.Chand & Company Ltd, 1994.
4. MahmoodNahvi and Joseph A. Edminister, “Electric Circuits”, Schaum’ Outline Series, McGraw Hill, 2002.
5. A.E.Fitzgerald, David E Higginbotham and Arvin Grabel, “Basic Electrical Engineering”, McGraw Hill Education(India) Private Limited, 2009.
6. Thereja .B.L., “Fundamentals of Electrical Engineering and Electronics”, S. Chand & Co. Ltd., 2008

CY 17301 ORGANIC CHEMISTRY L T P C

3 0 0 3

OBJECTIVE:

- To acquire knowledge on interconversion of sugars, reactivity of different heterocycles, importance of reagents in organic synthesis
- To acquire knowledge on active methylene compounds.
- To obtain knowledge on antimalarial, antibacterial and antiviral drugs.

UNIT I CARBOHYDRATES 9

Introduction – various definitions and classifications of carbohydrates – preparation, physical & chemical properties - structure and uses of monosaccharides (Glucose & Fructose) - Interconversions –

aldo pentose to aldo hexose – aldo hexose to aldo pentose - aldose to isomeric ketose – ketose to isomeric aldose – aldose to epimer

UNIT II HETEROCYCLIC COMPOUNDS 9

Preparation, physical & chemical properties and uses of Pyrrole – Furan – Furfural –Tetrahydro Furan – Thiophene – Indole – Pyridine - Quinoline - Isoquinoline.

UNIT III REAGENTS OFSYNTHETIC IMPORTANCE 9

Preparation and applications of Aluminium isopropoxide - Crown ethers - Lithium aluminium hydride - N- Bromo succinimide – Osmium tetroxide – Selenium dioxide - Ziegler Natta catalyst.

UNIT IV SYNTHETIC ORGANIC CHEMISTRY 9

Preparation and Synthetic utilities of Ethyl aceto acetate - Malonic ester - Enamines - 1, 3 dithane.

UNIT V PHARMACEUTICAL CHEMISTRY 9

Drugs- classification - synthesis and mode of action of antimalarial drugs (Isopentaquine and Chloroquine) - antibacterial drugs (Sulphaniliamide and Sulphapyridine) - antiviral drugs (Amantidine Hydrochloride, and Methisazone).

TOTAL: 45 PERIODS

OUTCOMES

On completion of the course, students will be able to

- Synthesize ascending and descending sugars
- Analyze reaction strategies of different heterocycles.
- Apply different reagents and their synthetic utilities
- Apply the role of active methylene compounds in the synthesis of different organic compounds.
- Design and synthesis of drugs.

TEXT BOOKS

1. Tiwari K.S., Vishnoi N.K.and Malhotra S.N "A text book of Organic Chemistry" Second Edition, Vikas Publishing House Pvt. Ltd. (1998) New Delhi
2. Jain M.K and Sharma S.C "Modern Organic Chemistry" revised edition (2017),Vishal publishing co., Jalandhar

REFERENCES

1. Morrison R.T and Boyd R.N "Organic Chemistry" VI Edition Prentice Hall Inc (1996) USA
2. Chemistry in Engineering and Technology, Vol.2, TMH Publishing Co Ltd., New Delhi, 1994
3. Finar I L "Organic Chemistry" ELBS (1994).
4. AshutoshKar "Medicinal Chemistry" Fourth edition, New Age International (P) Limited, New Delhi(2006).

REFERENCES

5. R.T. Morrison and R.N. Boyd "Organic Chemistry" VI Edition Prentice Hall Inc (1996) USA
6. Chemistry in Engineering and Technology, Vol.2, TMH Publishing Co Ltd., New Delhi, 1994
7. I L Finar "Organic Chemistry" ELBS (1994).
8. AshutoshKar "Medicinal Chemistry" Fourth edition, New Age International (P) Limited, New Delhi(2006)

EE17362 ELECTRICAL ENGINEERING LABORATORY

L T P C
0 0 4 2

OBJECTIVES

- To impart knowledge on verification of Kirchhoff's voltage and current laws.
- To gain knowledge about calibration of Wattmeter and Energy meter.
- To impart knowledge on load characteristics of DC generators and DC motors.
- To acquire knowledge on the load characteristics and equivalent circuit of single phase transformer by conducting load test.
- To predetermine the efficiency of DC machine by conducting Swinburne's test.

LIST OF EXPERIMENTS

1. Verification of Kirchhoff's voltage and current laws
2. Calibration of Wattmeter
3. Calibration of Energy meter
4. Experimental determination of power in three phase circuits by two-watt meter method.
5. Open circuit and load tests on separately excited DC Generator.
6. Load test on D.C. shunt motor
7. Swinburne's test
8. Load test on single phase induction motor
9. Load test on single phase Transformer
10. Equivalent circuit of a single phase transformer

TOTAL: 60 PERIODS

OUTCOMES

On completion of this course, the student will be able to:

- verify Kirchhoff's voltage and current laws.
- obtain the error curves for Wattmeter and Energy meter.
- draw the load characteristics of DC generators and DC motors.
- draw the load characteristics and equivalent circuit of single phase transformer by conducting load test.
- determine the efficiency of DC machine by conducting Swinburne's test.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Regulated Power Supply: 0 – 15 V D.C -5 Nos.
2. Circuit Connection Boards - 5 Nos.
3. Single Phase Energy Meter - 1 No
4. AC-Voltmeters (5 Nos.), Ammeters (5 Nos)
5. Single Phase Wattmeter – 03 Nos.
6. DC Shunt Motor with Loading Arrangement – 3 Nos
7. Single Phase Transformer – 4 Nos.
8. Single Phase Induction Motor with Loading Arrangement – 1 No.
9. Tachometer -Digital/Analog – 8 Nos.
10. Single Phase Auto Transformer – 2 Nos.
11. Single Phase Resistive Loading Bank – 2 Nos.
12. Three Phase Resistive Loading Bank. – 2 Nos.

13. SPST switch – 2 Nos.
14. Necessary Quantities of Resistors(Quarter Watt to 10Watt)

ME17361 MECHANICAL ENGINEERING LABORATORY **L T P C**
0 0 4 2

OBJECTIVE:

- To impart practical knowledge in operating IC engines and conduct experiments.
- To understand test procedures in testing material for engineering applications

LIST OF EXPERIMENTS

1. Port timing diagram
2. Valve timing diagram
3. Study of 2 stroke and 4 stroke I C Engine
4. Load test on 4-stroke petrol engine
5. Performance test on 4-stroke single cylinder diesel engine
6. Performance test on 4-stroke twin cylinder diesel engine
7. Heat balance test on diesel engines.
8. Tension test
9. Compression test
10. Hardness test (Rockwell and Brinell)
11. Spring test
12. Torsion test
13. Impact test

TOTAL PERIODS: 60

OUTCOMES

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

- Understand the working of 2 and 4-stroke IC engines.
- Understand the performance parameters of IC engines and their significance.
- Analyse the performance of various diesel engines.
- Able to know the distribution of heat energy in a diesel engine.
- Able to evaluate the estimate various mechanical strength of a material.

SEMESTER IV

MA17451 NUMERICAL METHODS L T P C
3 2 0 4

OBJECTIVES

- To provide the necessary basic concepts of a few numerical methods.
- To provide procedures for solving numerically different kinds of problems occurring in the field of Engineering and Technology.

UNIT I SOLUTION OF EQUATIONS 15

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel.

UNIT II INTERPOLATION 15

Interpolation with equal intervals - Newton's forward and backward difference formulae - Interpolation with unequal intervals – Newton's divided difference interpolation - Lagrange's interpolation – Cubic Splines

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 15

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule and Simpson's 3/8 rule – Romberg's method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal rule.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 15

Single Step methods - Taylor's series method - Euler's method - Modified Euler's method – Fourth order Runge - Kutta method for solving first order equations - Multi step methods - Milne's and Adams- Bash forth predictor corrector methods for solving first order equations.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 15

Finite difference method for solving second order differential equations - Finite difference techniques for the solution of two dimensional Laplace and Poisson equations on rectangular domain – One dimensional heat flow equation by implicit and explicit methods – One Dimensional Wave Equation by Explicit method.

TOTAL : 75 PERIODS

OUTCOMES

On completion of the course, students will be able to

- Solve algebraic equations and eigen value problems that arise during the study of Engineering problems.
- use various interpolation techniques for solving problems in Engineering.
- use numerical methods to solve problems involving numerical differentiation and integration.
- solve initial value problems numerically that arise in Science and Engineering.
- Solve boundary value problems that encounter in different fields of Engineering study.

TEXT BOOKS:

1. Kandasamy P., Thilagavathy K., and Gunavathy,S., 'Numerical Methods', Chand and Co., 2007.
2. Grewal B.S., and Grewal. J.S.,"Numerical methods in Engineering and Science", Khanna Publishers, 9th Edition, New Delhi, 2007.
3. Sastry S.S, "Introductory Methods of Numerical Analysis", Prentice- Hall of India PVT. LTD., 4th edition, New Delhi, 2006

REFERENCES:

1. Veerarajan T., Ramachandran T., 'Numerical Methods with Programs in C and C++' Tata McGraw Hill., 2007.
2. Jain M.K., Iyengar, S.R., and Jain, R.K., 'Numerical Methods for Scientific and Engineering Computation', New Age Publishers. 6th edition, 2007.
3. Chapra S.C., and Canale. R.P, "Numerical Methods for Engineers", 7th Edition, McGrawHill, New Delhi, 2015.
4. Brian Bradie "A friendly introduction to Numerical analysis", Pearson Education, Asia, New Delhi, 2007.
5. Sankara Rao K., "Numerical methods for Scientists and Engineers", Prentice Hall of IndiaPrivate, 3rd Edition, New Delhi, 2007.
6. Gerald C. F. and Wheatley, P.O., "Applied Numerical Analysis", 6th Edition, Pearson Education Asia, New Delhi, 2006.
7. Rajaraman V., Computer-Oriented Numerical Methods, Third Edition, Published by PHI Learning Private Limited (2013).

CY17251 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To find the scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To study the importance of environment by assessing its impact on the human world.
- To study the dynamic processes and understand the features of the earth's interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 12

Definition, scope and importance of Risk and hazards; Chemical hazards, Physical hazards, Biological hazards in the environment – concept of an ecosystem – ecological succession processes – Introduction, types, characteristic features, structure and function of the forest ecosystem - grassland ecosystem - desert ecosystem - aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – Significance of medicinal plants - biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

UNIT II ENVIRONMENTAL POLLUTION 10

Definition - causes, effects and control measures of Air pollution (Atmospheric chemistry - Chemical composition of the atmosphere; Chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, oxygen and ozone chemistry- Mitigation procedures - Control of particulate and gaseous emission, Control of SO_2, NO_X, CO and HC) - Water pollution : Physical and chemical properties of terrestrial and marine water and their environmental significance - Water quality parameters – physical, chemical and biological; absorption of heavy metals - Water treatment processes. Soil pollution - soil waste management: causes, effects and control measures of municipal solid wastes – Marine pollution - Noise pollution - Thermal pollution - Nuclear hazards– e-Waste – toxic substances in e-waste – risks related to toxic substances – role of an individual in prevention of pollution – pollution case studies.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and overutilization 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 and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources - energy production from waste materials. Energy Conversion processes – Biogas – production and uses, anaerobic digestion; case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Introduction to Environmental Biochemistry: Proteins – Biochemical degradation of pollutants, Bioconversion of pollutants.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization environmental ethics: Issues and possible solutions – Principles of green chemistry - nuclear accidents and holocaust, case studies – wasteland reclamation – consumerism and waste products – environment protection act – Air act – Water act – Wildlife protection act – Forest conservation act – The Biomedical Waste (Management and Handling) Rules; 1998 and amendments- scheme of labelling of environmentally friendly products (Ecomark). Enforcement machinery involved in environmental legislation- central and state pollution control boards - disaster management: floods, earthquake, cyclone and landslides. Public awareness and case studies.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – Dengue fever- Swine flu – women and child welfare – Environmental impact analysis (EIA)- GIS-remote sensing - role of information technology in environment and human health – Case studies. Effect of Radiation from computing devices.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, students will be able to

- Solve problems that cannot be solved by mere laws.

- Get familiarized with ecological balance.
- Get public awareness of environment at infant stage.
- Find ways to protect the environment and play proactive roles.
- Develop and improve the standard of better living.

TEXTBOOKS:

1. Benny Joseph, 'Environmental Science and Engineering', 2nd edition, Tata McGraw-Hill, New Delhi,2008.
2. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.

REFERENCES :

1. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India Pvt Ltd, New Delhi, 2007.
2. ErachBharucha, "Textbook of Environmental Studies", 3rd edition, Universities Press(I) Pvt, Ltd, Hydrabad, 2015.
3. Tyler Miller G. and Scott E. Spoolman, "Environmental Science", 15th edition, Cengage Learning India PVT, LTD, Delhi, 2014.
4. Rajagopalan R., 'Environmental Studies-From Crisis to Cure', 3rdedition,Oxford University Press,2015.

CH17401 CHEMICAL ENGINEERING THERMODYNAMICS- I L T P C
3 0 0 3

OBJECTIVE:

- To train the students for the familiarization of heat and work transfer calculation by applying the basic principles.
- To develop knowledge on selecting an equation of state for representing PVT behavior of fluids
- To impart knowledge on first law and second law of thermodynamics in chemical processes mainly refrigeration processes
- To train the students for the familiarization of single stage and multistage compression process
-

UNIT I BASIC CONCEPTS 6

Scope of thermodynamics; Definition of system, control volume, state and path function, equilibrium, reversibility, energy, work and heat. zeroth law; temperature scales

UNIT II PVT RELATIONSCHIPS 7

PVT behavior of fluids; Mathematical representation of PVT behaviour; Generalized compressibility factor correlation; Generalized equations of state

UNIT III LAWS OF THERMODYNAMICS 12

Joule's experiment, internal energy, first law, energy balance for closed systems, mass and energy balance for open systems Statements of the second law of thermodynamics, heat engine and refrigerator, Carnot cycle and Carnot theorems, thermodynamic temperature scale, entropy and its calculation, second law of thermodynamics for a control volume, Third law of thermodynamics, entropy from a microscopic point of view, Refrigeration, vapor compression and vapor absorption cycle.

UNIT IV THERMODYNAMIC REALTIONSHIPS 12

Thermodynamic potentials – internal energy, enthalpy, Helmholtz free energy, Gibbs free energy; thermodynamic property relations – Maxwell relations – partial derivatives and Jacobian method; residual properties; thermodynamic property tables and diagrams

UNIT V APPLICATIONS 8

Duct flow of compressible fluids, Compression and expansion processes, steam power plant, internal combustion engines, jet and rocket engines.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course, the students would be able to

- Identify the difference between heat and work, isentropic and isenthalpic processes
- Use equation of state, correlation to predict the PVT data
- Analyze the process with respect to first and second law of thermodynamics and understand entropy of the system
- Understand interrelationship of properties and their calculations
- Understand the purpose of inter cooling in multistage compressors

TEXT BOOKS:

1. Smith, J.M., Van Ness, H.C and Abbot M.M "Introduction to Chemical Engineering Thermodynamics ", McGraw Hill Publishers, VII Edition, 2010.
2. Rao, Y.V.C., "Chemical Engineering Thermodynamics" Universities Press, 2009.
3. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics, Prentice Hall India, II Edition, 2013.

REFERENCES:

1. Kyle, B.G., "Chemical and Process Thermodynamics III Edition", Prentice Hall of India Pvt. Ltd., 1999.
2. Pradeep Ahuja," Chemical Engineering Thermodynamics", PHI Learning Ltd, (2009).
3. Gopinath Halder," Introduction to Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).

CH17402 HEAT TRANSFER L T P C

3 2 0 4

OBJECTIVE:

- To learn various heat transfer methods involved in chemical processes.
- To study the mechanism of heat transfer in unit operations such as evaporation, drying etc.
- To be exposed to calculations involved in heat transfer principles
- To apply heat transfer concepts in real industry scenario
- To design heat transfer equipments such as Shell & Tube Heat exchanger, boiler etc

UNIT I CONDUCTION HEAT TRANSFER 15

Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer - Fourier's law of heat conduction - one dimensional steady state heat conduction equation for flat plate, hollow cylinder and sphere - Heat conduction through a series of resistances - Thermal conductivity measurement; effect of temperature on thermal conductivity; Heat transfer in extended surfaces.

UNIT II CONVECTION HEAT TRANSFER 15

Concepts of heat transfer by convection - Natural and forced convection, analogies between transfer of momentum and heat - Reynold's analogy, Prandtl and Coulburn analogy. Dimensional analysis in heat transfer, heat transfer coefficient for flow through a pipe, flow past flat plate, flow through packed beds.

UNIT III HEAT TRANSFER WITH PHASE CHANGE 15

Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling.

UNIT IV RADIATION AND UNSTEADY STATE HEAT CONDUCTION 15

Radiation heat transfer - Black body radiation, Emissivity, Stefan - Boltzman law, Plank's law, radiation between surfaces – unsteady state heat conduction-flat plate, cylinder and spheres.

UNIT V APPLICATIONS 15

Heat exchangers-types of heat exchangers; plate heat exchangers; use of correction factor charts; heat exchangers effectiveness; number of transfer unit - Chart for different configurations - Fouling factors. Evaoration-Theory of evaporation - single effect and multiple effect evaporation – Design calculation for single and multiple effect evaporation

TOTAL : 75 PERIODS

OUTCOME:

- Ability to understand the basic principles of heat transfer
- Ability to understand and solve conduction problems
- Ability to solve convection problems
- Ability to solve problems on radiation
- Ability to design and analyze the performance of heat exchangers and evaporators

TEXT BOOKS:

1. Kern, D.Q., "Process Heat Transfer", McGraw-Hill, 2001.
2. Holman, J. P., 'Heat Transfer ', X Edition., McGraw Hill, 2009.
3. Ozisik, M. N., Heat Transfer: A Basic Approach, McGraw-Hill, 1984

REFERENCES:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", XII Edition., McGraw-Hill, 2017.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I, VI Editionn., Asian Books Pvt. Ltd., India, 2006.

CH17403 MECHANICAL OPERATIONS L T P C

3 0 0 3

OBJECTIVE:

- To learn the characterization of solids and size reduction techniques
- To gain the knowledge on various separation processes such as solid-solid separation, Fluid-solid separation and Mechanical-physical separation.
- To select the appropriate separation technique or equipment based on nature of the solution or size of the particles.
- To expose to calculation and machinery involved in various solid handling operations
- To introduce nano-technological aspects

UNIT I SIZE ANALYSIS AND SIZE REDUCTION 9

General characteristics of solids, different techniques of size analysis, shape factor, surface area determination, estimation of particle size. Screening methods and equipment, screen efficiency, ideal and actual screens.

Laws of size reduction, energy relationships in size reduction, methods of size eduction, classification of equipments, crushers, grinders, power requirement, work index; size enlargement - principle of granulation, briquetting, pelletisation, and flocculation.

UNIT II MECHANICAL SEPARATIONS 9

Gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, super centrifuges, design of basket

centrifuges; industrial dust removing equipment, cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation, jigging

UNIT III FILTRATION 9

Theory of filtration, Batch and continuous filters, Flow through filter cake and filter media, compressible and incompressible filter cakes, filtration equipments - selection, operation and design of filters and optimum cycle of operation, filter aids.

UNIT IV MIXING, AGITATION, STORAGE AND TRANSPORTATION 9

Mixing and agitation - Mixing of liquids (with or without solids), mixing of powders, selection of suitable mixers, power requirement for mixing. Storage and Conveying of solids - Bunkers, silos, bins and hoppers, transportation of solids in bulk, conveyer selection, different types of conveyers and their performance characteristics.

UNIT V SYNTHESIS AND CHARACTERISATION OF NANOPARTICLES 9

Synthesis of Nanoparticles – Chemical and physical processing methods, Characteristics of Nanoparticles – FTIR, XRD, SEM, TEM - Applications -

TOTAL : 45 PERIODS

OUTCOME:

- Ability to characterize particles and determine its size & will be able to calculate the power required by various solid handling equipments
- Will be able to select the appropriate separation technique or equipment based on nature of the solution or size of the particles
- Ability to identify various filtration equipments in process industries and will be able to calculate time taken for filtration process
- Will have the knowledge on various equipments for storage and conveying of solid particles of various sizes.
- Will be to synthesis and characterize particles in a nano scale.

TEXT BOOKS:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", VII Editionn., McGraw-Hill, 2017.
2. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", Tata McGraw Hill, 2001.
3. Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., "Principles of Unit Operations", 2nd Edn., John Wiley & Sons, 2008.

REFERENCE:

1. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I, VI Edition., Asian Books Pvt. Ltd., India, 1999.

CY17401 PHYSICAL CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

- To acquire knowledge about the kinetics of chemical reactions, basic concepts of thermodynamics and distribution of matters.
- To obtain knowledge on the colloidal state of matter, its applications in nanotechnology, the basics of corrosion and control.

UNIT I CHEMICAL KINETICS 9

Rate of a reaction- order of a reaction – examples and rate equations for zero order, first order, second order and third order reactions – molecularity of a reaction – unimolecular and bimolecular reactions – half life period – problems based on rate constant and half life period - kinetics of parallel and opposing reactions – activation energy – Arrhenius equation – collision theory of reaction rates – theory of absolute reaction rates - photochemical reactions – definitions - kinetics and mechanism of hydrogen – bromine reaction.

UNIT II CHEMICAL THERMODYNAMICS 9

Basic definitions in thermodynamics – reversible and irreversible process - closed and open system – Zeroth law, first law, second law and third law of thermodynamics – concept of entropy - steady state and transient state processes – free energy - Maxwell relations - chemical potential – fugacity – equilibrium constant – relation between free energy and EMF – temperature dependence of equilibrium constant (problems).

UNIT III COLLOIDS 9

Introduction to colloids – properties of colloids – coagulation of solutions – origin of charge on colloidal particles – determination of size of colloidal particles – Donnan Membrane equilibrium – emulsions – gels – applications of colloids – nanoparticles (Au, Ag, Pt) – preparation – characterization – properties – application in catalysis and drug delivery systems.

UNIT IV CORROSION AND ITS CONTROL 9

Corrosion – definition - Mechanisms of Corrosion - chemical corrosion and electrochemical corrosion - galvanic series- types of corrosion - factors influencing corrosion – corrosion in water – corrosion in sulphur bearing solutions – microbial corrosion – corrosion in soil – corrosion of concrete – corrosion in acids and alkali - corrosion control – material selection – design - cathodic protection – corrosion inhibitors.

UNIT V THE DISTRIBUTION LAW 9

Distribution co-efficient - distribution Law — conditions for the validity of the distribution law – I_2–CCl_4–H_2O system – nature of interaction of the solute with one of the solvents – dissociation-association – applications of distribution law – process of extraction - diffusion - basic concept – Fick's Law.

TOTAL : 45 PERIODS

OUTCOMES

On completion of the course, students will be able to

- Analyze the kinetics of different chemical reactions
- Apply the concept of thermodynamics to simple systems
- Apply the knowledge on colloidal state in the synthesis of nano particles
- Describe cause of corrosion and analyse in detail
- Verify distribution law and its applications

TEXT BOOKS

1. Puri B.H. Sharma L.R. and M.S.Prathama, "Principles of Physical Chemisry", Chand S and Company, New Delhi (2001).
2. Bahl B. S., ArunBahl and G.D.Tuli, "Essentials of Physical Chemistry", Chand S and Company, New Delhi (2005).

REFERENCE

1. Laidler K. J., Chemical Kinetics, 3rd Edition, Pearson, 2009.
2. Peter Atkins & Julio de Paula, Atkins' Physical Chemistry, 7th Edition, Oxford University press.(2002).
3. Gordon M. Barrow, Physical Chemistry, Sixth Edition, Tata McGraw Hill (1998).
4. Kund and Jain, Physical Chemistry, S.Chand and Company, New Delhi (1996).

CH17411 FLUID MECHANICS LABORATORY L T P C
0 0 4 2

OBJECTIVE:

To learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

LIST OF EXPERIMENTS

1. Viscosity measurement of non-Newtonian fluids
2. Calibration of constant and variable head meters
3. Calibration of weirs and notches
4. Open drum orifice and draining time
5. Flow through straight pipe
6. Flow through annular pipe
7. Flow through helical coil and spiral coil
8. Losses in pipe fittings and valves
9. Characteristic curves of pumps
10. Pressure drop studies in packed column
11. Hydrodynamics of fluidized bed
12. Drag coefficient of solid particle

TOTAL: 60 PERIODS

OUTCOME:

Practical knowledge on the measurement of Fluid Flow and their characteristics at different operating conditions.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Viscometer
2. Venturi meter
3. Orifice meter
4. Rotameter
5. Weir
6. Open drum with orifice
7. Pipes and fittings
8. Helical and spiral coils
9. Centrifugal pump
10. Packed column
11. Fluidized bed

CY17412 ORGANIC CHEMISTRY LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- To provide experience on analysis, estimation and preparation of few organic compounds.
- To acquaint the students with the handling and analyzing of chemicals.

EXPERIMENTS

1. Qualitative analysis of organic compounds – Identification of aliphatic/aromatic, Saturated/unsaturated compounds.
2. Identification and characterization of various functional groups by their characteristic reactions: a) alcohol, b) aldehyde, c) ketone, d) carboxylic acid, e) phenol, f) ester, g) primary, secondary and tertiary amines h) imide i) nitro compounds.
3. Analysis of an unknown organic compound and preparation of suitable solid derivatives.
4. Analysis of carbohydrates.
5. Analysis of proteins.
6. Methodology of filtration, recrystallization andSolvent Extraction.
7. Introduction to organic synthetic procedures.
   i. Hydrolysis – Preparation of salicylic acid from methyl salicylate.
   ii. Oxidation – Preparation of benzoic acid from benzaldehyde.
   iii. Substitution – Conversion of acetone to iodoform.
   iv. Nitration – Preparation of *m*-dinitrobenzene from nitrobenzene.
   v. Sulphonation - Preparation of sulphanilic acid from aniline.

TOTAL : 60 PERIODS

OUTCOMES:

On completion of the course, students will be able to

- Analyze list of organic compounds and prepare their derivatives.
- Apply the principle of unit process in the preparation of organic compounds.
- Identify bio-molecules like carbohydrates and proteins.
- Perform basic types of purification procedures.
- Distinguish strong and weak nucleophiles.

REFERENCE

1. Vogel's Textbook of Practical Organic Chemistry,5TH edition, Pearson publications.
2. Gnanapragasam N.S., Organic Chemistry Lab manual, revised edition (2008), S.Viswanathan Pvt., Ltd.
3. Organic Chemistry Lab Manual, Chemistry Division, Chemical Engineering Department, A. C. Tech, Anna University (2007).

SEMESTER V

CH17501 CHEMICAL PROCESS INDUSTRIES L T P C
3 0 0 3

OBJECTIVE:

- To gain the knowledge in the manufacture of various chemicals present in day to day products.
- To understand the various unit processes and unit operations and the sequence involved in different chemical industries.
- To outline the components present in chemical process industries and design the chemical process plant.
- To give an exposure on aspects of safety for various chemical industries.

UNIT I INTRODUCTION AND CHLORO- ALKALI INDUSTRIES 9

The role of a chemical engineers in process industries, Introduction to common devices used in manufacturing processes, block diagrams, flowcharts and standard symbols used for devices, industrial safety and pollution,outline of plant and equipment design. Manufacture of Soda ash and sodiumbicarbonate, chlorine and caustic soda; bleaching powder and related bleaching agents, Sodium chloride, By-products of common salt industry.

UNIT II ACID INDUSTRIES 9

Mining and manufacture of sulphur, recovery of sulphur from polluting gases, sulphur trioxide and sulphuric acid, hydrochloric acid, Synthetic ammonia, Nitric acid, phosphoric acid

UNIT III SILICATE, PAPER AND SUGAR INDUSTRIES 9

Types and manufacture of Portland cement, Manufacture of glasses and special glasses, Ceramics and refractories, Manufacture of pulp – different processes of pulping – Manufacture of paper – Manufacture of Boards- Raw and refined sugar, by products of sugar industries, Starch and starch derivatives.

UNIT III OIL AND FIBRE INDUSTRIES 9

Hydrogenation of oils, fatty acids : soaps, synthetic detergents- manufacture of Nylon 6. 6. Polyesters Fibres – manufacturer of – Cellulosic Fibres – Viscose Rayon production manufacture of films - cellulose Acetate, PVC, Polyesters - polyethylene

UNIT V FERTILIZER INDUSTRIES 9

Growth elements, functions, ammonium sulphate, ammonium nitrate,ammonium phosphate, potassium chloride, potassium sulphate, single, triplesuper phosphate introduction to pesticides, herbicides and bio-fertilizers.

TOTAL : 45 PERIODS

OUTCOME:

- Ability to understand the manufacturing of various inorganic and organic chemicals
- Ability to understand the process flow diagram and various process parameters
- Ability to identify engineering problems during production
- Will be able outline the components present in various process industries
- Will have an idea of manufacturing fertilizers

TEXT BOOKS:

1. Austin, G.T.,Shreve's Chemical Process Industries, Fifth Edition, McGraw-Hill International Book Co, Singapore, 1984
2. Dryden, C.E., Outlines of Chemicals Technology, Edited and Revised byGopala Rao, M. and M.Sittig, Second Edition, Affiliated East-West press,1993.

REFERENCES:

1. Shukla and G.N. Pandey "Text book on Chemical Technology", Vikaspublishing company 1997
2. Kirk and othmer ,"Encyclopedia of Chemical Technology", III Edition.
3. Srikumar Koyikkal,"Chemical Process Technology and Simulation",PHILearning Ltd (2013).

CH17502 CHEMICAL ENGINEERING THERMODYNAMICS II

L	T	P	C
3	0	0	3

OBJECTIVE:

- To understand the theory and applications of thermodynamic properties of solutions
- To understand the methods used to describe and predict phase equilibria
- To understand and estimate the reaction rate constant at various conditions
- To understand the behavior of fluids under PVT conditions and also apply them for practical purpose

.

UNIT I PROPERTIES OF SOLUTIONS 9

Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs-Duhem equation, excess properties of mixtures.

UNIT II PHASE EQUILIBRIA 9

Criteria for equilibrium between phases in multi component non-reacting systems in terms of chemical potential and fugacity, application of phase rule, vapour-liquid equilibrium, phase diagrams for homogeneous systems and for systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium, ternary liquid-liquid equilibrium.

UNIT III CORRELATION AND PREDICTION OF PHASE EQUILIBRIA 9

Activity coefficient-composition models, thermodynamic consistency of phase equilibria, application of the correlation and prediction of phase equilibria in systems of engineering interest particularly to distillation and liquid extraction processes.

UNIT IV CHEMICAL REACTION EQUILIBRIA 9

Definition of standard state, standard free energy change and reaction equilibrium constant, evaluation of reaction equilibrium constant, prediction of free energy data, equilibria in chemical reactors, calculation of equilibrium compositions for homogeneous chemical reactors, thermodynamic analysis of simultaneous reactions.

UNIT V REFRIGERATION 9

Principles of refrigeration, methods of producing refrigeration, liquefaction process, co-efficient of performance, evaluation of the performance of vapour compression and gas refrigeration cycles.

TOTAL : 45PERIODS

OUTCOME:

- Will be able to calculate thermodynamic properties of solutions and mixtures
- will be able to apply solution thermodynamics fundamentals to solve VLE, LLE, SLE, and GLE problems including bubble point, dew point and flash calculations.
- Will be able to correlate and predict phase equilibria in Chemical engineering systems
- will understand the fundamental principles of chemical reaction equilibria including extent of reaction, equilibrium constant and its temperature-dependence, equilibrium conversion.
- will be able to perform energy conversion calculations for Rankine, power and compression refrigeration cycles.

TEXT BOOKS:

1. Smith, J.M., Van Ness, H.C and Abbot M.M "Introduction to Chemical Engineering Thermodynamics ", McGraw Hill Publishers, VI Edition, 2003
2. Rao, Y.V.C., "Chemical Engineering Thermodynamics" Universities Press, 2005
3. Narayanan, K.V. A Textbook of Chemical Engineering Thermodynamics, Prentice Hall India, 2004.

REFERENCES:

1. Kyle, B.G., "Chemical and Process Thermodynamics III Edition", Prentice Hall of India Pvt. Ltd., 1999.
2. Pradeep Ahuja," Chemical Engineering Thermodynamics", PHI Learning Ltd, (2009).
3. Gopinath Halder," Introduction to Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).
4.

CH17503 MASS TRANSFER I

L T P C
3 0 0 3

OBJECTIVE:

- To impart the knowledge on diffusion under various conditions
- Ability to determine mass transfer rates under laminar and turbulent conditions.
- Ability to apply mass transfer theories in various mass transfer operations such as humidification, drying and crystallization
- Ability to design cooling towers, crystallizers and dryers

UNIT I DIFFUSION 9

Introduction to mass transfer operations; Molecular diffusion in gases, liquids and solids; diffusivity measurement and prediction; multi-component diffusion.

UNIT II MASS TRANSFER CO-EFFICIENTS 10

Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, inter phase mass transfer, relationship between individual and overall mass transfer coefficients. NTU and NTP concepts, Stage-wise and differential contractors.

UNIT III HUMIDIFICATION 9

Humidification – Equilibrium, humidity chart, adiabatic and wet bulb temperatures; humidification operations; theory and design of cooling towers, dehumidifiers and humidifiers using enthalpy transfer unit concept.

UNIT IV DRYING 9

Drying– Equilibrium; classification of dryers; batch drying – Mechanism and time of cross through circulation drying, continuous dryers – material and energy balance; determination of length of rotary dryer using rate concept.

UNIT V CRYSTALLIZATION 8

Crystallization - Equilibrium, classification of crystallizers, mass and energy balance; kinetics of crystallization – nucleation and growth; design of batch crystallizers; population balance model and design of continuous crystallizers.

TOTAL : 45 PERIODS

OUTCOME:

- Will be to understand the concepts of diffusional mass transfer
- Will be able to use the correlations in calculating the mass transfer coefficients
- Will be able to apply the mass transfer concepts in the design of humidification columns

- Ability to understand the mechanism of crystallization and absorption
- Ability to design the driers and crystallizers

TEXT BOOKS:

1. Treybal, R.E., "Mass Transfer Operations", 3rd Edn, McGraw-Hill, 1981.
2. J.D. Seader and E.J. Henley, "Separation Process Principles", 2nd Ed., John Wiley, 2006.
3. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edn., McGraw-Hill, 2005.

REFERENCES:

1. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I and II 4th Edition,Asian Books Pvt. Ltd., India, 1998.
2. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey, 2003.
3. Binay K.Dutta,"Principles of Mass Transfer and Seperation Processes", PHI Learning Ltd, 2013.

CH17504 CHEMICAL REACTION ENGINEERING – I L T P C 3 2 0 4

OBJECTIVE:

- To impart the knowledge on chemical kinetics and analysis techniques
- To apply the knowledge of thermodynamics and kinetics to solve ideal reactor design problems
- To design chemical reactors used in process industries at various complicated levels
- To impart the knowledge on Residence time distribution and design of real reactors

UNIT I RATE EQUATION AND ANALYSIS OF KINETIC DATA 15

Rate equation, elementary, non-elementary reactions, theories of reaction rate and Prediction; Design equation for constant and variable volume batch reactors, analysis of experimental kinetics data, integral and differential analysis.

UNIT II DESIGN OF IDEAL REACTORS 15

Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, combination of reactors, size comparison of reactors.

UNIT III DESIGN OF REACTORS FOR MULTIPLE REACTIONS 15

Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield.

UNIT IV TEMPERATURE EFFECTS 15

Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate input and constant heat transfer coefficient, operation of batch and continuous reactors, optimum temperature progression.

UNIT V RESIDENCE TIME DISTRIBUTION 15

The residence time distribution as a factor of performance; residence time functions and relationship between them in reactor; basic models for non-ideal flow; conversion in non-ideal reactors.

TOTAL : 75 PERIODS

OUTCOME:

- Will be able to develop rate equation
- Will be able to design of ideal reactors for single and complex reactions
- Will be able to design of non-isothermal reactors
- Ability to design the non-ideal reactors through RTD studies

TEXT BOOKS:

1. Levenspiel O, "Chemical Reaction Engineering", Wiley Eastern Ltd., II Edition, 2000.
2. Fogler.H.S., "Elements of Chemical Reaction Engineering", Prentice Hall of India Ltd., III Edition, 2000
3. Smith, J.M, "Chemical Engineering Kinetics", McGraw Hill, III Edition, 1981.

REFERENCE:

1. Froment. G.F. &K.B.Bischoff, "Chemical Reactor Analysis and Design", John Wiley and Sons,1979.

CH17511 MECHANICAL OPERATIONS LABORATORY

L T P C
0 0 4 2

OBJECTIVE:

To enable the students to develop a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators.

LIST OF EXPERIMENTS

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press
4. Characteristics of batch Sedimentation
5. Reduction ratio in Jaw Crusher
6. Reduction ratio in Ball mill
7. Separation characteristics of Cyclone separator
8. Reduction ratio of Roll Crusher
9. Separation characteristics of Elutriator
10. Reduction ratio of Drop weight crusher
11. Size separation using Sub-Sieving

TOTAL : 60 PERIODS

OUTCOME:

Students would gain the practical knowledge and hands on various separation techniques like filtration, sedimentation, screening, elutriation, and centrifugation

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Sieve shaker
2. Leaf filter
3. Plate and Frame Filter Press
4. Sedimentation Jar
5. Jaw Crusher
6. Ball Mill
7. Cyclone Separator
8. Roll Crusher
9. Elutriator
10. Drop Weight Crusher
11. Sieves.

CH17512 HEAT TRANSFER LAB **L T P C**
0 0 4 2

OBJECTIVE:
To enable the students to develop a sound working knowledge on different types of heat transfer equipments.

LIST OF EXPERIMENTS
1. Performance studies on Cooling Tower
2. Batch drying kinetics using Tray Dryer
3. Heat transfer in Open Pan Evaporator
4. Boiling Heat Transfer
5. Heat Transfer through Packed Bed
6. Heat Transfer in a Double Pipe Heat Exchanger
7. Heat Transfer in a Bare and Finned Tube Heat Exchanger
8. Heat Transfer in a Condenser
9. Heat Transfer in Helical Coils
10. Heat Transfer in Agitated Vessels

TOTAL : 60 PERIODS

OUTCOME:
Student would be able to calculate heat transfer by conduction, different typesof convection using classical models for these phenomena.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS
1. Cooling Tower
2. Tray Dryer
3. Open Pan Evaporator
4. Boiler
5. Packed Bed
6. Double Pipe Heat Exchanger
7. Bare and Finned Tube Heat Exchanger
8. Condenser
9. Helical Coil
10. Agitated Vessel

SEMESTER – VI

CH17601 CHEMICAL REACTION ENGINEERING II L T P C
3 2 0 4

OBJECTIVE:

- To understand the design of catalyst
- To apply the knowledge of material and energy balances, mass transfer and chemical reaction engineering–I for solving problems involving heterogeneous reaction systems
- To understand and apply the principles of non-ideal flow in the design of reactors
- To enable the students to learn the gas-solid catalytic and non-catalytic reactors and gas-liquid reactors and design them

.

UNIT I CATALYSTS 11

Nature of catalysts, surface area and pore-volume distribution, catalyst preparation.

UNIT II HETEROGENEOUS REACTORS 17

Rate equations for heterogeneous reactions, adsorption isotherms, rates of adsorption and desorption, surface reaction analysis of rate equation and rate controlling steps.

UNIT III GAS-SOLID CATALYTIC REACTORS 17

Diffusion within catalyst particle, effective thermal conductivity, mass and heat transfer within catalyst pellets, effectiveness factor, Thiele Modulus, fixed bed reactors.

UNIT IV GAS-SOLID NON-CATALYTIC REACTORS 15

Models for explaining kinetics; volume and surface models; controlling resistances and rate controlling steps; time for complete conversion for single and mixed sizes, Fluidized and static reactors.

UNIT V GAS-LIQUID REACTORS 15

Absorption combined with chemical reactions; mass transfer coefficients and kinetic constants; application of film, penetration and surface renewal theories; Hatta number and enhancement factor for first order reaction, tower reactor design.

TOTAL : 75 PERIODS

OUTCOME:

- Ability to synthesis catalyst and determine its characteristics.
- Develop rate laws for heterogeneous reactions
- Design of reactors for gas-solid catalytic reactions
- Design of reactors for gas-solid non-catalytic.
- Design of towers for gas–liquid operations with and without chemical reaction

TEXT BOOKS:

1. Levenspiel, O., "Chemical Reaction Engineering ", III Edition, John Wiley,1999.
2. Fogler. H. S. " Elements of Chemical Reaction Engineering ", III Edition.,Prentice Hall of India, 1999.

REFERENCES:

1. Smith J.M., "Chemical Engineering Kinetics ", III Edition, McGraw-Hill, NewYork, 1981.
2. Froment G.F & K.B. Bischoff, "Chemical Reaction Analysis and Design",John Wiley and Sons, 1979.

CH17602 MASS TRANSFER II L T P C
3 2 0 4

OBJECTIVE:

- To teach the students different separation techniques
- To explain the design of a distillation column and absorption column
- To explain calculations involved in liquid -liquid extraction and solid-liquid extraction
- To explain calculations involved in adsorption and ion exchange

UNIT I ABSORPTION 15

Gas Absorption and Stripping – Equilibrium; material balance; limiting gas-liquid ratio; tray tower absorber - calculation of number of theoretical stages, tray efficiency, tower diameter; packed tower absorber – rate based approach; determination of height of packing using HTU and NTU calculations.

UNIT II DISTILLATION 15

Vapour liquid equilibria - Raoult's law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by Mc.Cabe - Thiele method, Total reflux, minimum reflux ratio, optimum reflux ratio. Introduction to multi-component distillation, azeotropic and
extractive distillation.

UNIT III LIQUID-LIQUID EXTRACTION 15

Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for batch and continuous extractors- differential contact equipment spray, packed and mechanically agitated contactors and their design calculations-packed bed extraction with reflux. Pulsed extractors, centrifugal extractors-Supercritical extraction.

UNIT IV LEACHING 15

Solid-liquid equilibria- leaching equipment for batch and continuous operations calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact(shank's system), equipments for leaching operation, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.

UNIT V ADSORPTION AND ION EXCHANGE & MEMBRANE SEPARATION PROCESS 15

Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves. Principle of Ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultra-filtration.

TOTAL : 75 PERIODS

OUTCOME:

- Will be able to design an absorber based on mass transfer principles
- Will be able to perform design calculations of distillation column
- Will be able to understand the principles of separation by liquid-Liquid extraction
- Ability to design leaching equipments
- Will be aware of principles of other separation processes.

TEXT BOOKS:

1. Treybal, R.E., "Mass Transfer Operations", 3rd Edn, McGraw-Hill, 1981.
2. Wankat, P., "Equilibrium Stage Separations", Prentice Hall, 1993.

3. J.D. Seader and E.J. Henley, "Separation Process Principles", 2nd Ed., John Wiley, 2006.
4. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edn., McGraw-Hill, 2005.

REFERENCES:

1. King, C. J., "Separation Processes ", 2nd Edition, Tata McGraw-Hill 1980.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I and II 4th Edition, Asian Books Pvt. Ltd., India, 1998.
3. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey, 2003.

CH17603 PROCESS INSTRUMENTATION, DYNAMICS AND CONTROL L T P C 3 0 0 3

OBJECTIVE:

- To teach the students about various measuring techniques
- To explain about open and closed loop systems
- To explain about frequency response systems
- To teach the students about advanced control systems

To introduce open and closed loop systems and its responses, control loop components and stability of control systems along with instrumentation.

UNIT I INSTRUMENTATION 9

Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flowrate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

UNIT II OPEN LOOP SYSTEMS 9

Laplace transformation and its application in process control. First order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.

UNIT III CLOSED LOOP SYSTEMS 9

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability.

UNIT IV FREQUENCY RESPONSE 9

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controllers Z-N tuning rules, C-C tuning rules.

UNIT V ADVANCED CONTROL SYSTEMS 9

Introduction to advanced control systems, cascade control, feed forward control, Smith predictor, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.

TOTAL : 45 PERIODS

OUTCOME:

1. Students will be able to measure various properties of the objects
2. They will be able to solve open loop and closed loop control problems
3. They will be to design the controllers based on the theory
4. They will understand the frequency techniques available to fine the stability of a system process
5. The students will be to know the advanced control sysatem

TEXT BOOKS:

1. Stephanopoulos, G., "Chemical Process Control", Prentice Hall of India, 2003.
2. Coughnowr, D., "Process Systems Analysis and Control ", 3rd Edn., McGraw Hill, New York, 2008.

REFERENCES:

1. Marlin, T. E., "Process Control ", 2nd Edn, McGraw Hill, New York, 2000.
2. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process control", 2nd Edn., John Wiley, New York, 1997.
3. Jason L. Speyer, Walter H. Chung,"Stochastic Processes, Estimation, and Control", PHI Ltd (2013).

CH17604 PROCESS ENGINEERING ECONOMICS L T P C
3 0 0 3

OBJECTIVE:

- To learn the basic concepts of economic analysis for process, involving equipment cost, and profitability.
- To teach principles of cost estimation, feasibility analysis, management, organization and quality control
- To provide a conceptual and methodological framework for evaluating the cost, revenue, profitability and risk of chemical engineering processes and products.

UNIT I PRINCIPLES OF MANAGEMENT AND ORGANISATION 12

Planning, organization, staffing, coordination, directing, controlling, communicating, organization as a process and a structure; types of organizations. Method study; work measurement techniques; basic procedure; motion study; motion economy; principles of time study; elements of production control; forecasting; planning; routing; scheduling; dispatching; costs and costs control, inventory and inventory control.

UNIT II INVESTMENT COSTS AND COST ESTIMATION 8

Time Value of money; capital costs and depreciation, estimation of capital cost, manufacturing costs and working capital, capital budgeting and project feasibility.

UNIT III PROFITABILITY, INVESTMENT ALTERNATIVE AND REPLACEMENT 9

Estimation of project profitability, sensitivity analysis; investment alternatives; replacement policy; forecasting sales; inflation and its impact.

UNIT IV ANNUAL REPORTS AND ANALYSIS OF PERFORMANCE 8

Principles of accounting; balance sheet; income statement; financial ratios; analysis of performance and growth.

UNIT V ECONOMIC BALANCE 8

Economic decisions in Chemical Plant - Economics of size - Essentials of economic balance – Economic balance approach, economic balance for insulation, evaporation, heat transfer.

TOTAL : 45 PERIODS

OUTCOME:

- Ability to estimate the capital investment, cost of production, depreciation and cash flows of chemical engineering processes
- Will be able to make decisions about the profitability of chemical engineering processes by applying discounted profitability analysis including net present value, internal rate of return and discounted payback period

- Ability to analyze the economic risk of a chemical engineering process by means of sensitivity, scenario, and decision tree analysis as well as calculation of expected net present value
- Will be able to explain how optimization of a chemical engineering processes based on profitability yields simple rules of thumb for the design of chemical engineering processes
- will be able to size and estimate the capital costs of heat exchangers and evaporators

TEXT BOOKS:

1. Peters, M. S. and Timmerhaus, C. D. RE West , "Plant Design and Economics for Chemical Engineers", III Edn, McGraw Hill, 2003.
2. Holand, F.A., Watson, F.A. and Wilkinson, J.K., "Introduction to process Economics", 2nd Edition, John Wiley, 1983.
3. Banga T.R., and Sharma S.C., Industrial Organization and Engineering economics, Khanna Publishers, New Delhi.

REFERENCES:

1. Allen, L.A., "Management and Organization", McGraw Hill.
2. Perry, R. H. and Green, D., "Chemical Engineer's Handbook ", 7th Edition, McGraw Hill.
3. Narang, G.B.S. and Kumar, V., "Production and Costing", Khanna Publishers, New Delhi.

CH17611 COMPUTATIONAL PROGRAMMING LABORATORY FOR CHEMICAL ENGINEERS

L T P C
0 0 4 2

OBJECTIVE:

To impart knowledge on the computational skills and solving the chemical engineering problems.

List of Experiments

Solving chemical engineering related problems using Aspen, Scilab, MATLAB,MS Office

1. To solve for Recycle and purge flows
2. To find bubble point and dew point of a system
3. Finding the pressure drop across a pipe
4. Estimating the pressure head using Bernoulli's equation
5. Solve for bottom and top product compositions
6. To estimate the total drying time in a dryer
7. Determine the separation efficiency of a cyclone separator
8. Determine the pressure drop across the filtration equipment
9. To find the exit temperature of heat exchanger
10. Determine the output slurry concentration of an evaporator
11. Find the conversion of CSTR, PFR
12. Solve for material and energy balance for a given process

Reference Book

Bruce A Finlayson, Introduction to chemical engineering Computing, 2nd Edition, John Wiley & Sons, 2006

TOTAL : 60 PERIODS

OUTCOME:

Students would solve any chemical engineering problems using the soft tools..

CH17612 CHEMICAL REACTION ENGINEERING LABORATORY **L T P C**
0 0 4 2

OBJECTIVE:
To impart knowledge on design of reactors.

LIST OF EXPERIMENTS
1. Kinetic studies in a Batch reactor
2. Kinetic studies in a Plug flow reactor
3. Kinetic studies in a CSTR
4. Kinetic studies in a Packed bed reactor
5. Kinetic studies in a PFR followed by a CSTR
6. RTD studies in a PFR
7. RTD studies in a Packed bed reactor
8. RTD studies in a CSTR
9. Studies on micellar catalysis
10. Study of temperature dependence of rate constant using CSTR.
11. Kinetic studies in Sono chemical reactor
12. Batch reactive distillation
13. Kinetics of photochemical reaction
14. Demonstration of heterogeneous catalytic reaction
15. Demonstration of gas-liquid reaction

TOTAL : 60 PERIODS

OUTCOME:
Students would get a sound working knowledge on different types of reactors.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS
1. Batch Reactor
2. Plug flow reactor
3. CSTR
4. Sono-chemical reactor
5. Photochemical reactor
6. Packed bed reactor

*Minimum 10 experiments shall be offered.

SEMESTER VII

CH17701 TRANSPORT PHENOMENA L T P C
2 2 0 3

OBJECTIVES:

- To understand different types of fluids, their flow characteristics and different mathematical models applied to actual situations
- To provide the fundamentals to solve real life problems involving transports of momentum, energy and mass in biological, mechanical and chemical systems using a unified approach.
- To explain the mechanism of fluids in motion under different conditions.

UNIT I TRANSPORT PHENOMENA BY MOLECULAR MOTION 12

Importance of transport phenomena; analogous nature of transfer process; basic concepts, conservation laws; continuous concept, field, reference frames, substantial derivative and boundary conditions; methods of analysis; differential, integral and experimental methods.

Phenomenological laws of transport properties Newtonian and non-Newtonian fluids; rheological models; theories of transport properties of gases and liquids; effect of pressure and temperature.

UNIT II ONE DIMENSIONAL TRANSPORT IN LAMINAR FLOW (SHELL BALANCE) 15

General method of shell balance approach to transfer problems; Choosing the shape of the shell; most common boundary conditions; momentum flux and velocity distribution for flow of Newtonian and non-Newtonian fluids in pipes for flow of Newtonian fluids in planes, slits and annulus heat flux and temperature distribution for heat sources such as electrical, nuclear viscous and chemical; forced and free convection; mass flux and concentration profile for diffusion in stagnant gas, systems involving reaction and forced convection.

UNIT III EQUATIONS OF CHANGE AND THEIR APPLICATIONS 17

Conservation laws and equations of change; Development of equations of continuity motion and energy in single multi-components systems in rectangular co-ordinates and the forms in curvilinear co-ordinates; simplified forms of equations for special cases, solutions of momentum mass and heat transfer problems discussed under shell balance by applications of equation of change, scale factors; applications in scale-up.

UNIT IV TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW 9

Turbulents phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat surface.

UNIT V ANALOGIES BETWEEN TRANSPORT PROCESSES 7

Importance of analogy; development and applications of analogies between momentum and mass transfer; Reynolds, Prandtl, Von Karman and Colburn analogies.

TOTAL: 60 PERIODS

OUTCOME:

- Will be to understand of transport processes.
- Ability to do heat, mass and momentum transfer analysis.
- Ability to analyze industrial problems along with appropriate boundary conditions.
- Ability to develop steady and time dependent solutions along with their limitations.
- Will gain knowledge of fundamental connections between the conservation laws in heat, mass, and momentum in terms of vector and tensor fluxes.

TEXT BOOKS:

1. R.B. Bird, W.E. Stewart and E.W. Lightfoot, "Transport Phenomena", JohnWiley, II Edition 2006.
2. Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena A UnifiedApproach ", Brodkey Publishing 2003.

REFERENCES:

1. L.S.Sissom, and D.R.Pitts, "Elements of Transport Phenomena", McGraw-Hill, New York, 1972.
2. R.W.Fahien, "Elementary Transport Phenomena", McGraw-Hill, New York,1983.
3. J.R. Welty, R.W. Wilson, and C.W.Wicks, Rorer G.E, Wilson R.W."Fundamentals of Momentum Heat and Mass Transfer", V Edn. John Wiley,New York, 2007.

CH17702 PROCESS EQUIPMENT DESIGN

L T P C
3 2 0 4

(All Tables/Chemical Engineers' Handbook/Data Books/Graph Sheets are permitted during the Examination.)

OBJECTIVE:

To impart practical knowledge on the shape and drawing of the process equipments.

UNIT I **15**

Fundamental principles, equations, general design and drawing considerations of cooling towers, evaporators and driers.

UNIT II

Heat exchangers, condensers and reboilers. **15**

UNIT III **15**

Distillation columns- sieve tray, and bubble cap tray columns and packed column.

UNIT IV

Equipments for absorption and adsorption of gases. **15**

UNIT V **15**

Equipments for liquid-liquid extraction and solid-liquid extraction

TOTAL: 75 PERIODS

OUTCOME:

Students would gain knowledge to develop key concepts and techniques to design the process equipment in a process plant. These key concepts would be utilized to make design and operating decisions.

TEXT BOOKS:

1. M.V.Joshi and V.V. Mahajan, "Process Equipment Design", MacMillan IndiaLtd.
2. S.D.Dawande, "Process Design of Equipments", Central Techno Publications, Nagpur, 2000.

REFERENCES:

1. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969.Indian Standards Institution, New Delhi.
2. R.H. Perry, "Chemical Engineers' Handbook", McGraw-Hill.
3. W.L.McCabe, J.C.Smith and Harriet, "Unit Operation of Chemical Engineering", McGraw-Hill.
4. Robert Treybal, "Mass Transfer Operations", McGraw-Hill.
5. J.M. Coulson and J.Richardson, "Chemical Engineering", vol. 6, Asian Books Printers Ltd.

CH17703 OPTIMIZATION OF CHEMICAL PROCESSES L T P C
3 0 0 3

OBJECTIVE:

- Introduce the fundamental concepts of Optimization Techniques;
- To make the learners aware of the importance of optimizations in real scenarios;
- To provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.
- To apply the methods of optimization in real life situation.

UNIT I OPTIMIZATION 15

Introduction; formulation of objective functions; fitting models to data; classification of functions; necessary and sufficient conditions for optimum; unimodal, multimodal functions; analytical methods lagrange multiplier methods.

UNIT II NUMERICAL METHODS 15

Unimodel functions; newton's quasi newton, secant methods; region elimination methods, polynomial approximation; quadratic and cubic interpolation techniques for optimum. Multimodal functions; direct methods; random, grid. Hooke's nelder and mead methods; Powell's technique; indirect methods; gradient and conjugate gradient methods; secant methods.

UNIT III LINEAR AND NON-LINEAR PROGRAMMING APPLICATIONS 15

Review on basic concepts of LP formulations; Simplex methods; Integer, quadratic, geometric and dynamic programming. Heat transfer and energy conservation; separation processes; fluid flow systems; reactor design and operation; large scale systems.

TOTAL : 45 PERIODS

OUTCOME:

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

- Recognize the importance of optimization of industrial process management
- Apply basic concepts of mathematics to formulate an optimization problem.
- Analyse and appreciate variety of performance measures for various optimization problems formulate optimization problems.
- Understand and apply the concept of optimality criteria for various type of optimization problems.
- Solve various constrained and unconstrained problems in single variable as well as Multivariable.

TEXT BOOKS:

1. Edgar, T.F., Himmelblau, D.M., "Optimisation of Chemical Processes", McGraw-Hill II Edition 2001.
2. Reklaitis, G.V., Ravindran, A., Ragsdell, K.M. "Engineering Optimisation", John Wiley, II Edition 2006

REFERENCES:

1. Biles, W.E., Swain, J.J.; "Optimisation and Industrial Experimentation", Inter Science, New York, 1980.
2. Seinfeld, J.H.; Lapidus, L; "Process Modelling, Estimation and Identification", Prentice Hall, Englewood Cliffs, New Jersey, 1974.
3. Beveridge, C.S.; Schechter, R.S.; "Optimisation: Theory and Practice", McGraw-Hill Book Co., New York, 1970.

CH 17711 PROCESS CONTROL LABORATORY

L T P C
0 0 4 2

OBJECTIVE:
To determine experimentally the methods of controlling the processes including Measurements using process simulation techniques.

LIST OF EXPERIMENTS
1. Response of first order system
2. Response of second order system
3. Response of Non-Interacting level System
4. Response of Interacting level System
5. Open loop study on a thermal system
6. Closed loop study on a level system
7. Closed loop study on a flow system
8. Closed loop study on a thermal system
9. Tuning of a level system
10. Tuning of a pressure system
11. Tuning of a thermal system
12. Flow co-efficient of control valves
13. Characteristics of different types of control valves
14. Closed loop study on a pressure system
15. Tuning of pressure system
16. Closed loop response of cascade control system

*Minimum 10 experiments shall be Offered.

TOTAL: 60 PERIODS

OUTCOME:
Students would have knowledge on the development and use of right type of control dynamics for process control under different operative conditions.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS
1. U tube manometer with controller
2. Interacting Tank
3. Non Interacting Tank
4. Open loop control system
5. Closed loop control system
6. ON/OFF controller
7. Control valve characteristics
8. Pressure Tuner
9. Temperature Tuner
10. Proportional Controller
11. Flow Transmitter
12. Level Transmitter
13. Cascade control system

CH17712 MASS TRANSFER LABORATORY

L T P C
0 0 4 2

OBJECTIVE:
To train the students to develop sound working knowledge on different types of mass transfer equipment.

LIST OF EXPERIMENTS
1. Separation of binary mixture using Simple distillation
2. Separation of binary mixture using Steam distillation
3. Separation of binary mixture using Packed column distillation

4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of Vacuum Dryer
7. Drying characteristics of Tray dryer
8. Drying characteristics of Rotary dryer
9. Water purification using ion exchange columns
10. Mass transfer characteristics of Rotating disc contactor
11. Estimation of mass/heat transfer coefficient for cooling tower
12. Demonstration of Gas – Liquid absorption

TOTAL : 60 PERIODS

OUTCOME:

Students would be able to determine important data for the design and operation of the process equipment like distillation, extraction, diffusivity and drying principles which are having wide applications in various industries

LIST OF EQUIPMENTS FOR BATCH OF 30 STUDENTS

1. Simple distillation setup
2. Steam distillation setup
3. Packed column
4. Liquid-liquid extractor
5. Vacuum Dryer
6. Tray dryer
7. Rotary dryer
8. Ion exchange column
9. Rotating disc contactor
10. Cooling tower
11. Absorption column

Minimum 10 experiments shall be offered.

ELECTIVES

PROFESSIONAL ELECTIVE I

CH17E11 ENZYME ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

To develop skills of the students in the area of Enzyme Engineering with mphasis on reactor operation and design.

UNIT I **9**
Types of Microorganism: Structure and function of microbial cells. Fundamentals of microbial growth, batch and continuous culture. Isolation and purification of enzymes from cells. Cell and Enzyme Immobilization.

UNIT II **9**
Fermentation – Types of mechanisms, Continuous fermentation – aeration and agitation, kinetics of fermentation – Processes

UNIT III **9**
Introduction of Bioreactor design: Continuously stirred aerated tank bioreactors. Mixing power correlation. Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power.

UNIT IV Enzyme and Enzyme Kinetics **9**
Introduction to Biochemistry, Function and applications. Nature and function of enzyme. Coenzyme / Cofactor. Classification of enzymes. Assay methods and units. Examples of applications of enzymes in industry, analytical technique medicine and Pharmaceuticals.

UNIT V **9**
Industrial Bioreactors Utilizing Isolated enzymes and biosensors development and applications. Designs of reactor, Batch and continue type; analysis for immobilized enzyme reactors. Sterile and non sterile operations; reactors in series with and without recycle.

TOTAL : 45 PERIODS

OUTCOME:
At the end of the course, the students would have learnt about classification of enzymes, immobilization, extraction and purification of enzymes and biosensors.

TEXT BOOKS:

1. Technological Applications of Bio-catalysts, BIOTOL series, Butter worth, 1995.
2. Cornish. A -Bowden, Analysis of Enzyme Kinetic Data, Oxford University Press, 1996.

REFERENCES:
1. Wiseman. A and Blakeborough N and Dunnill P, Enzymic and nonenzymic catalysis, Ex. Vol.5 Ellis and Harwood, U.K. (1981).
2. Wiseman A (Ed.), Topics in enzyme and fermentation Bio-technology, Ellis and Harwood, U.K. Vol-5.

CH17E12 FLUIDIZATION ENGINEERING L T P C
3 0 0 3

OBJECTIVE:
To enable the students to learn the design aspects of fluidized beds.

UNIT BASICS OF FLUIDIZATION 9
Packed bed – Velocity – Pressure drop relations – Correlations of Ergun, Kozney-karman – On set of fluidization – Properties of fluidized beds – Development of fluidization from fixed bed.

UNIT II FLUIDIZED BED TYPES 9
Minimum fluidization conditions – Expanded bed – Elutriation – Moving solids and dilute phase – spouted bed.

UNIT III DESIGN ASPECTS 9
Channeling – Bed expansion in liquid – Solid and gas – Solid fluidizations. Design aspects of fluidized bed systems.

UNIT IV HEAT AND MASS TRANSFER IN FLUIDIZED BEDS 9
Heat and mass transfer in fluidized bed systems – Industrial applications and case studies of fluidized bed systems.

UNIT V OTHER TYPES OF FLUIDIZATION 9
Single stage and multistage fluidization – Collection of fines – Use of cyclones.

TOTAL : 45 PERIODS

OUTCOME:
Upon completion of this course, the students will have the knowledge on fluidization phenomenon, behavior of fluidized beds and industrial applications.

TEXT BOOKS:
1. Levenspiel, "Fluidization Engineering", 2nd Edition, Butterworth – Heinmann, 1991.
2. Robert H. Perry and Don W. Green, "Perry's Chemical Engineer's Hand Book", 7th Edition, Mc Graw Hill – International, 1997.

REFERENCES:
1. Rowe and Davidson, "Fluidization", Academic Press,1971.
2. Leva, M., "Fluidization", McGraw Hill Book Co, 1959.
3. Wen-Ching Yang., "Handbook of Fluidization and Fluid-Particle Systems", Marcel Dekker Inc, 2003.

CH17E13 FOOD TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:
To enable the students to learn to design processing equipments for Food Industries.

UNIT I AN OVERVIEW 5
General aspects of food industry; world food needs and Indian situation.

UNIT II FOOD CONSTITUENTS, QUALITY AND DERIVATIVE FACTORS 10
Constituents of food; quality and nutritive aspects; food additives; standards; deteriorative factors and their control.

UNIT III GENERAL ENGINEERING ASPECTS AND PROCESSING METHODS 9

Preliminary processing methods; conversion and preservation operations.

UNIT IV FOOD PRESERVATION METHODS 12

Preservation by heat and cold; dehydration; concentration; drying irradiation; microwave heating; sterilization and pasteurization; fermentation and pickling; packing methods.

UNIT V PRODUCTION AND UTILISATION OF FOOD PRODUCTS 9

Cereal grains; pulses; vegetables; fruits; spices; fats and oils; bakery; confectionery and chocolate products; soft and alcoholic beverages; dairy products; meat; poultry and fish products.

TOTAL : 45 PERIODS

OUTCOME:

Upon completion of this course, the students would get the exposure on use of different chemical additives in foods during food processing and preservation

TEXT BOOKS:

1. Heid J.L. Joslyn M.A., Fundamentals of Food Processing Operation, The AVI publishing Co., West port 1967.
2. Potter N.N., Food Science, The AVI publishing Co., Westport, 1963.

REFERENCES:

1. Heldman D.R., Food Process Engineering, The AVI publishing co., 1975.
2. Charm S.E., The Fundamentals of Foods Engineering, The AVI Publishing Co., Westport, 1963.

CH17E14 INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

L T P C
3 0 0 3

OBJECTIVE:

To make the students understand the working principles of different types of instruments and their applications.

UNIT I INTRODUCTION OF SPECTROMETRY 9

Properties of electromagnetic radiation- wave properties – components of optical instruments – Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – Principle of Fourier Transform optical Measurements.

UNIT II MOLECULAR SPECTROSCOPY 9

Molecular absorption spectrometry – Measurement of Transmittance and Absorbance – Beer's law – Instrumentation - Applications -Theory of fluorescence and Phosphorescence –Instrumenation – Applications – Theory of Infrared absorption spectrometry – IR instrumentation - Applications – Theory of Raman spectroscopy – Instrumentation – applications.

UNIT III MAGNETIC RESONANCE SPECTROSCOPY AND MASS SPECTROMETRY 9

Theory of NMR – environmental effects on NMR spectra – chemical shift- NMR-spectrometers – applicatons of 1H and 13C NMR- Molecular mass spectra – ion sources – Mass spectrometer. Applications of molecular mass - Electron paramagnetic resonance- g values – instrumentation.

UNIT IV SEPARATION METHODS 9

General description of chromatography – Band broadening and optimization of column performance- Liquid chromatography – Partition chromatography - Adsorption chromatography – Ion exchange chromatography -size exclusion chromatography- Affinity chromatography-principles of GC and applications – HPLC- Capillary electrophoresis – Applications.

UNIT V ELECTRO ANALYSIS AND SURFACE MICROSCOPY 9

Electrochemical cells- Electrode potential cell potentials – potentiometry-reference electrode – ion selective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry . Study of surfaces – Scanning probe microscopes – AFM and STM.

TOTAL : 45 PERIODS

OUTCOME:

Upon completion of this course, the students would have knowledge about the Qualitative and quantitative instrument analysis of different materials.

TEXT BOOK:

1. Instrumental Methods of Analysis. D.A. Skoog, F. James Holler, Stanky, R.Crouch . Cengage Learning – 2007.

REFERENCE:

1. Instrumental Methods of Analysis, Willard.H.H, Merritt.I.I, Dean J.A, Settle. F.A, 6th Edition, CBS Publishers-1986

CH17E15 COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING L T P C 3 0 0 3

OBJECTIVES

To obtain skill in creating database retrieval of data and also to solve Mathematical models thro' linear and non-linear programming.

UNIT I INTRODUCTION 9

Review on Programming languages, Basic, Fortran, Review on operating system commands.

UNIT II SPREAD SHEETS 9

Application in Density, molecular weight, mole and percentage compositions, Empirical and Molecular formula calculations, Heat of mixing, Gas laws, Vapour pressure, Chemical Kinetics calculations.

UNIT III SPREAD SHEETS (DATA ANALYSIS) 9

Application in data processing, Statistical analysis of data, Regression. Analysis of variance, Interpolation, Graphical representations of various Chemical Engineering problem both in laboratory exercise and core subjects such as Mechanical operation, Reaction Engineering, Distillation etc.,

UNIT IV DATABASE 9

Design and developments of simple databases on Chemical and Physical properties of substances. Retrieval and Database in report, query and other formats, Interfacing with other softwares. Preparation of Material and energy Balances preparation of plant layout.

UNIT V MATHEMATICAL PROGRAMMING 9

Linear Programming, Transportation, Assignment, Dynamic Programming in Chemical Engineering, Formulation and solution through PC based programes.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Hanna, O.T. Scandell, O.C. Computational Methods in Chemical Engineering, Prentice Hall, 1995.
2. R.K. Taxali, T.K. dBase IV made simple, Tata McGraw-Hill 1991. 80

REFERENCES

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

PROFESSIONAL ELECTIVE II

CH17E21 AIR POLLUTION AND CONTROL L T P C
3 0 0 3

OBJECTIVE:

To enable the students to learn about Air Pollution, effects of air pollution, Global effects, Sampling of pollutants, Meteorology and air pollution, Atmospheric stability, Plume rise and dispersion and Prediction of air quality.

UNIT I INTRODUCTION 9

Air Pollution Regulatory Framework Histroy – Air Pollution Regulatory Framework - Regulatory System – Laws and Regulations – Clean air Act – Provisions for Recent Developments.

UNIT II AIR POLLUTION GASES 9

Measurement fundamentals – chemicals and physical properties – Phase Equilibrium - consecution laws – Incinerators – Design and Performance – Operation and Maintainance - Absorbers – Design operation and improving performances Absorbers.

UNIT III PARTICULATE AIR POLLUTION 9

Particle Collection mechanisms– Fluid particle - Dynamics – Particle size Distribution – Efficency – Gravity Setling chambers Cyclones- Electrostatic precepators Bannouses

UNIT IV HYBRID SYSTEM 9

Heat electrostatic precepitation – Genizing Heat Scrubbers – Dry Scrubbers – Electrostatically Augmented Fabric Fillration

UNIT V AIR POLLUTION CONTROL EQUIPMENT 9

Introduction – Installation – Cost Model.

TOTAL : 45 PERIODS

OUTCOME:

Upon completion of this course, the students would have the knowledge of ambient air pollution, its sources, its effects, and mechanisms for air pollution prevention.

TEXT BOOKS:

1. Air Pollution Control Equipment Louis Theodore, Burley Intuscence 2008.
2. Air Pollution Control CD Cooper and FC.Alley Wairland Press III Edition 2002.
3. Air Pollution Control Engg, Noel de nevey – Mcgrew Hill.

CH17E22 FRONTIERS OF CHEMICAL ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

To enable the students to understand the chemical product design and available renewable energy resources.

UNIT I PROCESS INTENSIFICATION 9

Novel reactor configurations; combination of reaction and separation; use of different energy fields, lab on a chip.

UNIT II CHEMICAL PRODUCT DESIGN 9

Scope and importance; identification of needs and specifications; sources of ideas and screening ideas; selection of product idea; process development for product manufacture; specialty chemical manufacture; economic aspects.

UNIT III RENEWABLE ENERGY 9

Hydrogen production, Hydrogen economy, Fuel Cell Technology, biofuel cells and bio-hydrogen, solar energy

UNIT IV MATERIALS ENGINEERING 9

Polymers and composites, ceramics and glasses, colloidal dispersions and nanoparticles, thin films and electronic materials

9

UNIT V BIOENGINEERING

Biomechanics, biotransport and biomaterials, biomolecular and cellular engineering, drug discovery and development.

TOTAL : 45 PERIODS

OUTCOME:

After completing this course, the students will be confident in their ability to apply chemical or bioengineering fundamentals. They will have the conception and application of properties of materials for use in engineering, structural and specialty needs necessary in the design and development of specific components

TEXTBOOKS:

1. Keil, F. J., Modeling of Process Intensification Wiley-VCH Verlag GmbH & Co. KGaA2007
2. Cussler, E.l. and Moggridge, G.D., "Chemical product design" Cambridge University Press, Cambridge, 2001
3. Hoffmann,P, Tomorrow's energy: hydrogen, fuel cells, and the prospects for a cleaner planet, MIT Press, Sabon, 2002

REFERENCE:

1. Mitchell, B.S., An introduction to materials engineering and science for chemical and materials engineers, John Wiley and Sons Inc., New Jersey, 2004

CH17E23 INDUSTRIAL PROCESS PLANT SAFETY

L T P C
3 0 0 3

OBJECTIVE:

To enable the students to become a skilled person in hazopard hazarel analysis and finding out the root cause of an accident. Gain knowledge in devising safety policy and procedures to be adopted to implement total safety in a plant

UNIT I INTRODUCTION TO SAFETY PROGRAMMES 9

Safety in industries; need for development; importance safety consciousness in Indian chemical industry; social environmental setup; tolerance limit of the society; psychological attitude towards safety programmes. Elements of safety programme; effective realization; economic and social benefits; effective communication training at various levels of production and operation.

UNIT II INDUSTRIAL SAFETY 9

Chemical process industries; potential hazards; chemical and physical job safety analysis; high pressure; high temperature operation; dangerous and toxic chemicals; highly radioactive materials; safe handling and operation of materials and machineries; planning and layout.

UNIT III SAFETY PERFORMANCE 9

Appraisal; effective steps to implement safety procedures; periodic inspection and study of plant layout and constant maintenance; periodic advice and checking to follow safety procedures; proper selection and replacement of handling equipments; personal protective equipments.

UNIT IV ACCIDENTS 9

Industrial accidents – accident costs – identification of accident spots; remedial measures; identification and analysis of causes of injury to men and machines – accident prevention – accident proneness – vocational guidance, fault free analysis. Fire prevention and fire protection.

UNIT V HEALTH HAZARDS AND LEGAL ASPECTS 9

Health hazards – occupational – industrial health hazards – health standards, and rules – safe working environments – parliamentary legislations – factories act – labour welfare act – ESI Act – Workmen Compensation Act .Role of Government, safety organizations, management and trade unions in promoting industrial safety.

TOTAL : 45 PERIODS

OUTCOME:

Upon completion of this course, the students would have learnt the basic concepts relating to chemical hazards, risk, and ethics. They also develop knowledge of quantitatively analyze release and dispersion rates of liquids and vapors.

TEXT BOOKS:

1. Ridley Safety at Work, VII Edition, Butterworth Heinman 2007.
2. William Handley, Industrial Safety Hand Book McGraw-Hill Book Company 2nd Edition, 1977.
3. Fawatt, H.H. and Wood, W.S.Safety and Accident Prevention in Chemical Operation, Interscience, 1965

REFERENCES:

1. Heinrich, H.W. Dan Peterson, P.E. and Nester Rood. Industrial Accident Prevention, McGraw-Hill Book Co., 1980
2. Blake, R.P., Industrial Safety, Prentice Hall Inc., New Jersy – 3rd Edn. 1963.

CH17E24 DRUGS AND PHARMACEUTICAL TECHNOLOGY L T P C

3 0 0 3

OBJECTIVE:

To give the students an understanding of the polytechnical nature of engineering and drug discovery in the pharmaceutical industry involving Chemical Engineering.

UNIT I INTRODUCTION 9

Development of drugs and pharamaceutical industry; organic therapeutic agents uses and economics

UNIT II DRUG METABOLISM AND PHARMACO KINETICS & MICROBIOLOGICAL AND ANIMAL PRODUCTS 9

Drug metabolism; physico chemical principles; pharma kinetics-action of drugs on human bodies.

Antibiotics- gram positive, gram negative and broad spectrum antibiotics; hormones

UNIT III IMPORTANT UNIT PROCESSES AND THEIR APPLICATION 9

Chemical conversion processes; alkylation; carboxylation; condensation and cyclisation; dehydration, esterification, halogenation, oxidation, sulfonation; complex chemical conversions fermentation.

MANUFACTURING PRINCIPLES & PACKING AND QUALITY

UNIT IV CONTROL 9

Compressed tablets; wet granulation; dry granulation or slugging; advancement in granulation; direct compression, tablet presses formulation; coating pills; capsules sustained action dosage forms; parential solutions, oral liquids; injections; ointments; standard of hygiene and manufacturing practice. Packing; packing techniques; quality control.

UNIT V PHARMACEUTICAL PRODUCTS & PHARMACEUTICAL ANALYSIS 9

Vitamins; cold remedies; laxatives; analgesics; non-steroidal contraceptives; external antiseptics; antacids and others. Analytical methods and tests for various drugs and pharmaceuticals – spectroscopy, chromatography, fluorimetry, polarimetry, refractometry and pH metry

TOTAL : 45 PERIODS

OUTCOME:

Students will be equipped with the knowledge to transform raw materials into useful pharmaceutical and fine chemical products with commercial interest through systematic use of engineering concepts and methods

TEXT BOOK:

1. Rawlines, E.A.; " Bentleys Text book of Pharmaceutics ", III Edition, Bailliere Tindall, London, 1977.

REFERENCES:

1. Yalkonsky, S.H.; Swarbick. J.; " Drug and Pharamaceutical Sciences ", Vol. I, II, III, IV, V, VI and VII, Marcel Dekkar Inc., New York, 1975.
2. "Remingtons Pharmaceutical Sciences ", Mack Publishing Co., 1975.

GE17E25 HUMAN VALUES AND PROFESSIONAL ETHICS L T P C 3 0 0 3

OBJECTIVES:

To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES 10

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – 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

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

UNIT V GLOBAL ISSUES 8

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility

TOTAL: 45 PERIODS

OUTCOME :

Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society

TEXTBOOKS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCES:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009
3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, "Fundametals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001
5. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi 2013.
6. World Community Service Centre, ' Value Education', Vethathiri publications, Erode, 2011

WEB SOURCES:

1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org
4. www.ethics.org

PROFESSIONAL ELECTIVE – III

CH17E31	**ELECTROCHEMICAL ENGINEERING**	**L T P C** **3 0 0 3**

OBJECTIVE:

To solve problems related to the production, storage, distribution and utilization of electrochemical energy and the associated environmental issues

UNIT I **9**

Review basics of electrochemistry: Faraday's law -Nernst potential –Galvanic cells – Polarography, The electrical double layer: It's role in electrochemical processes –Electro capillary curve –Helmoltz layer –Guoy –Steven's layer – fields at the interface.

UNIT II **9**

Mass transfer in electrochemical systems: diffusion controlled electrochemical reaction –the importance of convention and the concept of limiting current. over potential, primary-secondary current distribution –rotating disc electrode.

UNIT III **10**

Introduction to corrosion, series, corrosion theories derivation of potential-current relations of activities controlled and diffusion controlled corrosion process. Potential-pH diagram, Forms of corrosion-definition, factors and control methods of various forms of corrosion-corrosion control measures-industrial boiler water corrosion control –protective coatings –Vapor phase inhibitors –cathodic protection, sacrificial anodes –Paint removers.

UNIT IV **8**

Electro deposition –electro refining –electroforming –electro polishing – anodizing –Selective solar coatings, Primary and secondary batteries –types of batteries, Fuel cells.

UNIT V **9**

Electrodes used in different electrochemical industries: Metals-Graphite –Lead dioxide –Titanium substrate insoluble electrodes –Iron oxide –semi conducting type etc. Metal finishing-cell design. types of electrochemical reactors, batch cell, fluidized bed electrochemical reactor, filter press cell, Swiss roll cell, plug flow cell, design equation, figures of merits of different type of electrochemical reactors.

TOTAL : 45 PERIODS

OUTCOME:

Student would be able to integrate professional, ethical, social and environmental factors in electrochemical engineering design and problem solving and understand the impact of these factors on global energy issues

TEXT BOOKS:

1. Picket, " Electrochemical Engineering ", Prentice Hall. 1977.
2. Newman, J. S., " Electrochemical systems ", Prentice Hall, 1973.

REFERENCES:

1. Barak, M. and Stevenge, U. K., " Electrochemical Power Sources - Primary and Secondary Batteries" 1980
2. Mantell, C., " Electrochemical Engineering ", McGraw Hill, 1972.

CH17E32 INDUSTRIAL NANOTECHNOLOGY

L T P C
3 0 0 3

OBJECTIVE:

To enable the students to learn about basis of nanomaterial science, preparation method, types and application

UNIT I INTRODUCTION **8**

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-
ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for

study (qualitative only).

UNIT II GENERAL METHODS OF PREPARATION 9

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS 12

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays-unctionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications

UNIT IV CHARACTERIZATION TECHNIQUES 9

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation

UNIT V APPLICATIONS 7

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery

TOTAL : 45 PERIODS

OUTCOMES:

Upon completing this course, the students Will familiarize about the science of nanomaterials Will demonstrate the preparation of nanomaterials Will develop knowledge in characteristic nanomaterial

TEXT BOOKS:

1. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, "Nanoscale charecterisation of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000

REFERENCES:

1. G Timp (Editor), "Nanotechnology", AIP press/Springer, 1999.
2. Akhlesh Lakhtakia (Editor),"The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007.

CH17E33 WASTEWATER TREATMENT L T P C
3 0 0 3

OBJECTIVE:

To focus on the wastewater transport system and the theory and design technique for the wastewater treatment process.

UNIT I WASTE WATER TREATMENT AN OVERVIEW 9

Terminology – Regulatios – Health and Environment Concerns in waste water management –

Constituents in waste water inorganic – Organic and metallic constituents.

UNIT II PROCESS ANALYSIS AND SELECTION 9

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.

UNIT III CHEMICAL UNIT PROCESSES 9

Role of unit processes in waste water treatment chemical coagulation – Chemical precipitation for improved plant performance chemical oxidation –Neutralization – Chemical Storage.

UNIT IV BIOLOGICAL TREATMENT 9

Overview of biological Treatment – Microbial metabolism – Bacterial growth and energatus – Aerobic biological oxidation – Anaerobic fermentation and oxidation – Trickling filters – Rotating biological contractors – Combined aerobic processes – Activated sludge film packing.

UNIT V ADVANCED WASTE WATER TREATMENT 9

Technologies used in advanced treatment – Classification of technologies Removal of Colloids and suspended particles – Depth Filtration – Surface Filtration – Membrane Filtration Absorption – Ion Exchange – Advanced oxidation process.

TOTAL : 45 PERIODS

OUTCOME:

Upon completion of this course, the students would have knowledge on physical/chemical/biological characteristics of and the evaluation technique for sewage.

TEXT BOOKS:

1. Waste water Engineering Treatment and Reuse: Mc Graw Hill, G. Tchobanoglous, FI Biston, 2002.
2. Industrial Waste Water Management Treatment and Disposal by Waste Water Mc Graw Hill III Edition 2008.

CH17E34 MODERN SEPARATION TECHNIQUES

L T P C
3 0 0 3

OBJECTIVE:

To enable the students to learn the principle and technical concept of advanced separation processes.

UNIT I BASICS OF SEPARATION PROCESS 9

Review of Conventional Processes, Recent advances in Separation Techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid.

UNIT II MEMBRANE SEPARATIONS 9

Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fiber Membrane Reactors and their relative merits, commercial, Pilot Plant and Laboratory Membrane permeators involving Dialysis, Reverse Osmosis, Nanofiltration, Ultra filtration and Micro filtration, Ceramic-Hybrid process and Biological Membranes.

UNIT III SEPARATION BY ADSORPTION 9

Types and choice of Adsorbents, Adsorption Techniques, Dehumidification Techniques, Affinity Chromatography and Immuno Chromatography, Recent Trends in Adsorption.

UNIT IV INORGANIC SEPARATIONS 9

Controlling factors, Applications, Types of Equipment employed for Electrophoresis,

Dielectrophoresis, Ion Exchange Chromatography and Eletrodialysis, EDR, Bipolar Membranes.

UNIT V OTHER TECHNIQUES 9

Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids, liquids and gases, zone melting, Adductive Crystallization, other Separation Processes, Supercritical fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.

TOTAL : 45 PERIODS

OUTCOME:

The students would fully understand key concepts of separation processes including equilibrium stages, reflux, countercurrent contacting, limiting cases, efficiency and mass transport effects.

REFERENCES:

1. King, C. J., "Separation Processes", Tata McGraw Hill, 1982.
2. Roussel, R. W., "Handbook of Separation Process Technology", John Wiley, New York, 1987.
3. Nakagawal, O. V., "Membrane Science and Technology"' Marcel Dekkar, 1992.

CH17E35 PETROLEUM TECHNOLOGY L T P C 3 0 0 3

OBJECTIVE:

To make the students understand petroleum engineering principles, their application to petroleum and natural gas manufacturing problems.

UNIT I INTRODUCTION 9

Refinery products – Refinery Feeds – Crude distillation – Coking and thermal process.

UNIT II CATALYTIC CRACKING 9

Catalytic Cracking - Catalytical hydro cracking – Hydroprocessing and Reused processing hydro treating.

UNIT III CATALYTICAL 9

Reforming and isomerization alkylation and polymerization – Product blending – Supporting processes.

UNIT IV LUBRICIATING 9

Lubriciating oil blending stocks petrochemical feedstocks.

UNIT V COST EVALUATION 9

Cost Evaluation – Economic evaluation of petroleum reused and refineries.

TOTAL : 45 PERIODS

OUTCOME:

On completing this course, the students will be able to understand the concepts of catalytic cracking lubricating used by the oil and gas production technician today.

TEXT BOOKS:

1. Petroleum Refining : Technology and economics CRC Press V Edition 2007 J.CH Garry , Hardward G.E and M.J.Kaiser.
2. Modern Petroleum Technology Upstream Vol I A.G. Lucas Hurley Edition 2002

PROFESSIONAL ELECTIVE IV

CH17E41 PIPING AND INSTRUMENTATION

L T P C
3 0 0 3

UNIT I **15**

Fluid Flow: Types of pipes–metallic and Non-metallic pipe. Piping and pipeline codes. Fluid properties. Pressure drop due to friction, minor losses-values, fittings, enlargement, reduction, entrance and exit loss. Single phase incompressible flow of Newtonian and Non-Newtonian liquids-veloctiy, flow equation. Complex piping system -pipe in series and parallel. Pipe network. Single phase compressible flow-flow analysis for ideal and non-ideal gas. Work, energy and power required for compression of gas.

UNIT II **15**

Piping Design: Economic diameter, equivalent length estimation. Fitting number and types. Gravity flow, Sizing economics. Steam line –optimum diameter, temperature (low and high) considerations, and vacuum considerations. Pressure design calculation for plant piping, slurry piping and plastic piping-Pipeline design – waste water system, compressed air system, oil piping system, slurry system and Non-Newtonian fluid system

UNIT III **15**

Pipeline Operation and Maintenance: Friction reduction, cleaning, coating, war, freezing prevention of by bleeding, leak detection, leak detection using SCADA. Pipeline failure- outside force damage, internal pressure, subsidence strains, Rupture. Pipeline economics and cost. Piping insulations and repair techniques

TOTAL :45 PERIODS

TEXT BOOKS

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

REFERENCE BOOK

1. George A. Antaki, "Piping and Pipeline Engineering: Design, Construction, Maintenance, Integrity and Repair", Marcel Dekker Publication,2003.

CH17E42 PROCESS MODELLING AND SIMULATION

L T P C
3 0 0 3

OBJECTIVE:

To give an overview of various methods of process modeling, different computational techniques for simulation.

UNIT I INTRODUCTION **7**

Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

UNIT II STEADY STATE LUMPED SYSTEMS **9**

Degree of freedom analysis, single and network of process units, systems yielding linear and non-linear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

UNIT III UNSTEADY STATE LUMPED SYSTEMS **9**

Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

UNIT IV STEADY STATE DISTRIBUTED SYSTEM 7

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

UNIT V UNSTEADY STATE DISTRIBUTED SYSTEM & OTHER MODELLING APPROACHES 13

Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor, hierarchy in model development, classification and solution of partial differential equations. Empirical modeling, parameter estimation, population balance and stochastic modeling.

TOTAL : 45 PERIODS

OUTCOME:

Upon completing the course, the student should have understood the development of process models based on conservation principles and process data and computational techniques to solve the process models.

TEXT BOOKS:

1. Ramirez, W.; " Computational Methods in Process Simulation ", 2nd Edn., Butterworths Publishers, New York, 2000.
2. Luyben, W.L., " Process Modelling Simulation and Control ",2nd Edn, McGraw-Hill Book Co., 1990

REFERENCES:

1. Felder, R. M. and Rousseau, R. W., " Elementary Principles of Chemical Processes ", John Wiley, 2000.
2. Franks, R. G. E., " Mathematical Modelling in Chemical Engineering ", John Wiley, 1967.
3. Amiya K. Jana, "Process Simulation and Control Using ASPEN", 2nd Edn, PHI Learning Ltd (2012).
4. Amiya K. Jana, "Chemical Process Modelling and Computer Simulation" 2nd Edn, PHI Learning Ltd,(2012).

CH17E43 PROCESS PLANT UTILITIES L T P C 3 0 0 3

OBJECTIVE:

To enable the students to understand the process plant utilities and optimization techniques to optimize various parameters in chemical industries.

UNIT I IMPORTANT OF UTILITIES 9

Hard and Soft water, Requisites of Industrial Water and its uses. Methods of water Treatment such as Chemical Softening and Demineralization, Resins used for Water Softening and Reverse Osmosis. Effects of impure Boiler Feed Water.

UNIT II STEAM AND STEAM GENERATION 9

Properties of Steam, problems based on Steam, Types of Steam Generator such as Solid Fuel Fired Boiler, Waste Gas Fired Boiler and Fluidized Bed Boiler. Scaling and Trouble Shooting. Steam Traps and Accessories.

UNIT III REFRIGERATION 9

Refrigeration Cycles, Methods of Refrigeration used in Industry and Different Types of Refrigerants such as Monochlorodifluro Methane, Chlorofluro Carbons and Brins. Refrigerating Effects and

Liquefaction Processes.

UNIT IV COMPRESSED AIR 9

Classification of Compressor, Reciprocating Compressor, Single Stage and Two Stage Compressor, Velocity Diagram for Centrifugal Compressor, Silp Factor, Impeller Blade Shape. Properties of Air – Water Vapors and use of Humidity Chart. Equipments used for Humidification, Dehumidification and Cooling Towers.

UNIT V FUEL AND WASTE DISPOSAL 9

Types of Fuel used in Chemical Process Industries for Power Generation such as Natural Gas, Liquid Petroleum Fuels, Coal and Coke. Internal Combustion Engine, Petrol and Diesel Engine. Waste Disposal.

TOTAL : 45 PERIODS

OUTCOME:

At the end of this course, the students will understand the importance of health, safety and the environment in process industries. Steam, power, water, air are extensively used in process industries and their efficient operation is imperative for economic and safe operation is essential for the survival of industries

TEXTBOOKS:

1. Eckenfelder, W. W, Jr. “Industrial Water Pollution Control” McGraw-Hill: New York, 1966.
2. P. L. Ballaney, “Thermal Engineering”, Khanna Publisher New Delhi, 1986.
3. Perry R. H. Green D. W. “Perry’s chemical Engineer’s Handbook”, McGraw Hill, New York, 2007.

REFERENCES:

1. P. N. Ananthanarayan, “Basic Refrigeration & Air conditioning”, Tata McGraw Hill, New Delhi, 2007.

CH17E44 BIOCHEMICAL ENGINEERING L T P C

3 0 0 3

OBJECTIVE

This course mainly discusses the role of enzymes and microbes in biotechnology sectors.

UNIT I INTRODUCTION 6

Industrial biochemical processes with typical examples, comparing chemical and biochemical processes, development and scope of biochemical engineering as a discipline. Industrially important microbial strains; their classification; structure; cellular genetics.

UNIT II KINETICS OF ENZYME ACTION 9

Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action, modulation and regulation of enzyme activity, types of inhibition. Immobilized enzyme technology: enzyme immobilization, Immobilized enzyme kinetics: effect of external mass transfer resistance.

UNIT III KINETICS OF MICROBIAL GROWTH 9

Kinetics of cellular growth in batch and continuous culture, models for cellular growth unstructured,structured and cybernetic models , medium formulation. Thermal death kinetics of cells and spores, stoichiometry of cell growth and product formation , Design and analysis of biological reactors.

UNIT IV TRANSPORT PHENOMENA 9

Transport phenomena in bioprocess systems: Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, power requirements for sparged and agitated vessels, scaling of

mass transfer equipment, heat transfer.

UNIT V DOWN STREAM PROCESSING 12

Down stream processing: Strategies to recover and purify products; separation of insoluble products, filtration and centrifugation; cell disruption-mechanical and non-mechanical methods; separation of soluble products: liquid-liquid extractions, membrane separation (dialysis, ultra filtration and reverse osmosis),chromatographic separation-gel permeation chromatography, electrophoresis, final steps in purification –crystallization and drying.

TOTAL : 45 PERIODS

OUTCOME:

Upon completion of this course, the students would develop the ability to design novel bioprocesses for their research in various areas. They will have the ability to find solutions to the problems which occur when materials and processes interact with the environment.

TEXT BOOKS:

1. Biochemical engineering fundamentals by J.E.Bailey and D.F.Ollis, 2nd ed, 1986, McGraw Hill.
2. Bioprocess Engineering by Michael L. Shuler and Fikret Kargi, 2nd edition, Pearson education.

REFERENCES:

1. Biochemical engineering by James M.Lee – Prentice-Hall-1992.
2. Bioprocess engineering principles, Pauline M. Doran, Academic Press.
3. Biochemical Engineering, H.W. Blanch and D.S. Clark, Marcel Dekker, 1997.

CH17E45 ENERGY TECHNOLOGY L T P C 3 0 0 3

OBJECTIVE:

To enable the students to understand the interaction between different parts of the energy system

UNIT I ENERGY 8

Introduction to energy – Global energy scene – Indian energy scene - Units of energy, conversion factors, general classification of energy, energy crisis, energy alternatives.

UNIT II CONVENTIONAL ENERGY 8

Conventional energy resources, Thermal, hydro and nuclear reactors, thermal, hydro and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

UNIT III NON-CONVENTIONAL ENERGY 10

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

UNIT IV BIOMASS ENERGY 10

Biomass origin - Resources – Biomass estimation. Thermochemical conversion – Biological conversion, Chemical conversion – Hydrolysis & hydrogenation, solvolysis, biocrude, biodiesel power generation gasifier, biogas, integrated gasification.

UNIT V ENERGY CONSERVATION 9

Energy conservation - Act; Energy management importance, duties and Responsibilities; Energy

audit – Types methodology, reports, instruments. Benchmalcing and energy performance, material and energy balance, thermal energy management.

TOTAL : 45 PERIODS

OUTCOME:

On completion of this course, the students would have the ability to apply the fundamentals of energy conversion and applications.

TEXT BOOKS:

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.
4. Energy Management, Paul W.O'Callaghan McGraw – Hill, 1993

REFERENCES:

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Enery - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981. Handbook of Energy Audit by 7th edition Albert Thumann, P.E., C.E.M & William J Younger C.E.M, Faiment Press 2008

PROFESSIONAL ELECTIVE – V

CH17E51 FERMENTATION ENGINEERING

L T P C
3 0 0 3

OBJECTIVE:

To enable the students to understand the role of fermentation microorganisms and (bio) chemical activities and conversions that take place during fermentations, and their impact on quality.

UNIT I INTRODUCTION TO FERMENTATION PROCESSES 9

Microbial biomass – Microbial Engymes – Microbial metabolites – Recombinant products – Transformation Process – Microbial growth binetus – Isolation and preservation and improvement of industrially important micro organism.

UNIT II INSTRUMENTATION AND CONTROL. 9

Measurement of process variables – Temperature and its control – Flow measurement and control – Gases and Liquids – Pressure measurement and control – Cenline analysis – Control System – Combination of Control Systems – Computer application in termentation technology.

UNIT III RECOVERY AND PURIFICATION OF FERMENTATION PRODUCTS 9

Removal of Microbial cells – Foam Separation – Precipitation Filtration – Different Filtration process – Centifugation – Different centrifuge cell description – Different methods – Solvent recovery – Superfluid extraction – Chromatography – Membrane processes – Drying – Crystallization – Whole growth processing.

UNIT IV EFFLUENT TREATMENT 9

Strength of fermentation effluent – Treatment and disposal – Treatment Processes – Physical, chemical and biological – Aerobic process – Anareobic treatment.

UNIT V FERMENTATION ECONOMICS 9

Introduction – Isolation of micro organisms of industrial interest – Strain improvement – Market potential – Plant and equipment – Media – Air sterilization – Heating and cooling – Recovery costs.

TOTAL : 45 PERIODS

OUTCOME:

Upon completion of this course, the students would be able to carry out fermentation processes and monitor their progress by measurements and analyses.

TEXTBOOKS:

1. Principles of fermentation Technology P.Stanbury Buttuworth Hanman – 1999.
2. Fermentation and Biochemical Engineering Handbook – C.C Haber. William Andrew II Edition 2007.
3. Bioprocess Engineering Hydersen B.K Nancy A.dela K.L.Nelsen Wiley Interscience, 1994.

CH17E52 PETROLEUM REFINING AND PETROCHEMICALS

L T P C
3 0 0 3

OBJECTIVES:

On completion of the course the students are expected:

- To know about various types and compositions of crude
- To gain knowledge on various treatment techniques involved in the processing of crude
- To become familiar in performing design calculations for process equipments used in the processing of crude and other treatment of products

UNIT I CRUDE OIL **15**

Origin and formation of petroleum; composition; petroleum reserves in India an in world; types classification, composition, and evaluation of petroleum crude; physical properties and testing methods of crude and petroleum products; fractionation of petroleum: dehydration and desalination of crudes, distillation of petroleum.

UNIT II DISTILLATION OF CRUDE OIL **15**

Treatment processes: thermal and catalytic cracking processes; thermal and catalytic refining processes; solvent extraction; hydro treatment processes; polymerization; isomerisation; finishing and purification processes; manufacture of LPG, petrol, diesel, kerosene, naphtha, wax, sulphur, tar. Alkylation.

UNIT III DESIGN OF UNIT OPERATIONS **15**

Design of petroleum refining equipment: design of tube still heaters, heat exchangers, coolers, condensers, and reboilers; refinery energy and material balances; controlling hydrocarbon losses in refinery; application of pollution control techniques.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Nelson, W.L, "Petroleum Refinery Engineering", McGraw Hill Publishing Company Limited, 1985.
2. Hobson, G.D., "Modern Petroleum Refining Technology", Fourth Edition, Institute of Petroleum U.K, 1973

REFERENCE BOOK

1. Watkins, R.N, "Petroleum Refinery Distillation", Second Edition, Gulf Publishing Company, Texas, 1981.

CH17E53 ENVIRONMENTAL TECHNOLOGY L T P C

3 0 0 3

OBJECTIVE:
To provide technical expertise in Environmental Engineering which will enable them to have a career and professional accomplishment in the public or private sector

UNIT I ENVIRONMENT AWARENESS 9
Environment – friendly chemical Process; Hazard and risk analysis; Environmental Audit.

UNIT II CHEMICAL ENGINEERING PROCESSES 9
Unit Operations – application of - Abatement of water pollution; Current strategies to control air pollution; Disposal of solid wastes

UNIT III RECYCLING METHODOLOGY 9
Economic recovery and recycling of waste; Transport fuel- Bio-diesel for a cleaner environment.

UNIT IV CLEAN TECHNOLOGY 9
Towards Eco- friendly products of chemical industry; Pesticides –Their transfer and Transformation in the environment, Biological and electrochemical technology for effluent treatments

UNIT V POLLUTION PREVENTION 9
Mass exchange network synthesis for pollution control and minimization Implications of environmental constraints for process design, policies for regulation of environmental impacts, Concept of common effluent treatment; Environmental legislations, Role of Government and Industries

TOTAL : 45 PERIODS

OUTCOME:
Upon completion of this course, the students would understand the importance of environmental audit, concepts behind the methodologies to control pollution, the importance of recycling and concepts behind pollution prevention.

TEXTBOOKS:

1. Rao, C.S Environmental Pollution control Engineering, Wiley- Eastern Ltd. 1991.
2. Peavy H.S. Rowe D.R., and George Technologious, Environmental Engineering, Mc Graw Hill Book Company, Ny, 1985.
3. Rao M.N and H.V.N. Rao. "Air pollution" ,Tata McGraw Hill Publishing Co. Ltd.1989.
4. Theodore L and Buomlore A.J Air pollution control equipments. Prentice Hall Inc, NY. 1982.

CH17E54 POLYMER TECHNOLOGY L T P C

3 0 0 3

OBJECTIVE:
To enable the students to compute molecular weight averages from the molecular weight distribution, Condensation polymerization and transition in polymers.

UNIT I INTRODUCTION 6
History of Macromolecules – structure of natural products like cellulose, rubber,proteins – concepts of macro molecules – Staudinger's theory of macromolecules – difference between simple organic molecules and macromolecules.

UNIT II ADDITION POLYMERIZATION 12

Chemistry of Olefins and Dienes – double bonds – Chemistry of free radicals – monomers – functionality – Polymerization: Initiation – types of initiation – free radical polymerization – cationic polymerization – anionic polymerization – coordination polymerization – industrial polymerization – bulk, emulsion, suspension and solution polymerization techniques – Kinetics – Copolymerization concepts.

UNIT III CONDENSATION POLYMERIZATION 9

Simple condensation reactions – Extension of condensation reactions to polymer synthesis – functional group reactivity – polycondensation – kinetics of polycondensation- Carother's equation – Linear polymers by polycondensation – Interfacial polymerization – crosslinked polymers by condensation – gel point.

UNIT IV MOLECULAR WEIGHTS OF POLYMERS 9

Difference in molecular weights between simple molecules and polymers – number average and weight average molecular weights – Degree of polymerization and molecular weight – molecular weight distribution – Polydispersity – molecular weight determination. Different methods – Gel Permeation Chromatography – Osmometry, Light Scattering.

UNIT V TRANSITIONS IN POLYMERS 9

First and second order transitions – Glass transition, Tg – multiple transitions in polymers – experimental study – significance of transition temperatures – crystallinity in polymers – effect of crystallization – in polymers – factors affecting crystallization crystal nucleation and growth – relationship between Tg and Tm – Relationship between properties and crystalline structure.

TOTAL : 45 PERIODS

OUTCOME:

At the end of this course, the student would be able to demonstrate knowledge and understanding on the principles related to the synthesis and characterization of polymers.

TEXTBOOKS:

1. Billmeyer.F.W.,Jr, Text Book of Polymer Science, Ed. Wiley-Interscience, 1984.
2. Seymour.R.B., and Carraher.C.E., Jr., Polymer Chemistry, 2nd Ed., Marcel Dekker, 1988.
3. Gowariker.V.T., Viswanathan.N.V., and Sreedar.J., Polymer Science, Wiley Eastern Ltd., 1988.

REFERENCES:

1. Joel,R.F; Polymer Science and Technology, Eastern Economy Edition, 1999.
2. Rodriguez, F., Cohen.C., Oberic.K and Arches, L.A., Principles of Polymer Systems, 5th edition, Taylor an

CH17E55 PULP AND PAPER TECHNOLOGY

L T P C
3 0 0 3

OBJECTIVE:

Focused on papermaking science and technology and is intended to be especially valuable to students majoring in programs leading to careers in corporate or government positions which would interface with the paper related industries.

UNIT I INTRODUCTION 9

Introduction Basic pulp and paper technology – Wood haves dry – Wood as a raw material.

UNIT II WOODYARD OPERATION 9

Woodyard operation - Mechanical pulping – Chemical pulping – Secondary fibre pulp processing.

UNIT III PAPER MACHINE **9**

Paper Machine wet and addition paper machine dry and operation – Paper machine - Wet and operation.

UNIT IV PAPER AND PAPERBOARD **9**

Paper and paperboard frames and products – Surface treatments – Finishing operation– End uses.

UNIT V PROPERTIES AND TESTING OF PULP AND PAPER **9**

Properties and Testing of pulp and paper Process control – Quality assurance – Water and air pollution control.

TOTAL : 45 PERIODS

OUTCOME:

The students would be able to explain the most important structural and chemical properties of wood and fibres from bases of papermaking. The student can also identify different paper grades and can explain the main unit processes of paper manufacturing.

TEXTBOOK:

1. Pulp and paper chemistry and Technology Monica ER Monica, Goran Gellerstcdt Gunnar Hennksson De Gneyter 2009.