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FOREWORD

Chemical Engineering involves the design and maintenance of chemical plants and the development of chemical processes for converting raw materials and chemicals into valuable products. It combines knowledge of chemistry and engineering for the production of chemicals and related by-products. This branch of engineering is a varied field, covering areas of energy engineering, environmental engineering, mineral processing, pharmaceuticals, polymer engineering, petroleum engineering etc. Chemical Engineers operate chemical plants and improve methods of production and productivity as well.

The primary function of chemical engineers is to study raw materials for their consistency/properties, their conversion into products, the process and equipments involved in conversion and safety aspects. Chemical engineering addresses problems in health care, including technology and medicine. It also helps to develop processing systems for waste management and food processing, in a more affordable and healthy fashion. Chemical Engineers also play a major role in national defense with their involvement in the handling, development and disposal of high-tech chemical weapons and ammunition.

In the early 21st century, societal demands for better energy conservation and environmentally safe business practices changed the nature of chemical engineering in a larger way.

B.Tech. programme of Chemical Engineering is aimed at offering the knowledge and skills of invention, development, design, operation and management of processes in chemical industries. It combines the work of several fields such as chemistry, industrial engineering, materials science as well as electrical engineering.

In the new curriculum of R16, skill-oriented activities are included to enable the students to acquire hands-on experience of technology to make them better suited for industry requirements.

R-16 curriculum comprises of:

- *Five elective streams of current technologies (Environmental and Safety Engineering, Mineral Processing, Pharmaceuticals and Fine Chemicals, Polymer Engineering, Petroleum Engineering)*
- *Advanced courses in Energy Management, Industrial Safety, Effluent Treatment, etc.*
- *Laboratory sessions integrated with regular courses wherever possible.*

The BoS of chemical engineering consists of experienced professionals from industry, academia and research organizations

External BoS Members:

1. Dr.G.Prabhakar, *Professor & Head, Dept. of Chemical Engineering, S V University, Tirupathi.*
2. Dr.V.V.Basava Rao, *Professor, Dept. of Chemical Engineering, Osmania University, Hyderabad.*
3. Dr.S.V.Satyanarayana, *Professor, Dept. of Chemical Engineering, JNTU, Ananthapur.*
4. Sri R.Banerjee Babu, *General Manager, Production, JOCIL, Dokiparru.*
5. Dr.M.Prasad Babu, *Scientist, Nagarjuna Fertilizers and Chemicals Ltd, Hyderabad.*

My heartfelt thanks are due to all the BoS and Academic Council Members for actively taking part in the design of the innovative curriculum and course contents.

Dr. M. Ramesh Naidu
HOD, CHEM

B.Tech. - CHEMICAL ENGINEERING

Programme Educational Objectives

To produce graduates with the following capabilities:

1. Knowledge and competency in Chemical Engineering complemented with appropriate skills and attributes.

2. Design capabilities and soft skills for problem solving.

3. Effective communication skills, individual, supportive and leadership qualities with the right attitudes and ethics to work in teams on multidisciplinary projects.

4. Aptitude for research, lifelong learning, and continuously striving for contributions in frontier technology.

Programme Outcomes:

The graduates of this programme will have the ability to:

1. apply knowledge of mathematics, science, and engineering in core industry.

2. design and conduct experiments, as well as to analyze and interpret data.

3. design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

4. identify, formulate, and solve engineering problems related to chemical industry.

5. understand professional and ethical responsibility.

B.Tech.
CHE
I YEAR

R-16 CURRICULUM

(Applicable for students admitted into First Year from academic year 2016-17 onwards)

I Year I Semester

Course Code	Course Title	L	T	P	C
16HS103	Engineering Mathematics-I	3	1	2	5
16HS102	Engineering Physics	3	-	-	3
16HS105	Technical English Communication	3	-	2	4
16CS101	Basics of Computers and Internet	3	-	2	4
16CS102	Computer Programming	3	1	2	5
16EE101	Basics of Engineering Products	3	-	2	4
16HS104	English Proficiency and Communication Skills	-	-	2	1
16HS110	Engineering Physics Laboratory	-	-	3	2
	Total	**18**	**2**	**15**	**28**

I Year II Semester

Course Code	Course Title	L	T	P	C
16HS108	Engineering Mathematics-II	3	1	2	5
16HS107	Engineering Chemistry	3	-	-	3
16ME101	Engineering Graphics	1	-	3	3
16EE102	Basics of Electrical and Electronics Engineering	3	-	2	4
16HS111	Engineering Chemistry Laboratory	-	-	3	2
16HS109	Environmental Science and Technology	2	-	-	2
16ME103	Work shop Practice	-	-	3	2
16CH101	Basics of Chemical Engineering	3	-	-	3
	Total	**15**	**1**	**13**	**24**

L : Lecture Hours/week ; T : Tutorial Hours/week ;
P : Practical Hours/week ; C : Credits of the Course ;

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II YEAR

R-16 CURRICULUM

(Applicable for students admitted into First Year from academic year 2016-17 onwards)

II Year I Semester

Course Code	Course Title	L	T	P	C
16HS202	Probability and Statistics	4	-	-	4
16EL102	Soft Skills Laboratory	-	-	2	1
16CS202	Data Structures	3	-	2	4
16CH102	Materials Science and Technology	4	-	-	4
16CH201	Chemical Process Calculations	3	1	-	4
16CH202	Momentum Transfer	3	-	2	4
16CH203	Process Instrumentation	3	1	-	4
	Employability and Life Skills Elective*	-	-	-	1-3
	Total	**20**	**2**	**6**	**26-28**

* Courses and Programmes such as Foreign Languages, Summer Internship, NCC, NSS, Yoga, Music, Dance, Value Added Courses etc. for which credits and other details shall be defined by concerned coordinators.

II Year II Semester

Course Code	Course Title	L	T	P	C
16EL103	Professional Communications Laboratory	-	-	2	1
16CH204	Chemical Engineering Thermodynamics-I	3	1	-	4
16CH205	Mechanical Unit Operations	3	-	2	4
16CH206	Organic Chemistry	3	1	2	4
16CH207	Process Heat Transfer	3	-	2	4
	Department Elective	-	-	-	3
	Department / Open Elective	-	-	-	3-4
	Employability and Life Skills Elective*	-	-	-	1-3
	Total	**12**	**2**	**8**	**24-27**

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CHE
III YEAR

R-16 CURRICULUM

(Applicable for students admitted into First Year from academic year 2016-17 onwards)

III Year I Semester

Course Code	Course Title	L	T	P	C
16CH301	Chemical Engineering Thermodynamcis-II	3	1	-	4
16CH302	Chemical Reaction Engineering-I	3	-	2	4
16CH303	Mass Transfer Operations-I	3	-	2	4
16CH304	Process Dynamics and Control	3	-	2	4
	Department / Open Elective	-	-	-	3-4
	Department Elective	-	-	-	3
	Employability and Life Skills Elective*	-	-	-	1-3
	Total	**12**	**1**	**6**	**23-26**

III Year II Semester

Course Code	Course Title	L	T	P	C
16HS301	Professional Ethics	2	-	-	2
16CH305	Chemical Reaction Engineering-II	3	-	2	4
16CH306	Chemical Technology	3	-	2	4
16CH307	Mass Transfer Operations-II	3	-	2	4
16CH308	Process Modeling and Simulation	3	-	2	4
	Department Elective	-	-	-	3
	Department / Open Elective	-	-	-	3-4
	Employability and Life Skills Elective*	-	-	-	1-3
	Total	**17**	**-**	**8**	**25-28**

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IV YEAR

R-16 CURRICULUM

(Applicable for students admitted into First Year from academic year 2016-17 onwards)

IV Year I Semester

Course Code	Course Title	L	T	P	C
16MS201	Management Science	3	-	-	3
16CH401	Chemical Engineering Plant Design and Economics	3	1	-	4
16CH402	Chemical Process Equipment Design	3	-	2	4
16CH403	Optimization of Chemical Processes	3	1	-	4
16CH404	Transport Phenomena	3	1	-	4
	Department Elective	-	-	-	3
	Department / Open Elective	-	-	-	3-4
	Employability and Life Skills Elective*	-	-	-	1-3
	Total	**15**	**3**	**2**	**22-25**

IV Year II Semester

Course Code	Course Title	L	T	P	C
16CH411/16CH412	Project work / Internship	-	-	30	15
	Total	**-**	**-**	**30**	**15**

In addition to L, T, P, C the following information in hours/semester is also provided for each course.

WA/RA : Writing Assignment / Reading Assignment
SSH/HSH : Self Study Hours / Home Study Hours
CS : Case Study and Example
SA : Skills Activity
S : Seminar
BS : Beyond Syllabus

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ELECTIVES

R-16 CURRICULUM

(Applicable for students admitted into First Year from academic year 2016-17 onwards)

DEPARTMENT ELECTIVE STREAMS AND COURSES

STREAM - 1: ENVIRONMENTAL AND SAFETY ENGINEERING

Course Code	Course Title	L	T	P	C
16CH240	Effluent Treatment Methods	3	-	-	3
16CH340	Solid Waste Management and Treatment	3	-	-	3
16CH350	Environmental Regulations and Impact Analysis	3	-	-	3
16CH440	Industrial Safety and Hazard Analysis	3	-	-	3

STREAM - 2: MINERAL PROCESSING

Course Code	Course Title	L	T	P	C
16CH241	Mineral Process Technology	3	-	-	3
16CH341	Mining Methods and Unit Operations	3	-	-	3
16CH351	Physical Separation Process	3	-	-	3
16CH441	Extraction Metalurgy	3	-	-	3

STREAM - 3: PHARMACEUTICAL AND FINE CHEMICALS

Course Code	Course Title	L	T	P	C
16CH242	Pharmaceuticals Chemistry	3	-	-	3
16CH342	Pharmaceutical and Fine Chemicals	3	-	-	3
16CH352	Pharmaceutical Analytical Techniques	3	-	-	3
16CH442	Drug Design and Formulation	3	-	-	3

B.Tech.
CHE
ELECTIVES

R-16 CURRICULUM

(Applicable for students admitted into First Year from academic year 2016-17 onwards)

DEPARTMENT ELECTIVE STREAMS AND COURSES

STREAM - 4: POLYMER AND PLASTICS ENGINEERING

Course Code	Course Title	L	T	P	C
16CH243	Polymer Structure and Property Relationship	3	-	-	3
16CH343	Manufacturing of Industrial Polymers	3	-	-	3
16CH353	Polymer Processing Technology	3	-	-	3
16CH443	Polymer Testing Methods	3	-	-	3

STREAM - 5: PETROLEUM ENGINEERING

Course Code	Course Title	L	T	P	C
16CH244	Petroleum Production Operations	3	-	-	3
16CH344	Petroleum Refinery Engineering	3	-	-	3
16CH354	Petrochemicals	3	-	-	3
16PL401	Natural Gas Engineering	3	-	-	3

INDIVIDUAL ELECTIVE COURSES

Course Code	Course Title	L	T	P	C
16CH245	Conventional Energy Sources	3	-	-	3
16CH345	Non Conventional Energy Sources	3	-	-	3
16CH355	Energy Management and Auditing	3	-	-	3
16CH445	Energy Integraion	3	-	-	3

B.Tech.
CHE
ELECTIVES

R-16 CURRICULUM

(Applicable for students admitted into First Year from academic year 2016-17 onwards)

OPEN ELECTIVE STREAMS AND COURSES

A) MINOR STREAMS:

MANAGEMENT STREAM

Course Code	Course Title	L	T	P	C
16MS202	Principles and Practice of Management	3	-	-	3
16MS301	Managerial Economics	3	-	-	3
16MS302	Finance for Engineers	3	-	-	3
16MS401	Engineering Entrepreneurship	3	-	-	3

HUMANITIES STREAM

Course Code	Course Title	L	T	P	C
16HS219	Indian History and Culture	3	-	-	3
16HS224	Polity and Governance of India	3	-	-	3
16HS307	Economic and Social Development of India	3	-	-	3
16HS308	Geography and Environmental Concerns of India	3	-	-	3

IT STREAM

Course Code	Course Title	L	T	P	C
16IT201	Object oriented Programming	3	-	2	4
16CS303	Web Technologies	3	1	2	5
16CS254	Scripting Languages	3	-	2	4
16CS201	Database Management Systems	3	1	2	5
16IT309	Unix Programming	3	1	-	4
16CS301	Software Engineering	3	-	2	4
16CS302	Data Mining Techniques	3	-	2	4
16IT409	Multimedia Systems	3	-	2	4

B) OPEN STREAMS OF OTHER DEPARTMENTS

Elective Streams offered by other departments that are opted by the students are included in this category.

C) INDIVIDUAL ELECTIVE COURSES OF OTHER DEPARTMENTS

Individual elective courses of other departments that are opted by the students are included in this category.

I

YEAR

CHEMICAL ENGINEERING

B.Tech.

I SEMESTER

- 16HS103 - Engineering Mathematics - I
- 16HS102 - Engineering Physics
- 16HS105 - Technical English Communication
- 16CS101 - Basics of Computers and Internet
- 16CS102 - Computer Programming
- 16EE101 - Basics of Engineering Products
- 16HS104 - English Proficiency and Communication Skills
- 16HS110 - Engineering Physics Laboratory

II SEMESTER

- 16HS108 - Engineering Mathematics - II
- 16HS107 - Engineering Chemistry
- 16ME101 - Engineering Graphics
- 16EE102 - Basics of Electrical and Electronics Engineering
- 16HS111 - Engineering Chemistry Laboratory
- 16HS109 - Environmental Science and Technology
- 16ME103 - Workshop Practice
- 16CH101 - Basics of Chemical Engineering

COURSE CONTENTS

I SEM & II SEM

16HS103 ENGINEERING MATHEMATICS - I

Hours Per Week :

L	T	P	C
3	1	2	5

Total Hours :

L	T	P
45	15	30

WA/RA	SSH/HSH	CS	SA	S	BS
10	45	-	-	-	-

Course Description and Objectives:

It is aimed to offer various analytical as well as numerical methods to solve first and second order ordinary differential equations; to impart the knowledge of partial differentiation; to acquaint with the various methods to solve first and second order partial differential equations; to make the student familiar with applications of first order ordinary differential equations. To make the student to use different mathematical tools of MATLAB related to above concepts.

Course Outcomes:

The student will be able to:

- recognise and solve different types of first order ordinary differential equations.
- find the complementary functions and particular integral of second and higher order ordinary differential equations with constant coefficients.
- apply the knowledge of ordinary differential equations in some instances.
- solve ordinary differential equations, with initial conditions, numerically.
- find the local maxima/minima of given function of two variables.
- eliminate arbitrary constants/functions from given relations to form partial differential equations.
- solve linear and non-linear partial differential equations of standard types.
- classify second order partial differential equations and solve them.

SKILLS:

- ✓ *Solve given differential equation by suitable method.*
- ✓ *Compute numerical solutions of differential equation by apt method.*
- ✓ *Compute maxima/minima of given function.*
- ✓ *Solve given partial differential equation by appropriate method.*

ACTIVITIES:

- *Differentiate methods to solve given differential equation.*
- *Compute numerical solutions to differential equation and compare the result with MATLAB output.*
- *Compute maxima/minima of given function.*
- *Differentiate methods to solve given partial differential equation.*
- *Estimation of acoustic impedance of a given material.*

UNIT - 1 **L- 9, T-3**

FIRST ORDER DIFFERENTIAL EQUATIONS: Variable separable, Homogeneous differential equations, Linear differential equations, Bernoulli's differential equations, Exact and non-exact differential equations.

UNIT - 2 **L- 9, T-3**

SECOND ORDER DIFFERENTIAL EQUATIONS: Linear differential equations with constant coefficients, Homogeneous differential equations of second and higher order, Methods to find particular integral when RHS is of the form - e^{ax}, sinax, cosax and x^n.

UNIT - 3 **L- 9, T-3**

APPLICATIONS OF FIRST ORDER DIFFERENTIAL EQUATIONS: Orthogonal trajectories (including polar form), Newton's law of cooling, Law of natural growth and decay.

NUMERICAL METHODS TO SOLVE DIFFERENTIAL EQUATIONS: Taylor series method, Picard's method, Euler's and modified Euler's method, Runge-Kutta method.

UNIT - 4 **L- 9, T-3**

MAXIMA/MINIMA OF FUNCTIONS OF TWO VARIABLES: Review of partial differentiation - Partial derivatives, Partial derivatives of higher order; Homogeneous function, Euler's theorem, Total differential coefficient, Maxima and Minima of a function of two variables, Conditions for extreme values, Lagrange method of undetermined multipliers.

JACOBIANS : Definition, Properties, Jacobian of implicit functions.

UNIT - 5 **L- 9, T-3**

PARTIAL DIFFERENTIAL EQUATIONS: Formation of partial differential equations, Linear (Lagrange) equations, Method of multipliers, Non-linear partial differential equations (Types), Charpit's method, Second order linear equations with constant coefficients only, Classifications, Rules to find complimentary function and particular integral (special cases).

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total hours-30

1. Basic mathematical operations using MATLAB.
2. Solving simple expressions.
3. Limits.
4. Continuity.
5. Symbolic differentiation.
6. Symbolic integration.
7. Plotting of curves.
8. Plotting of surfaces.
9. Maxima & minima of functions of one variable.
10. Maxima & minima of functions of two variable.

11. Solving first order O.D.E.
12. Euler's Method and R-K Method.

TEXT BOOKS:

1. H. K. Dass and Er. Rajanish Verma, "Higher Engineering Mathematics", 3rd edition, S. Chand & Co, 2014.
2. B. S. Grewal, "Higher Engineering Mathematics", 44th edition, Khanna Publishers, 2014.
3. Rudra Pratap, "Getting started with MATLAB", Oxford University Publication, 2009.

REFERENCE BOOKS:

1. Srimanta Pal and Subodh C. Bhunia, "Engineering Mathematics", Oxford Publications, 2015.
2. B. V. Ramana, "Advanced Engineering Mathematics", McGraw Hill education, 25th reprint, 2015.

16HS102 ENGINEERING PHYSICS

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
10	45	-	10	-	10

Course Description and Objectives:

Technology is the experimental information for the physicist, where the theories can be tested. Recent technical developments have been the results of collaboration of physicists and engineers.

Study of engineering physics is a unique opportunity to learn the fundamental concepts of physics and apply this knowledge to both scientific and engineering problems.

The present course deals with various fields such as Lasers, Optical fibers, Photonics, Nano and functional materials, make the students to enrich basic knowledge in various fields of physics and apply the same in engineering fields.

Course Outcomes:

The student will be able to:

- understand the applications of ultrasonics and to calculate the velocity of ultrasonic waves in liquids.
- acquire basic knowledge in Non-destructive techniques.
- understand basic concepts of laser and optical fiber which help in designing and developing new devices in emerging fields.
- grasp the basics of quantum mechanics.
- understand the fabrication of solar devices.
- use nano science and technology for innovative and compact design.
- demonstrate synthesis, properties and applications of nanomaterials and functional materials.

SKILLS:

- ✓ *Determine the velocity of ultrasonics in a given liquid using interferometer.*
- ✓ *Study the wavelengths of light sources and lasers.*
- ✓ *Estimate the efficiency of a given solar cell.*
- ✓ *Learn about the type of the optical fiber and its ability to propagate light waves from its numerical aperture.*
- ✓ *Know voltage – current characteristics of a given light emitting diode.*

UNIT - 1 **L-9**

ULTRASONICS: Introduction, Production of ultrasonic waves - Piezoelectric method; Properties of ultrasonic waves, Types of ultrasonic waves, Determination of velocity of ultrasonic waves in solids and liquids, SONAR - Medical applications.

NON-DESTRUCTIVE TESTING: Introduction, Types, Visual inspection, Liquid penetrate testing, Ultrasonic Testing Systems, X - Ray radiography.

UNIT - 2 **L-9**

LASERS: Characteristics of laser light, Spontaneous and Stimulated emission of radiation, He-Ne laser, CO_2 laser, Semiconductor laser, Applications.

HOLOGRAPHY: Holography and applications.

FIBER OPTICS: Principle of optical fiber, Acceptance angle, Numerical aperture, Types of fibers, Dispersion and attenuation in optical fibers, Optical fiber communication system, Fiber optic sensors.

UNIT - 3 **L-9**

QUANTUM MECHANICS: Introduction, Matter waves, Schroedinger's time independent wave equation, Physical significance of the wave function, Particle in one dimensional potential well, Tunneling phenomenon.

FREE ELECTRON THEORY OF METALS: Introduction, Classical free electron theory, Electrical conductivity of metal, Quantum free electron theory, Fermi - Dirac distribution function and its variation with temperature.

PARTICLE ACCELERATORS: Introduction, Cyclotron, Synchrocyclotron, Betatron and applications.

UNIT - 4 **L-9**

SOLAR ENERGY: Solar radiation, Photovoltaic effect, Solar cells, Efficiency of solar cell, Solar thermal energy conversion systems.

PHOTONICS: LED, LCD, Photo conducting materials, Photo detectors, Photonic crystals, Non- linear optical behaviour of materials, Applications.

UNIT - 5 **L-9**

NANO MATERIALS: Introduction, Fabrication of nano materials - Ball milling - Sol-Gel method; Physical and chemical properties of nano materials, Applications.

FUNCTIONAL MATERIALS: Smart materials, Shape memory alloys, Chromic materials (Thermo, Photo and electro), Metallic glasses, Advanced ceramics, Composites, Fiber reinforced plastics/metals, Biomaterials.

TEXT BOOKS:

1. V.Rajendran, "Engineering Physics", 7th edition, McGraw Hill Education (India) Pvt.Ltd., 2014.
2. D.K. Bhattacharya and Poonam Tandon, "Engineering Physics", Oxford University Press, 2015.

REFERENCE BOOKS :

1. M.R. Srinivasan, "Engineering Physics", 1st edition, New Age International Publishers, 2008.
2. M.N. Avadhanulu & P.G. Kshirsagar, "Engineering Physics", 1st edition, Chand and Company Ltd., 1992.
3. Sukhatme S.P., "Solar Energy", 2nd edition, TMH publication, 2005.
4. Dr. Arumugam "Materials Science", 3rd edition, Anuradha Publications, 2002.

ACTIVITIES:

- *Estimation of acoustic impedance of a given material.*
- *Measurement of distances using ultrasonic range finder.*
- *Study of linear density of yarn/ fibre using Melde's experiment.*
- *Determination of refractive index of a given liquid using laser.*
- *Find the height of a room using laser.*
- *Identify the type of semi-conductor using Hall effect.*
- *Study of numerical aperture of optical fibres made of different materials.*
- *Design of solar panel to obtain required voltage.*
- *Evaluation of thermal conductivity of materials.*
- *Measure the temperature using thermo couple.*

16HS105 TECHNICAL ENGLISH COMMUNICATION

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
10	15	5	6	4	5

Course Description and Objectives :

To introduce students the specific use of English for the purpose of Technical Communication that would strengthen their skills in the areas of writing and speaking and thereby enable them to function effectively in their professional sphere. The objective of this course is to direct the students towards developing their technical writing skills in particular and overall language proficiency in general. It will be done by making students peruse good samples of technical writing covering a wide range of contemporary issues relevant to the engineering profession. Students will, also be revisiting, the fundamentals of grammar to get trained on use of standard English.

Course Outcomes:

The student will be able to:

- acquire an understanding of the rules of grammar.
- strengthen their reading and listening comprehension skills to follow the academic discourse in the engineering classroom.
- have a command of basic vocabulary related to different subject areas.
- have a grasp on the mechanics of writing and express their ideas through construction of simple texts.
- attain language proficiency to participate in the classroom discussions.

SKILLS:

- ✓ *Apply different sub skills like skimming, scanning, reading for information, reading for inference etc to understand different kinds of text.*
- ✓ *Apply different sub skills like top down, bottom up approaches to listening, and understand phonetic and phonological features of the English language to deconstruct long spoken discourses.*
- ✓ *Use functional vocabulary relevant to subject areas like environment, tourism, engineering, technology and media to express ideas lucidly.*
- ✓ *Use appropriate sentence structure, cohesive devices and diction to construct simple text in writing and regular correspondence like e-mails, letters etc.*
- ✓ *Capture and understand key points during class room discourses through applying sub skills of writing like note-making, paraphrasing and summarizing.*

UNIT - 1 **L-9**

- Text : **ENVIRONMENTAL CONSCIOUSNESS**
  (Climate Change, Green Cover, Pollution, Renewable vs. Non renewable energy sources (from Energy Unit)
- Grammar : Articles, Prepositions, Sentence types and construction
- Vocabulary : Root, Prefixes, Suffixes
- Composition : Paragraph writing (Descriptive and narrative)
- Laboratory Practice : Introduction to phonetics
  (Organs of Speech, Consonants, Vowels and Diphthongs, Syllable, Stress and Intonation)

UNIT - 2 **L-9**

- Text : **EMERGING TECHNOLOGIES**
  (Solar power, Cloud computing, Nanotechnology, Wind energy (to be covered from Energy unit))
- Grammar : Time and tense (Present-past-future; Helping verbs, Modals)
- Vocabulary : Synonyms, Antonyms
- Composition : Letter writing (Informal)
- Laboratory Practice : Grammar Practice (Speaking of past, present and future)

UNIT - 3 **L-9**

- Text : **TRAVEL AND TOURISM**
  (Advantages and disadvantages of travel-tourism, Atithi devo bhava, Tourism in India)
- Grammar : Subject-Verb agreement, Sentence construction
- Vocabulary : Idioms and phrases
- Composition : Letter writing (Formal)
- Laboratory Practice : Situational conversations – Role - Plays
  (Introducing, Greeting, Enquiring, Informing, Requesting, Inviting)

UNIT - 4 **L-9**

- Text : **ENGINEERING ETHICS**
  (Challenger disaster, Biotechnology, Genetic engineering, Protection from natural calamities, How pertinent is the nuclear option? An environment of energy (from Energy Unit))
  Avoiding sexist language (Gender Sensitization)
- Grammar : Sentence transformation (Degrees, Voice, Speech and Synthesis)
- Vocabulary : Phrasal verbs
  Composition : Note-making, Text, Nandan Nilekani's In Search of Our Energy Solutions (from Energy Unit)
  Summarizing, Text on "Flight from conversation" (New York Times)
- Laboratory Practice : Situational conversations, Role-Plays (Emotions, Directions, Descriptions, Agreements, Refusals, Suggestions)

ACTIVITIES:

- *Doing phonetic transcription of selected words from the list provided using talking dictionaries of AHD and CALD.*
- *Completing graded grammar exercises in Rosetta Stone.*
- *Completing graded listening and reading comprehension exercises in Rosetta Stone.*
- *Watching TED videos and making notes.*
- *Watching TED videos to paraphrase and summarize.*
- *Ad- making.*
- *Preparing brochure.*
- *Dialogue writing followed by role play.*
- *Poster designing.*
- *Team presentation with PPTs and Group Discussion.*

UNIT - 5 **L-9**

- Text : **MEDIA MATTERS**

  (History of media, Language and media, Milestones in media, Manipulation by Media, Thousands march against nuclear power in Tokyo (from Energy Unit), Entertainment media, Interviews)

- Grammar : Common errors
- Vocabulary : One-word substitutes
- Composition : E-mail – Short message service (SMS), Writing advertisements, Reporting; Social media - Blogging, Facebook, Twitter (acceptable and non acceptable content)
- Laboratory

  Practice : Group discussions – (Topics from Energy Unit), Dumping of nuclear wastes, Exploration of eco-friendly energy options, Lifting of subsidies on petrol, Diesel, LPG etc)

TEXT BOOK:

1 *"Mindscapes* - English for Technologists and Engineers", Orient Black Swan, 2012.

REFERENCE BOOKS:

1. V. R. Narayana Swamy, "Strengthen Your Writing", 1st edition, Orient Longman, 2003.
2. Thomas Elliott Berry, "The Most Common Mistakes in English Usage", 1st edition, Tata McGraw Hill, 2004.
3. T. Balasubramanian, "A Textbook of English Phonetics for Indian Students", Macmillan Ltd., 2000.
4. Sasikumar.V and P.V. Dhamija,. "Spoken English: A Self-Learning Guide to Conversation Practice", 34th Reprint, Tata McGraw Hill, New Delhi, 1993.
5. Margaret M Maison, "Examine Your English", 1st edition, Orient Longman, 1999.
6. Ashraf Rizwi, "Effective Technical Communication", Tata McGraw Hill, 2005.

16CS101 BASICS OF COMPUTERS AND INTERNET

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
5	40	-	8	5	-

Course Description and Objectives:

This course provides students with a working knowledge of the terminology, processes, and components associated with Computers and Internet. Students will get exposure to Building blocks of Computers, Operating Systems, Application software, Networking, Internet, World Wide Web, Security, Maintenance, Information Systems, and the application development processes.

Course Outcomes:

The student will be able to:

- understand the terms and concepts of Computer Science and Information Technology (hardware, software, networking, security, Internet/Web, and Technologies).
- use the products and services of computers.
- use Internet/Web services as a resource for developing shared applications.
- install different operating systems and application software.

SKILLS:

- ✓ *Assemble and disassemble the personal computer system.*
- ✓ *Install different desktop operating systems.*
- ✓ *Use the basic text processing, simple data analysis and data presentation tools.*
- ✓ *Configure network parameters.*
- ✓ *Secure the personal computer and information from various external threats.*

ACTIVITIES:

- *Prepare a report on various generations of computers and its peripherals.*
- *Disassembling and assembling of a personal computer system.*
- *Install the Linux operating system and other software required in a personal computer system.*
- *Connect the system to an Ethernet and configure the same.*
- *Prepare an MS Word Document.*
- *Prepare a spread sheet with various mathematical operations, charts and sorting etc.*
- *Make a report on power point presentation for the given topic.*

UNIT - 1 **L-10**

COMPUTING SYSTEMS: Introduction to computer, Computers for individuals, Importance of computers, Parts of computer system, Memory devices, Input and output devices, Types of monitors, Types of printers, Number systems, Bits and bytes, Text codes and types of processors.

UNIT - 2 **L-10**

OPERATING SYSTEMS: Types of operating systems, User interfaces, PC operating systems, Network operating systems, Types of software, Programming languages, Compiler and interpreter, Program control flow and algorithm.

UNIT - 3 **L-8**

NETWORKS AND DATABASES: Networking basics, Uses of network, Types of networks, Network hardware, Introduction to data bases and database management systems.

UNIT - 4 **L-8**

INTERNET AND WWW: Internet's services, World wide web, Browser setups, Using search engine, Email and other internet applications.

UNIT - 5 **L-9**

CYBER SECURITY: The need of computer security, Basic security concepts, Threats of users, Online spying tools, Threats to data, Cybercrime, Protective measures.

LABORATORY EXPERIMENTS

Course Outcomes:

The student will be able to:

- know the usage of the computer systems.
- setup the IDEs for the computer programming languages.
- get exposure on office automation tools like Microsoft Word, Excel, and power point.
- identify the different computer system and data threats and also protect them by installing antivirus software.

LIST OF EXPERIMENTS Total hours-30

1. Demonstrate the Personal Computer Peripherals and get a report on each peripheral.
2. Demonstrate the Personal computer assembling procedure and do the same.
3. Install wide varieties of free and open source operating systems.
4. Demonstrate Network Interface Card (NIC) configuration and any internet browsers options setup.
5. Demonstrate the Java Development Kit (JDK) installation and environmental variable (PATH) setup.

6. Demonstrate the following experiments using Office automation tools.
    a. Text formatting and table.
    b. Mathematical equations.
    c. Watermarking using Analysis tool.
    d. Calculate student mark details.
    e. Create four types of charts.
    f. Import external data, sort & filter using Power Point tool.
    g. Create text and images with effects.
    h. Create animation and sound effects.
7. Demonstrate the installation of anti-virus software to detect different types of virus programs.

TEXT BOOK :

1. Peter Norton, “Introduction to Computers”, 7th edition, Tata-McGrawHill, 2010.

REFERENCE BOOKS:

1. ITL Education Solution Limited, “Introduction to Computer Science”, 2nd edition, Pearson Education, 2011.
2. Eric Maiwald, “Fundamentals of Network Security”, 3rd edition, Tata-McGrawHill, 2004.

16CS102 COMPUTER PROGRAMMING

Hours Per Week :

L	T	P	C
3	1	2	5

Total Hours :

L	T	P
48	15	30

WA/RA	SSH/HSH	CS	SA	S	BS
5	40	5	8	5	5

Course Description and Objectives:

This course is aimed at offering fundamental concepts of programming language to the students. It starts with the basics of C-programming and deals with the structure and various attributes required for writing a 'C' program. It also introduces various operators and control statements used in programming. Then it switches to functions and arrays. It goes on with strings, pointers, files & the user defined data types. As a first-level course in computer science, it forms the basis to understand usage of various attributes in writing a program.

Course Outcomes:

The student will be able to :

- understand the basic terminology used in computer programming to write, compile & debug programs in 'C' language.
- use different data types to design programs involving decisions, loops and functions.
- understand the allocation and Usage of dynamic memory.
- understand the usage of files & structures.

SKILLS:

- ✓ *Identify suitable data types for an application.*
- ✓ *Apply control statements for decision making problems.*
- ✓ *Use multidimension array for matrix application.*
- ✓ *Design a program to calculate average of a class.*
- ✓ *Analyze the difference between static & dynamic memory allocation.*

UNIT - 1 **L- 10, T-3**

INTRODUCTION TO C PROGRAMMING: Structure of C program - Comments, Processor statement, Function header statement, Variable declaration statement and Executable statement; C character set, Constants, Identifiers, Operators, Punctuations, Keywords, Modifiers, Identifiers, Variables, C scopes, Basic data types, Type qualifiers, Storage classes, Reading and writing characters, Formatted I/O.

UNIT - 2 **L-9, T-3**

OPERATORS AND CONTROL STATEMENTS: Operators - Assignment, Arithmetic, Relational, Logical, Bitwise, Ternary, Address, Indirection, Sizeof, Dot, Arrow, Parentheses operators; Expressions - Operator precedence, Associative rules; Control statements - Category of statements, Selection, Iteration, Jump, Label, Expression and Block.

UNIT - 3 **L-9, T-3**

FUNCTIONS AND ARRAYS: Function - Declaration, Prototype, Definition, Calling by value and call by address, Standard library functions and Recursive functions; Array - Declaration, Initialization, Reading, Writing, Accessing and Passing as a parameter to functions, 2D-arrays, Multidimensional arrays.

UNIT - 4 **L-9, T-3**

STRINGS AND POINTERS: Strings - Declaration, String library functions, Array of strings, Command line arguments; Pointers - Declaration, Initializing pointers, Multiple indirection, Relationship between arrays and pointers; Scaling up - Array of arrays, Array of pointers, Pointer to a pointer, Pointer to an array; Pointer to functions, Dynamic memory allocation functions.

UNIT - 5 **L-8, T-3**

STRUCTURES AND FILES: Structures - Declaration, Initialization and accessing, Array of structures and passing structures to functions, Structure pointers, Arrays and structures within structures, Unions, Bit-fields, Types and enumerations; Files - I/O and processing operations on text and binary files; Pre-processor directives.

ACTIVITIES:

- *Implement matrix operations.*
- *Implement malloc and calloc functions.*
- *Copy the content of one file into the other.*
- *Implement string manipulations functions.*

LABORATORY EXPERIMENTS

Course Outcomes:

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

- write, compile and debug programs in C language.
- formulate problems and implement algorithms in C.
- develop programming components that efficiently solve computing problems in real-world.

LIST OF EXPERIMENTS Total hours-30

1. Compute the factors of a number.
2. Compute the average of ‘n’ numbers.
3. Find whether a number is palindrome or not.
4. Find whether a number is a power of 2 or not.
5. Compute the factorial of a number.
6. Implement any kind of operation (+,-,*,/,%) using a switch case.

7. Swap two values useing call by value and call by reference.
8. Using structure of arrays.
9. Find the reversal of a number.
10. Find the frequency of each number in the array.
11. Which takes 0's & 1's as input and the array should consist of all 0's first and then 1's.
12. Copy the first 10 words of a file into the other file.
13. Count the number of words in a file.
14. Create a structure which stores the student's information in a class.
15. Reverse the contents of the array.
16. Implement pointer of pointers.
17. Give n^{th} term of the Fibonacci number.
18. Find the factorial of a number using recursion.
19. Find the number of vowels in a file.
20. Access the structure and union members.

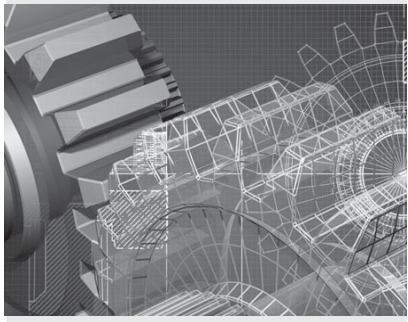
TEXT BOOK:

1. Ajay Mittal, "Programming in C - A practical Approach", 1^{st} edition, Pearson Education, India, 2015.

REFERENCE BOOKS:

1. Reema Thareja, "Introduction to C Programming", 2^{nd} edition, Oxford University Press India, 2015.
2. Herbert Schildt, C, "The Complete Reference", 4^{th} edition, Tata McGraw-Hill, 2000.
3. E. Balagurusamy, "Programming in ANSI C", 4^{th} edition, Tata McGraw- Hill, 2008.

16EE101 BASICS OF ENGINEERING PRODUCTS



Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
5	40	-	8	5	-

Course Description and Objectives:

This course enables the students to understand the basics of civil, mechanical, electrical and electronics systems and components used in day-to-day life. It deals with construction materials, power generation principles and working of a few commonly used household appliances. Besides, the student will be able to identify/appreciate various concepts, service and maintainance of engineering products.

Course Outcomes:

The student will be able to:

- gain knowledge and hands-on experience on various engineering products.
- install, operate, maintain and troubleshoot basic mechanical, electrical and electronic appliances.
- understand the concept of conservation of energy.
- gain awareness on choosing appropriate construction materials.

SKILLS:

- ✓ *Identify UPS requirements for a given load.*
- ✓ *Provide a Lighting scheme for specific working environment.*
- ✓ *Design a composition of Heating element for a particular application.*
- ✓ *Trouble shoot issues relating to Immersion Heater and Induction Heater.*
- ✓ *Provide an earthing for Domestic Outlet.*
- ✓ *Select, Configure and maintain a few engineering appliances. Such as TV, Radio, Telephone, Mobile phone, Wifi Router, Micro oven, PA system etc.*

ACTIVITIES:

- *Trouble shooting of immersion heater and induction heaters.*
- *Disassembe and Assembe the Domestic Appliances such as Mixer Grinder, Fan etc.,*
- *Provide Earthing for Domestic Outlet.*
- *Design the Electric Wiring system for a prototype house.*
- *Design the UPS for a defined load.*
- *Practice assembly of a FM radio.*
- *Configure a Wifi Router for required number of users.*

UNIT - 1 **L-9**

WORKING PRINCIPLE OF AC, REFRIGERATOR, PUMPS, IC ENGINES AND SCREW JACK: Working principle of Air - Conditioner and Refrigerator, Components, Assembly and disassembly; Working principle of Centrifugal and Reciprocating pumps - Types, Parts and applications, Working principle of Screw jack and its components, Working principle of IC engines- 2 stroke and 4 stroke.

UNIT - 2 **L-10**

BRICKS: General, Qualities and Classification of bricks, Tests for bricks, Size and Weight of bricks,

Timber - Definition, Qualities of good timber, Decay of timber and Advantages of timber in construction.

CEMENTS: Types and composition of Cement, Setting of cement, Tests for physical properties of

cement, Different grades of cement.

AGGREGATES: Classification of aggregates, Source, Size and Shape of aggregates, Tests for aggregates.

STEEL: Types of steel, Physical properties and Mechanical properties of steel, Simple layout design, Paints, Tiles, fittings, Ventilation, Furniture and green house aspects.

UNIT - 3 **L-8**

ELECTRIC ENERGY SYSTEMS: Overview of Power System Structure, Conventional and Non Conventional Generations, Types of Turbines, Generators, Substations, Towers, Earthing procedure, Protection schemes, Single Phase and Three Phase Systems, Methods of Electrical Wiring Systems, Wiring procedure and calculations, Wiring methods, Un-Interruptible Power Supply (UPS), Components in UPS, Its functionality, Calculation of ratings for UPS components to a specific load.

UNIT - 4 **L-10**

LIGHT: Light Energy, Evolution of Light sources, Working of Incandescent, Fluorescent, MV, SV and LED Lamps, Comparison and Applications.

HEAT: Heat Energy, Modes of Heat Transfer, Resistance and Induction Heating, Comparison and applications.

MOTOR: Electric Motors, Classification, Construction and working principles of motors used in Domestic applications, Mixer grinder, Ceiling and exhaust fan, Hair dryer, Washing machine, Water pump, Air coolers, Vacum cleaner, Computer cooling motor, Electric bike.

UNIT - 5 **L-8**

HOUSE HOLD ELECTRONIC APPLIANCES: Working principles of television, Radio, Remote control, Telephone, Microwave oven, Cell phone, PA system, Induction stove, WiFi router and DTH.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total hours-30

Demonstration of Modelling / functioning / disassembly / assembly / fault rectification / understanding of the following.

1. Air-conditioners and Refrigerators
2. 2 Stroke and 4 Stroke Engines
3. Reciprocating Pumps

4. Power Screw Jack
5. Size and Water absorption capacity of Bricks
6. Initial and final setting time of Cement
7. Toughness value of coarse aggregates
8. Bulking of Sand
9. Earthing Schemes
10. Electric Wiring
11. UPS system
12. Immersion Heater, Induction Heater and Iron Box
13. Ceiling Fan and Mixer
14. Television
15 Radio
16. Remote Control
17. Telephone
18. Fax Machine
19. Mobile Phone
20. PA System

TEXT BOOKS:

1. M.S.Shetty, “Concrete Technology”, 1st edition, S.Chand and Co, 2005.
2. S. C. Rangwala, “Engineering Materials”, 36th edition, Charotar Publishing House, Anad, 2009.
3. Govindasamy and A Ramesh, “Electrical engineering - Electrical machines and Appliances Theory, 1 st edition, Tamilnadu text book corporation, 2010.
4. Janakaraj, A Sumathi et al, “Electrical engineering - Electrical machines and Appliances Theory”, 1 st edition, Tamilnadu text book corporation, 2011.
5. Marshall Brain, “How Stuff Works”, 1 st edition, John Wiley&Sons, 2001.
6. Pravin Kumar, “Basic Mechanical Engineering”, 1 st edition, Pearson Publishers, 2013.

16HS104 ENGLISH PROFICIENCY AND COMMUNICATION SKILLS

Hours Per Week :

L	T	P	C
0	-	2	1

Total Hours :

L	T	P
0	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
-	-	-	-	-	-

Course Description and Objectives:

To equip the students with Functional English by exposing them to a wide range of language use in different contexts and thereby encourage them to use the language comfortably in real life situations. The objective of this course is to strengthen the comprehension skills of listening and reading by acquiring adequate vocabulary through perusing authentic materials gathered from news papers, journals and other mass communication media.

Course Outcomes:

The student will be able to:

- use functional English to speak and express themselves in different social contexts
- write simple letters, narratives, factual reports and descriptive passages for both academic and non-academic purposes in English.
- gain proficiency to undergo Preliminary English Test (PET), an Intermediate Level English Certification Test administered by Cambridge English Language Assessment, UK.

SKILLS:

- ✓ *Use appropriate words in right order for effective sentence formation, and writing short texts.*
- ✓ *Read and extract information from different texts and draw inferences by understanding elements like tone and transitional words.*
- ✓ *Understand short and long spoken discourses through analysis of elements like stress and intonation.*
- ✓ *Articulate clearly thoughts and ideas on simple every day topics.*

UNIT - 1 **P-6**

FUNCTIONS: Introducing Self/Others, Expressing needs/feelings/opinions (SWOT Analysis)

SKILL FOCUS:

Reading – Understanding factual information

Writing – Word order and sentence formation

Listening – Decoding for meaning following elements of stress, Intonation and accent

Speaking – Articulating syllables clearly, Speaking fluently with correct pronunciation

Vocabulary – Discerning to use right word for the given context

Grammar – Spellings, Use of Nouns, Adjectives, Verbs, Prepositions in the sentence structure

PRACTICE: Objective PET Units 1 - 6

UNIT - 2 **P-6**

FUNCTIONS: Defining; Describing People, Places, Things and Process.

SKILL FOCUS:

Reading – Inferences from sentences and short messages, True or False

Writing – Rewording, Sentence transformation, Convincing

Listening – Understanding the short messages and conversations

Speaking – Role-plays, Short conversations

Vocabulary / Grammar – Use of Adjectives/Adverbs, Comparatives and Superlatives

PRACTICE: Objective PET Units 7 – 12

UNIT - 3 **P-6**

FUNCTIONS: Describing Spatial and Temporal Relations, Giving Directions/Instructions

SKILL FOCUS:

Reading – Reading between the lines, Inferences, True/False

Writing – Developing hints, Writing short messages/paragraphs

Listening – Searching for factual information, Gap filling

Speaking – Snap Talks, JAM, Elocution

Vocabulary / Grammar – Prepositions, Phrasal Verbs, PET word list

PRACTICE: Objective PET Units 13 - 18

UNIT - 4 **P-6**

FUNCTIONS: Narrating, Predicting, Negotiating, Planning

SKILL FOCUS:

Reading – Reading for evaluation and appreciation, Comprehension

Writing – Letters, e-mails, 7 C's

Listening – Following long conversations / Interviews

ACTIVITIES:

- *SWOT Analysis.*
- *Snap talks.*
- *Spell Bee.*
- *Short conversations.*
- *Role play.*
- *Quiz.*
- *Elocution.*
- *JAM.*
- *Group. Discussion Debate.*
- *Team presentations.*

Speaking – Discussions, Debate, Descriptions

Vocabulary / Grammar – Modals, Conditionals, Verb forms (Time and Tense)

PRACTICE: Objective PET Units 19 – 24

UNIT - 5 **P-6**

FUNCTIONS: Requesting, Denying, Suggesting, Persuading

SKILL FOCUS:

Reading – Understanding factual information

Writing – Short Stories, Explanatory Paragraphs

Listening – Inferences from long speeches/conversations

Speaking – Announcements, Presentations

Vocabulary / Grammar - Punctuation, Cloze tests

PRACTICE: Objective PET Units 25 – 30

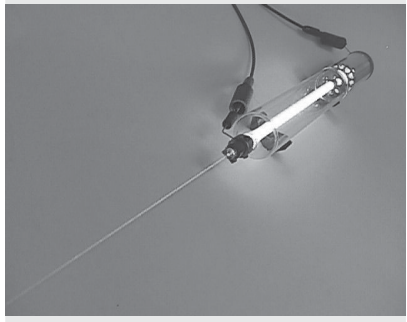
TEXT BOOK:

1. Louise Hashemi and Barbara Thomas, “Objective PET”, Student’s Book with Answers, 2nd edition, Cambridge University Press, 2015.

REFERENCE BOOKS :

1. Cambridge Preliminary English Test Without Answers 8.
2. Annette Capel and Rosemary Nixon, “Introduction to PET”, Oxford University Press.

16HS110 ENGINEERING PHYSICS LABORATORY



Hours Per Week :

L	T	P	C
-	-	3	2

Total Hours :

L	T	P
-	-	45

Course objectives and Description:

This lab is intended to make the students realize the theoretical concepts of physics having hands on experience in conducting the experiments.The students have to perform at least ten from the list of experiments.

Course Outcomes:

The student will be able to:

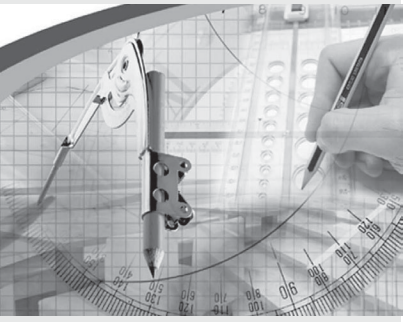
- realize the concept of resonance by conducting the experiments of AC sonometer and Melde's experiment.
- acquire the knowledge on magnetic field theory and thermal conductivity by conducting experiments, field along the axis of a circular coil and thermal conductivity of bad conductor
- understand the concepts of light by conducting the experiments of determination of wave length, numerical aperture of an optical fibre and also from V–I characteristics of Solar cell and LED.

LIST OF EXPERIMENTS

1. Determination of Velocity of ultrasonic waves in liquids.
2. Melde's Experiment - Transverse and Longitudinal modes.
3. Determination of wave length – Helium - Neon laser.
4. Determination of Planck's constant.
5. Determination of Frequency of Alternating current.
6. Field along the axis of a circular coil – Stewart and Gee's apparatus.
7. Band gap of semiconductor.
8. Determination of Hall coefficient.
9. Thermal conductivity of bad conductor - Lee's method.
10. Optical Fibre – Determination of numerical aperture.
11. Solar Cell – Efficiency.
12. Study of V – I characteristics of LED.
13. Seebeck effect - Determination of Seebeck coefficient of a thermo couple.

REFERENCE BOOKS:

1. Jayaraman, "Engineering Physics Laboratory manual", 1st edition, Pearson Education, 2014.
2. Engineering Physics laboratory Manual – Department of Physics, VFSTR University, 2016.



16HS108 ENGINEERING MATHEMATICS – II

Hours Per Week :

L	T	P	C
3	1	2	5

Total Hours :

L	T	P
45	15	30

WA/RA	SSH/HSH	CS	SA	S	BS
10	45	-	-	-	-

Course Description and Objectives:

It is aimed to offer different methods for finding rank of a matrix, solving linear equations using matrices, to compute Eigen values and Eigen vectors, to verify C.H.T and apply it to find power of a matrix. Also, to make the students familiarize with double and triple integrals, to make the student acquainted with the concepts of vector differentiation and integration. To make the student to use different mathematical tools of MATLAB related to above concepts.

Course Outcomes:

The student will be able to:

- carry out the basic operations of matrix algebra.
- use row operations to reduce a matrix to echelon form, normal form.
- determine consistency of a system linear equations.
- compute eigen values and eigen vectors.
- evaluate double integrals and triple integrals.
- evaluate double integrals in polar coordinates.
- utilize Cartesian and polar coordinates to find area.
- understand the concept of gradient, divergance and curl.
- apply vector integral theorems in finding surface and volume integrals.

SKILLS:

- ✓ *Appreciate various methods to find the rank of a matrix.*
- ✓ *Solve given system of linear equations.*
- ✓ *Compute Eigen values and Eigen vectors of a matrix.*
- ✓ *Compute the power of a matrix by suitable method.*
- ✓ *Evaluate Multiple integrals.*
- ✓ *Evaluate surface and volume integrals through vector integral theorems.*

UNIT - 1 **L-9, T-3**

RANK OF MATRIX AND LINEAR EQUATIONS: Rank of a matrix, Normal form, Triangular form, Echelon from, Consistency of system of linear equations, Gauss-Jordan method, Gauss elimination method, Gauss-Siedal method.

UNIT - 2 **L-9, T-3**

EIGEN VALUES AND EIGEN VECTORS: Eigen values, Eigen vectors, Properties (without proofs), Cayley-Hamilton theorem (without proof), Power of a matrix, Diagonalisation of a matrix.

UNIT - 3 **L-9, T-3**

MULTIPLE INTEGRALS: Double integrals, Evaluation, Evaluation in polar coordinates, Change of order of integration, Change of variables, Applications to area in cartesian coordinates and polar coordinates, Triple integrals, Fundamentals, Evaluation of triple integrals.

UNIT - 4 **L-9, T-3**

VECTOR DIFFERENTIATION: Vector function, Differentiation, Scalar and vector point function, Gradient, Normal, Divergence, Directional derivative, Curl, Vector identities.

UNIT - 5 **L-9, T-3**

VECTOR INTEGRATION: Line integral, Surface integral, Volume integral, Green's theorem, Stoke's theorem, Gauss theorem of divesergence (without proofs).

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total hours-30

1. Matrix Algebra.
2. Rank of a matrix.
3. System of equations (Direct method).
4. System of equations (Cramer's Rule).
5. System of equations (matrix inversion method).
6. Eigen values and Eigen vectors of a matrix.
7. Powers of matrix & Cayley-Hamilton Theorem.
8. Vector algebra.
9. Gradient.
10. Divergence.
11. Curl.
12. Multiple Integrals (Area etc).
13. Interpolation.

TEXT BOOKS:

1. H. K. Dass and Er. Rajanish Verma, "Higher Engineering Mathematics", 3rd edition, S. Chand & Co., 2014.
2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 44th edition, 2014.
3. Rudra Pratap, "Getting started with Matlab", Oxford University Press, 2009.

REFERENCE BOOKS:

1. Srimanta Pal and Subodh C. Bhunia, "Engineering Mathematics", Oxford Publications, 2015.
2. B. V. Ramana, "Advanced Engineering Mathematics", 25th reprint, McGraw Hill Education, 2015.
3. R K Jain and S R K Iyengar, "Advanced Engineering Mathematics", 2nd edition, Narosa Publishing House, 2007.
4. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th edition, John Wiley & Sons (Asia) Pvt. Ltd., 2001.

ACTIVITIES:

- *Differentiate the methods to find the rank of a matrix.*
- *Solve given system of linear equations and compare with MATLAB output.*
- *Compute Eigen values and Eigen vectors of a matrix and compare with MATLAB output.*
- *Compute the power of a matrix by suitable method.*
- *Evaluate multiple integrals and compare with MATLAB output.*
- *Evaluate surface and volume integrals through vector integral theorems.*

16HS107 ENGINEERING CHEMISTRY

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	45	-	10	-	-

Course Description and Objectives:

This course aims to develop fundamental knowledge on new engineering materials and their significance in science and engineering applications. In addition, characterization of materials using basic and advanced experimental techniques is also offered. Besides, analysis of water sample and treatment method for domestic, commercial and industrial applications are also covered.

Course Outcomes:

The student will be able to:

- understand the limitations of using hard water for domestic and industrial purposes.
- choose and apply suitable methods to soften the hard water for industrial and domestic applications.
- understand electrochemistry and its importance for applications such as fuel cells, modern lithium ion batteries etc.
- understand the types of corrosion and their implications followed by their control and prevention methods.
- familiarize the preparation, properties and applications of various polymers.

SKILLS:

- ✓ *Analyse the total hardness of water sample.*
- ✓ *Understand the basic principles involved in various batteries.*
- ✓ *Understand the mechanisms of corrosion and various controlling methods.*
- ✓ *Synthesize various polymers.*
- ✓ *Identify the functional groups present in chemical compounds using Infrared and Ultraviolet instruments.*

UNIT - 1 **L-9**

WATER TECHNOLOGY: Introduction, WHO, BIS standards of water, Hardness of water, Determination of hardness by EDTA (Numerical Problems), Disadvantages of hard water, Scales and sludges, Caustic embrittlement, Boiler corrosion, Priming and foaming, Softening methods - Zeolite process, Ion Exchange process; Desalination of brackish water - Reverse osmosis, Electrodialysis.

UNIT - 2 **L-9**

ELECTRO CHEMISTRY: Electrode potential, Electrochemical series, Nernst equation, Reference electrodes, Calomel and standard hydrogen electrode, Ion selective electrode, Glass electrode, Determination of pH using glass electrode; Primary cell, Secondary cell - Lead-acid storage cell, Lithium ion battery; Fuel cells - Hydrogen oxygen, Methanol oxygen.

UNIT - 3 **L-9**

SCIENCE OF CORROSION: Introduction, Dry corrosion, Wet corrosion, Mechanisms of wet corrosion, Bimetallic corrosion, Concentration cell corrosion, Factors influencing the rate of corrosion; Corrosion control methods - Cathodic protection, Electroplating, Electrolessplating, Corrosion inhibitors.

UNIT - 4 **L-9**

POLYMERS: Introduction, Types of polymerization - Preparation, Properties and applications of polyethylene, PVC, Teflon, Bakelite, Urea formaldehyde, Silicones; Rubber, Vulcanization, Synthetic rubbers - Buna-S, Buna-N, Neoprene; Introduction to conducting polymers; Poly thiophene.

UNIT - 5 **L-9**

INSTRUMENTAL TECHNIQUES: Interaction of radiation with matter, UV-Visible spectroscopy - Beer, Lambert's law, Qualitative and quantitative analysis, Block diagram of UV-Visible spectrophotometer, IR spectroscopy - Types of vibrations, Block diagram of IR spectrophotometer.

TEXT BOOKS:

1. P.C Jain and Monica Jain, "Engineering Chemistry", 17th edition, Dhanpat Rai Publications, 2010.
2. Shashi Chavala, "A Text book of Engineering Chemistry Engineering Materials and Applications", 3rd edition, Dhanpat Rai Publications, 2015.

REFERENCE BOOKS:

1. K.S. Maheswaramma and Mridula chugh, "Engineering Chemistry", 1st edition, Pearson publication, 2015.
2. M.R. Senapati, "Advanced Engineering Chemistry", 2nd edition, Lakshmi Publications, 2006.
3. H. W. Wilard and Demerit, "Instrumental methods of Analysis", 7th edition, CBS Publications,1986.
4. Gurudeep Raj and Chatwal Anand, "Instrumental Methods of Analysis", 5th edition, Himalaya Publications, 2007.

ACTIVITIES:

- *Collect water samples from different villages near VFSTR University and determine the total hardness, and total alkalinity.*
- *Present the water analysis report to the villagers and suggest proper measures to be taken.*
- *Measure the rate of corrosion of iron objects by weight loss method.*
- *Identify some of the functional groups like carboxylicacid, aldehyde and ketones by I.R. Spectroscopy.*
- *Collect water sample from different villages and estimate the fluoride present in the raw water and suggest some steps for the removal of fluoride.*

16ME101 ENGINEERING GRAPHICS

Hours Per Week :

L	T	P	C
1	-	3	3

Total Hours :

L	T	P
15		45

WA/RA	SSH/HSH	CS	SA	S	BS
6	15	-	5	-	-

Course Description and Objectives:

The main aim of this course is to familiarize the students with the conventional concepts of engineering drawing and computer aided applications in various fields. Engineering graphics is an "International language of Engineers". It is the most effective method of communicating technical ideas in a 2D and 3D format.

Course Outcomes:

The student will be able to:

- sketch engineering objects in the freehand mode.
- create geometric construction with hand tools.
- create dimensions of objects.
- prepare plan and elevation of any pictorial view.
- draw freehand lettering.
- make isometric sketches using graphics.
- draw orthographic multi-view sketches using graphics.

SKILLS:

- ✓ *Draw free hand sketches, layouts, circuit diagrams, plan and elevations.*
- ✓ *Draw geometrical objects like polygons, solids of different types.*
- ✓ *Visualize the objects in real time situations.*
- ✓ *Develop 3D views (isometric views).*

UNIT - 1 **L-3, P-10**

INTRODUCTION TO ENGINEERING DRAWING: Types of lines, Lettering, Dimensioning, Construction of polygon and conics (Ellipse, Parabola and Hyperbola by general method), Ellipse by oblong method.

UNIT - 2 **L-3, P-8**

ORTHOGRAPHIC PROJECTIONS: Principle of projection, Planes of projections, Projections of points, Projection of straight lines, Inclined to one plane and both the planes, Projections of planes, Simple planes, Planes inclined to one reference planes.

UNIT - 3 **L-3, P-8**

PROJECTIONS OF SOLIDS: Projections of prisms, Pyramids, Cylinders, Cones, Solid axis inclined to one plane.

UNIT - 4 **L-3, P-10**

AUTOCAD: Introduction to AutoCAD

ISOMETRIC VIEWS: Isometric drawing of simple objects, Isometric view of prisms, Pyramids, Cone and cylinder, Simple orthographic views into isometric views through AutoCAD.

UNIT - 5 **L-3, P-9**

ORTHOGRAPHIC VIEWS: Conversion of pictorial views into orthographic views through AutoCAD.

TEXT BOOKS:

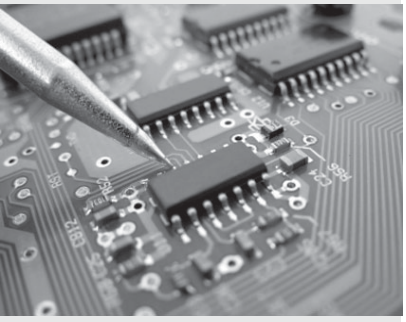
1. N.D.Bhatt, “Engineering Drawing”, 53rd edition, Charotar Publication, 2014.
2. Basant Agrawal , C.M.Agrawal “Engineering Drawing” , 2nd edition., Tata McGraw Hill,2014.

REFERENCE BOOKS:

1. J. hole, “Engineering Drawing”, 2nd edition, Tata McGraw Hill, 2008.
2. K.L. Narayana, “Engineering drawing”, 2nd edition, Scitech Publications, 2008.

ACTIVITIES:

- *Draw line diagram of different machineries.*
- *Draw plan and elevations of buildings and engineering products.*
- *Understand, visualize 3-D components/ products and develop drawings.*
- *Draw different curves used in several engineering applications such as bridges, dams etc.*



16EE102 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
5	40	-	8	5	5

Course Description and Objectives:

This course provides an in-sight into the functioning of basic electrical components like resistor, inductor and capacitor. It deals with the constructional and operational details of both D.C & A.C machines. It also deals with the basic electronic components like P-N Junction Diode, Zener diode, Transistor and their characteristics.

Course Outcomes:

The student will be able to:

- understand the notation and usage of components in electric circuits.
- analyze AC (single and three phase) and DC, AC circuits using different methods and laws.
- operate various electrical machines.
- understand the concepts of semiconductor devices and their operation.

SKILLS:

- ✓ *Distinguish between linear and nonlinear elements by looking at VI characteristics.*
- ✓ *Develop a simple loop generator.*
- ✓ *Design a voltage regulator using Zener diode.*
- ✓ *Design a half wave rectifier using PN junction diode.*
- ✓ *Design a full wave rectifier using PN junction diodes.*

UNIT – 1 **L-9**

FUNDAMENTALS OF DC CIRCUITS: Circuit concepts, Concepts of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, R, L and C as linear elements, Ohm's Law, Kirchhoff's Laws - Application to simple series, Parallel circuits, Mesh and nodal analysis of simple resistive circuits (Simple numerical problems).

UNIT – 2 **L-9**

FUNDAMENTALS OF A.C. CIRCUITS: Generation of A.C. voltage - Frequency, Average value, R.M.S. value, Form factor, Peak factor for sinusoidal only, Phasor representation of alternating quantities, Analysis of simple series and parallel A.C. circuits (simple numerical problems).

BALANCED THREE PHASE SYSTEMS: Relation between phase and line quantities of voltages and currents in star and delta connected systems (Elementary treatment only).

UNIT – 3 **L-9**

FUNDAMENTALS OF ELECTROMAGNETISM: Concepts of Magneto motive force, Reluctance, Flux and flux density, Concept of self Inductance and mutual Inductance, Coefficient of coupling (only elementary treatment and Simple numerical problems).

TRANSFORMERS: Principle of operation of single phase transformer, Constructional features, EMF equation (simple numerical problems).

UNIT – 4 **L-9**

DC MACHINES: Constructional details of a D.C. Machine, D.C. Generator, Principle of operation, EMF equation, Types of D.C. generators (simple numerical problems), D.C. Motor, Principle of operation, Torque equation, Types of D.C. motors (simple numerical problems).

A.C MACHINES: Principle of operation of three phase induction motors, Slip ring and squirrel cage motors, Torque equation, Constructional details of synchronous machine.

UNIT – 5 **L-9**

SEMICONDUCTOR DEVICES: Classification of solids based on energy band theory, Intrinsic and Extrinsic semiconductors, P-type and N-type semiconductors, P-N junction diode and its characteristics, Half and Full wave rectifiers, Zener diode and its characteristics, Voltage regulator, Bi polar junction transistor, Operation, Types, Applications.

LABORATORY EXPERIMENTS

Course Outcomes:

The student will be able to:

- apply the ohm's law, KVL and KCL laws to different circuits.
- calculate the power and energy in electric circuits.
- operate and find the transformation ratio of transformer at different loads.
- study and verify the characteristics of semiconductor devices.
- calculate the efficiency of both HWR and FWR.

LIST OF EXPERIMENTS Total hours-30

ACTIVITIES:

- *Decoding the value of resistors.*
- *Design and fabricate a simple loop permanent magnet generator.*
- *Design and fabricate a simple air cored transformer.*
- *Fabricate full and half wave rectifiers using PN junction diodes.*
- *Fabricate a voltage regulator using Zener diode.*

1. Verification of Ohm's law.
2. Verification of Kirchhoff's current law.
3. Verification of Kirchhoff's voltage law.
4. Measurement of Energy in single phase resistive load circuit.
5. Measurement of Power in single phase resistive load circuit.
6. Transformation ratio of a single phase transformer at different loads.
7. Verification of PN junction diode characteristics under both forward and reverse bias.
8. Verification of Zener diode characteristics under both forward and reverse bias.
9. Implementation of Half Wave Rectifier without filter.
10. Implementation of Full Wave Rectifier without filter.

TEXT BOOKS:

1. V.K.Mehta, "Principles of Electrical Engineering and Electronics", 3rd edition, S. Chand Publications, New Delhi, 2010.
2. D.P Kothari, "Basic Electrical and Electronics Engineering", 1st edition., TMH, New Delhi, 2014.

REFERENCE BOOKS:

1. Millman & Halkias, "Integrated Electronics", McGraw Hill, 1979.
2. A.K. Thereja and B.L. Thereja, "Electrical Technology", Vol.– II, S Chand Publications, 2007.
3. U.Bakshi & A.Bakshi, "Basic Electrical Engineering", 1st edition., Technical Publications, Pune, 2005.

WEB LINKS:

1. http:// nptel.ac.in/courses/108108076/
2. https:// books.google.co.in/books/about Basic_Electrical_Engineering.html?id=xN8qZFRkLpYC

16HS111 ENGINEERING CHEMISTRY LABORATORY

Hours Per Week :

L	T	P	C
-	-	3	2

Total Hours :

L	T	P
-	-	45

Course description and Objectives:

This course is aimed at enlightening the importance of theoretical concepts of chemistry and experimental techniques for characterization of materials.

Course Outcomes:

The student will be able to:

- analyse the total hardness present in water samples.
- determine the total alkalinity of water used in industries.
- acquire the knowledge on polymers used as insulators.
- familiarize advanced techniques in chemical analysis using conductometer and pH meter.

LIST OF EXPERIMENTS

1. Determination of Total Alkalinity of water.
2. Estimation of Total hardness of water.
3. Find the percentage of available chlorine in Bleaching powder.
4. Estimation of Fe (II) by Dichrometry method.
5. Preparation of Phenol - Formaldehyde Resin.
6. Synthesis of Urea- Formaldehyde Resin.
7. Estimation of Concentration of acid by pH metry.
8. Determination of Strength of acid by Conductometry.
9. Measurement of Mn^{+7} by Colorimetry.
10. Determination of concentration of a salt by ion exchange method.
11. Find the concentration of Mn^{+7} and Cr^{+6} by UV-Visible Spectrophotometry.
12. Find the rate of corrosion by weight loss method.

TEXT BOOKS:

1. J.Mendham, R.C.Denney, J.D. Bares, M.Thomas and B.Siva Sankar, “Vogel’s Text book of qualitative Chemical Analysis”, Pearson Publications - Volume I, 2009.
2. Dr.Sunita Rattan “Experiments in Applied Chemistry”, S.K. Kataria & Sons Publications, 2008.

16HS109 ENVIRONMENTAL SCIENCE AND TECHNOLOGY

Hours Per Week :

L	T	P	C
2	-	-	2

Total Hours :

L	T	P
30	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
10	20	4	-	4	-

Course Description and Objectives:

Environmental Science and Technology offers technological aspects of environmental science and in maintaining environmental integrity in relation to human development. It helps every engineer to plan appropriate strategies for addressing environmental issues and also contribute to the development of innovative technologies for solving such issues. It produces professionals who will ensure sustainable development of the nation in general and environmental in particular.

Course Outcomes:

The student will be able to:

- observe and integrate the diverse information from sources outside the classroom.
- think critically, creatively, resourcefully and strategically, including identifying steps needed to reach goals, manage projects, evaluate progress, and adapt approaches, developing both self reliance, and civic mindedness.
- adapt eco-friendly technologies in order to maintain hygienic conditions.
- understand the human activities that are detrimental to environment.
- collaborate across diverse disciplines to identify and create solutions that conserve and help maintain biodiversity in the long term.
- discuss the issues involved in the generation of renewable energy resources.

SKILLS:

- ✓ *Understand structural relationships, abstract models, symbolic languages and deductive reasoning.*
- ✓ *Gain perspectives to adrress the challenges, improvise and devise solutions.*
- ✓ *Identify solutions to environment and development issues, using planning, analysis, modeling, and new approaches.*
- ✓ *Acquire fieldwork techniques to study, observe and prepare documents, charts, PPTs, Models etc.*
- ✓ *Understand how natural resources should be used judiciously, to protect biodiversity and maintain ecosystem.*

UNIT - 1 **L-6**

NATURAL RESOURCES: Environmental studies - Definition scope and its importance, Need for public awareness; Natural resources - Forest resources, Deforestation, Water resources, Properties and conflicts, Mineral resources, Extraction and impacts, Food resources, Modern agriculture methods, Fertilizer pesticide problems, Water logging, Salinity, Energy resources, Renewable and non-renewable energy resources, Harness technology, Solar energy technologies, Land resources, Land degradation, Soil erosion; Role of an individual in conservation of natural resources.

UNIT - 2 **L-6**

ECOSYSTEMS AND BIODIVERSITY: Ecosystem - Concept, Structure and functions of an ecosystem, Food chains, Food webs, Ecological pyramids, Energy flow, Energy regulation, Succession, Biogeochemical cycles, Aquatic ecosystems; Biodiversity - Introduction, Bio-geographical classification, Values of biodiversity, Biodiversity at global, National and local levels, Hot-spots of biodiversity, Threats to biodiversity, Endangered and endemic species of India, Conservation of biodiversity.

UNIT - 3 **L-6**

WASTE MANAGEMENT AND GREEN TECHNOLOGY: Solid waste management - Causes, Effects and control measures of municipal and Industrial wastes; Pollution - Air, Water, Thermal, Soil and noise pollutions, Role of an individual in prevention of pollution; Remote sensing / GIS - Introduction, definitions, Applications of the remote sensing; Innovative practices - Objectives, Innovative practices in agriculture and forest community, Bio-villages; Green technology for sustainable development; Life cycle assessment and its concept.

UNIT - 4 **L-6**

SOCIAL ISSUES AND EIA: Sustainable development, Water conservation, Cloud seeding, Rainwater harvesting methods watershed management, Global warming, Acid rain, Ozone layer depletion, Environmental legislation - Wildlife protection act, Water act, Forest conservation act, Air act, Environmental protection act; Environmental Impact Assssment (EIA) - Introduction, Definition of E.I.A and E.I.S, Scope and objectives, Importance of E.I.A in proposed projects / industry / developmental activity.

UNIT - 5 **L-6**

ENVIRONMENTAL SANITATION: Food sanitation - Food and drugs Act, Food preservations, Milk sanitation, Tests for milk, Pasteurization of the milk; Water, Air, Soil and food borne diseases, Maintenance of sanitary and hygienic conditions; Role of youth in the development, Promoting activities, Youth as initiators, Field work/environmental visit - Visit to a local area to document environmental assets river/ forest/ grassland / hill /mountain, Study of local environment, Common plants, Insects, Birds; Study of simple ecosystems - Pond, River, Hill slopes etc., Visit to industries/water treatment plants/effluent treatment plants.

TEXT BOOKS:

1. Anubha Kaushik and CP Kaushik, “Perspectives in Environmental Studies”, 5th edition, 2016
2. Benny Joseph, “Environmental studies”, 2nd edition, McGraw Hill Education, 2015.

REFERENCE BOOKS:

1. Dr. M. Chandrasekhar, “A Text book of Environmental Studies”, HI-TECH publications, 2006.
2. Dr. M. Anji Reddy, “A Text book of environmental science and Technology”, B S Publications, 2008.
3. Dr. K. Mukkanti, “A Text book of Environmental Studies”, S.CHAND and Company Ltd, 2009.
4. EHILRS and ST, “Text book of Municipal and Rural Sanitation”, M.S Hill, 1998.
5. C. S. Rao, Wiley Eastern Ltd, “Environmental Pollution Control Engineering”, New Age International Ltd, 2001.
6. Dr. M. Anji Reddy, “Introduction to Remote Sensing”, B S Publications, 2004.
7. Kurian Joseph and R.Nagendram, “Essentials of environmental studies”, Pearson Education Pt Ltd, Delhi, 2007.

ACTIVITIES:

- *Painting contests on environmental issues and themes.*
- *Models of energy resources, Pollution and Solid Waste Management-3R strategy.*
- *Quiz competition.*
- *Essay writing competition.*
- *Skit, JAM and debate.*
- *Field work and documentation.*
- *Assignments.*

16ME103 WORKSHOP PRACTICE

Hours Per Week :

L	T	P	C
-	-	3	2

Total Hours :

L	T	P
-	-	45

WA/RA	SSH/HSH	CS	SA	S	BS
-	-	-	20	-	-

Course Description and Objectives :

This course is aimed to impart knowledge and provide hands-on experience in Carpentry, Fitting, Tinsmithy, Blacksmithy and House wiring. In addition it also provides knowledge on various manufacturing processes such as Foundary, Welding, Machine Shops and CNC Machines.

Course Outcomes :

The student will be able to:

- identify various tools connected to the trades such as Carpentry, Fitting, Tinsmithy, Blacksmithy and House wiring.
- fabrication of wooden joints and understand joining of metals.
- make metal joints and sheet metal work.
- make metal tools like knives, needles, swords, arrows etc.

SKILLS:

- ✓ *Prepare wooden and metal furniture.*
- ✓ *Electrical wiring and power supply in residences.*
- ✓ *Make funnels, trays, locker, steel almirahs etc.*
- ✓ *Fabrication of various agriculture tools, hooks, axes, axels, rims etc.*
- ✓ *CNC machines and various machining operations and processes.*

EXERCISES IN THE FOLLOWING TRADES :

1. Carpentry.
2. Fitting.
3. Tin smithy and Black smithy.
4. House wiring.
5. Foundry and welding (Demonstration).
6. Machine shop and CNC (Demonstration).

Note: In each trade, the student has to perform at least two jobs.

TEXT BOOKS:

1. S.K. Hazra Choudhury, "Elements of workshop Technology", 11th edition, Media Promoters, 1997.
2. Gopal, T.V., Kumar, T., and Murali, G., "A first course on workshop practice: Theory, Practice and Work Book", Suma Publications, Chennai, 2005.
3. Venkatachalapathy, V. S, "First year Engineering Workshop Practice", Ramalinga Publications, Madurai, 1999.

ACTIVITIES:

- *To make wooden joints like Mortise and Tenon joint, T-lap Joint which are used to prepare a wooden furniture.*
- *To prepare metal joints and metal sheet products like V-Joint and trays by using mild steel flats and Galvonised iron sheets.*
- *Trials on electrical circuit connections.*

16CH101 BASICS OF CHEMICAL ENGINEERING

Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P
45	15	-

WA/RA	SSH/HSH	CS	SA	S	BS
7	45	3	10	-	-

Course Description and Objectives:

This course deals with the fundamentals of chemical engineering and methods to solve practical problems. The objective of the course is to make the students learn about various unit operations in chemical process industries.

Course Outcomes:

The student will be able to:

- have an insight into the fundamentals of Momentum transfer, Heat transfer, Mass transfer etc.
- familiarize with the typical chemical engineering terminology that they will come across in their future courses.

SKILLS:

- ✓ *Choose a type of extraction for given chemical process.*
- ✓ *Differentiate various heat exchangers.*

UNIT - I **L-9**

INTRODUCTION : Introduction, Unit operations, Unit processes, Basic laws, Useful mathematical methods, Units and dimensions, Conversion factors, Dimensional analysis.

UNIT - II **L-9**

PHYSICO-CHEMICAL CALCULATIONS : Energy, Equivalent mass (weight), Electrochemical processes, Hardness of water, Humidity and saturation.

MATERIAL AND ENERGY BALANCES : Material balance, Energy balance.

UNIT - III **L-9**

FLOW OF FLUIDS : Introduction, Nature of a fluid, Viscosity, Flow field, Flow of a fluid past a solid surface, Conservation of mass, Conservation of energy, Friction losses in laminar flow through a circular tube, Friction losses in turbulent flow, Pressure drop in flow through porous media, Fluidization, Cavitation, Water hammer, Pumping of fluids.

UNIT - IV **L-9**

HEAT TRANSFER : Conduction, Convection, Radiation, Flow arrangements in heat exchangers, Variation of fluid temperatures in heat exchangers, Heat transfer equipment, Evaporation.

CHEMICAL KINETICS : Introduction, Thermodynamics review, Determination of rate equation, Effect of temperature on reaction rate, Catalysis, Reactors.

UNIT - V **L-9**

MASS TRANSFER : Diffusion, Interphase mass transfer, Absorption, Vapor-liquid equilibrium, Relative volatility, Distillation, Reflux, Calculation of number of theoretical stages by McCabe-Thiele method. Liquid liquid extraction, Single stage equilibrium extraction, Multistage extraction process, Drying, Adsorption.

TEXT BOOK:

1. Salil K Ghosal, Shyamal K Sanyal and Siddhartha Datta, “Introduction to Chemical Engineering”, Tata McGraw- Hill, 2001.

REFERENCE BOOK:

1. Mc. Cabe W. L, Smith. J. C and Harriot. P, “Unit Operations in Chemical Engineering”, 7Th edition, McGraw-Hill, 2005.

ACTIVITIES:

- *Identification of various mass transfer equipment.*
- *Identification of various heat transfer equipment.*

II

YEAR

CHEMICAL ENGINEERING

B.Tech.

I SEMESTER

- 16HS202 - Probability and Statistics
- 16EL102 - Soft Skills Laboratory
- 16CS202 - DATA Structures
- 16CH102 - Materials Science and Technology
- 16CH201 - Chemical Process Calculations
- 16CH202 - Momentum Transfer
- 16CH203 - Process Instrumentation
- - Employability and Life Skills

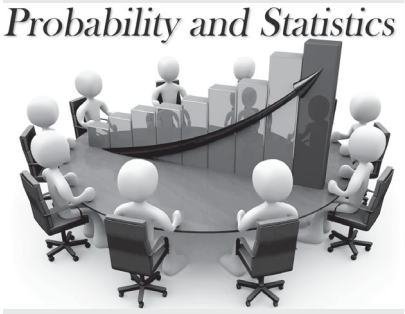
II SEMESTER

- 16EL103 - Professional Communications Laboratory
- 16CH204 - Chemical Engineering Thermodynamics-I
- 16CH205 - Mechanical Unit Operations
- 16CH206 - Organic Chemistry
- 16CH207 - Process Heat Transfer
- - Department Elective
- - Department / Open Elective
- - Employability and Life Skills

COURSE CONTENTS

I SEM & II SEM

16HS202 PROBABILITY AND STATISTICS



Hours Per Week :

L	T	P	C
4	-	-	4

Total Hours :

L	T	P
60	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	35	-	10	2	-

Course Description and Objectives:

This course deals with descriptive statistics, correlation and regression and their applications, probability, theoritical distributions and testing of hypothesis.

The objective of this course is to enable the student to understand and apply statitical techniques, curve fitting, correlation and regression, probability and also to make the student familiar with discrete, continuous distributions and testing of hypothesis.

Course Outcomes:

The student will be able to:

- distinguish between quantitative and categorical data and represent the data in graphical and tabular forms.
- calculate and interpret measures for the centre and spread of a data set.
- decide how and when to use the normal model.
- calculate and interpret correlation coefficient and regression lines.
- understand the rules of probability and apply them.
- compute probabilities using theoritical distributions.
- test hypothesis for population parameters.

UNIT - 1 **L-9**

STATISTICS : Basic definitions, Frequencies, Graphical representation, Histogram, Ogive curves, Measures of central tendency, Arithmetic mean, Median, Mode, Mean deviation, Standard deviation, Symmetry and skewness, Karl Pearson's coefficient of skewness.

UNIT - 2 **L-9**

CURVE FITTING, CORRELATION & REGRESSION : Least squares method, Curve fitting (straight line and parabola only). Covariance, Correlation, Types, Pearson's coefficient of correlation, Rank correlation, Spearman's rank correlation. Regression, Regression lines.

UNIT - 3 **L-8**

PROBABILITY : Introduction, Definition (classical and axiomatic approach), Addition theorem, Conditional probability, Multiplication theorem, Total probability, Bayes theorem.

UNIT - 4 **L-8**

DISTRIBUTIONS: Random variables, Discrete and continuous variables, Introduction to distributions.

BINOMIAL DISTRIBUTION : Definition, Mean and Standard deviation, Recurrence relation, Applications, Fitting of binomial distribution.

POISSON DISTRIBUTION : Definition, Mean and standard deviation, Recurrence relation, Poisson Distribution is an approximation of Binomial distribution, Applications, Fitting of Poisson distribution.

NORMAL DISTRIBUTION : Definition, Normal curve, Mean and standard deviation, Median, Mode, Normal distribution applications.

UNIT - 5 **L-12**

SAMPLING METHODS : Population and sampling, Parameters and statistics, Types of sampling. Test of hypothesis and test of significance: Null hypothesis, Errors, Level of significance, Confidence Limits, Testing large samples, Sample distribution of proportion, T-distribution for small sample, difference between means of small sample, Chi square test for goodness of fit, Chi square test for test of independence.

TEXTBOOKS:

1. Miller and Freund, "Probability and Statistics for Engineers", 8th edition, Pearson Publishers, 2013.
2. H. K. Dass & Er. Rajanish Verma, "Higher Engineering Mathematics", 3rd revised edition, S. Chand and Company, 2014.

REFERENCE BOOK:

1. S.C. Gupta and V.K. Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand and Company, New Delhi, 2005.

16EL102 SOFT SKILLS LABORATORY

Hours Per Week :

L	T	P	C
-	-	2	1

Total Hours :

L	T	P
-	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
-	-	-	-	-	-

Course Description and Objectives:

The Soft Skills Laboratory course is aimed at training undergraduate students on employability skills. Designed to impart work related skills, the course will enable trainees to develop interpersonal communication, leadership, Preparing Resume, Group Discussion, and Interview Skills. It will give them the required competence and confidence to handle professional tasks.

Course Outcomes:

The student will be able to:

- equip with requisite professional and inter-personal skills.
- possess the ability to think critically on issues for informed decision making and know how to communicate effectively, through choice of appropriate language and speech, while dealing with others at the workplace.
- identify and introspect on individual strengths and weaknesses, will emerge with improved levels of self-awareness and self-worth, for greater efficacy at workplace.

SKILLS:

- ✓ *Communicate and understand the difference between soft skills and hard skills.*
- ✓ *Learn professionalism and Employability skills.*
- ✓ *Plan Career by drawing their SWOT, Setting the Goal, learn the importance of Time and Stress Management.*
- ✓ *Learn Vocabulary, Situational English, Group Discussion, Reading Comprehension and Listening Comprehension which are essential for all competitive examinations.*
- ✓ *Prepare Resume and learn how to face interview.*
- ✓ *Learn Gender sensitive language, Good manners, emotional intelligence and essential skills.*

ACTIVITIES:

- *Formal and informal communication.*
- *SWOT analysis.*
- *Stephen covey Time Management matrix.*
- *Stress Management techniques.*
- *Vocabulary flash cards.*
- *Situational Dialogues.*
- *Group Discussion.*
- *Resume preparation.*
- *Mock Interview.*
- *Reading comprehension activities.*
- *Listening comprehension Activity by watching the American accent video.*
- *Emotional intelligence, etiquette quiz.*

UNIT - 1 **P-8**

A) COMMUNICATION : Need for effective communication - The process of communication, Levels of communication, Flow of communication, Choice of diction and style with reference to setting (formal, semi-formal or informal); Communication networks, Barriers to communication, Miscommunication, Noise and ways to overcome the barriers.

B) SOFT SKILLS: Difference between soft and hard skills, Need for soft skills, Professionalism, Employability skills.

C) CAREER PLANNING: Job vs career, Goal setting, SWOT analysis, Planning and prioritization, Four quadrant time management system, Self-management, Stress-management.

ACTIVITY : Johari Window for SWOT analysis, Setting a SMART goal using the provided grid, Writing a statement of purpose (SOP).

UNIT - 2 **P-8**

A) VOCABULARY BUILDING: Word etymology, Roots, Prefixes and suffixes, Synonyms and antonyms, Collocations, One-word substitutes, Analogies, Idioms and phrases, Contextual guessing of unfamiliar words, Task-oriented learning (50 words).

ACTIVITY: Making a flash card (one per day by each student), Vocabulary exercises with hand-outs, Vocabulary quiz (evaluation will be a combination of the 50 words provided by the instructor and the flash cards made by the student (one per day).

B) FUNCTIONAL ENGLISH : Situational dialogues, Role plays (including small talk), Self introduction, Opening and closing a telephonic conversation, Making an appointment, Making a query, Offering/ Passing on information, Communicating with superiors, Expressing agreement/objection, Opening bank account (combination of prepared and impromptu situations given to each student).

C) GROUP DISCUSSION : Articulation and flow of oral presentation, Dynamics of group discussion, Intervention,Summarizing and conclusion, Voice modulation, Content generation, Key word approach (KWA), Social, Political, Economic, Legal and technical approach (SPELT), View point of affected part (VAP), Language relevance, Fluency and coherence.

ACTIVITY : Viewing a recorded video of GD and Mock sessions on different types of GD topics - Controversial, Knowledge, Case study (including topics on current affairs).

UNIT - 3 **P-4**

A) RESUME-WRITING : Structure and presentation, Defining career objective, Projecting one's strengths and skill-sets, Summarizing, Formats and styles and covering letter.

ACTIVITY : Appraising some samples of good and bad resumes, Preparing the resume, Writing an effective covering letter.

B) FACING INTERVIEWS : Interview process, Understanding employer expectations, Pre-interview planning, Opening strategies, Impressive self-introduction, Answering strategies, Other critical aspects such as body language, Grooming, Other types of interviews such as stress-based interviews, Tele-interviews, Video interviews, Frequently asked questions (FAQs) including behavioural and HR questions and the aspect looked at by corporate during interviews.

ACTIVITY: Writing responses and practicing through role plays and mock interviews on the FAQs including feedback.

UNIT - 4 **P-4**

A) READING COMPREHENSION : Reading as a skill, Techniques for speed reading, Understanding the tone, Skimming and scanning, Appreciating stylistics, Impediments for speed reading, Eye fixation, Sub-vocalization, Critical reading, Reading based on purpose, Reading for information, Reading for inference.

ACTIVITY : Reading comprehension exercises with texts drawn from diverse subject areas (Hand-outs), Newspaper activity with students divided into 4 groups, Each group looks at critical component of communication such as Listening, Speaking, Reading and writing enabling them to be better communicators as well as be more aware about the current affairs, Which help in group discussion.

B) LISTENING COMPREHENSION : Listening as a skill, Different types of listening, Active and passive listening, Top-down approach, Bottom-up approach, Understanding the non verbal cues of communication, Intonation and stress.

ACTIVITY : Narration of a story, Speech excerpts with different accents (Indian, British, American), listening comprehension exercises with audio and video excerpts.

UNIT - 5 **P-6**

IMPACT OF LANGUAGE ON PERSONALITY : Gender sensitive language in MNCs, Cultural sensitivity, Social awareness, Emotional intelligence, Good manners, Self-grooming, Positive body language, Accepting and handling responsibility, Assertiveness, Problem solving, Negotiating skills, Networking and creating a good first impression, Seven essential skills for a team player, Attentive listening, Intelligent questioning, Gently persuading, Respecting other's views, Assisting others, Sharing, Participating actively.

ACTIVITY : Johari Window, Games and case studies.

REFERENCE BOOKS:

1. Edward Holffman, "Ace the Corporate Personality", McGraw-Hill,2001.
2. Adrian Furnham, "Personality and Intelligence at Work", Psychology Press, 2008.
3. John Adair Kegan Page, "Leadership for Innovation", 1st edition, Kogan, 2007.
4. M.Ashraf Rizvi, "Effective Technical Communication", 1st edition, Tata McGraw-Hill, 2005.
5. Krishna Mohan and NP Singh, "Speaking English Effectively", 1st edition, Macmillan, 2008.
6. Soft Skills Material of Infosys Under the Academic Initiative of Campus Connect.
7. Dr. S.P. Dhanvel, "English and Soft Skills", Orient Blackswan, 2011.
8. Rajiv K. Mishra, "Personality Development", Rupa and Co, 2004.

16CS202 DATA STRUCTURES

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
5	40	-	8	5	-

Course Description and Objectives:

This course is aimed at offering fundamental concepts of data structures and explaining how to implement them. It begins with the basic concepts of data and data structures and introduces the primitive and non-primitive data structures in detail. It forms the basis for understanding various ways of representing data and its usage in different computing applications.

Course Outcomes:

The student will be able to:

- apply advanced C programming techniques such as pointers, dynamic memory allocation, structures to develop solutions for particular problems.
- analyze characteristics of various data structures.
- differentiate between Graphs and Trees.
- understand the importance of sorting and applying it wherever useful.
- understand the usefulness of data structures in solving problems.

SKILLS:

- ✓ *Identify the required data structures for various applications.*
- ✓ *Identify the sorting algorithm suitable for a given scenario.*
- ✓ *Implement array or linked list for a given problem.*
- ✓ *Analyse Pros & Cons of each of the data structure.*
- ✓ *Usage of trees and graphs.*

UNIT - 1 **L-9**

SORTING AND SEARCHING: Introduction - Data, Data type, Data structure, Primitive and Non-primitive - Data type, Data structure; Storage structures - Sequential and linked storage representations; Applications of structures, Hashing.

SORTING: Selection sort, Bubble sort, Insertion sort, Quick sort, Merge sort.

SEARCHING: Binary search and linear search.

UNIT - 2 **L-9**

LINKED LISTS: Introduction, Types of linked list - Singly linked list, Doubly linked list, Circular linked List; Operations - Insertion, Deletion, Traverse forward/reverse order; Multi lists, Applications of linked lists.

UNIT - 3 **L- 9**

STACKS AND QUEUES: Stacks - Introduction, Array and linked representations, Implementation and their applications; Queues - Introduction, Array and linked representations, Implementation and their applications, Types - Linear, Circular and doubly ended queues; Applications.

UNIT - 4 **L-9**

TREES: Introduction, Properties, Binary Tree - Introduction, Properties, Array and linked representations; Tree traversals and their Implementation, Expression trees, BST definition and implementation; AVL Trees - Definition and implementation.

UNIT - 5 **L-9**

GRAPHS: Introduction, Properties, Modeling problems as graphs representations - Adjacency matrix, Adjacency list; Traversals - Breath first search and depth first search; Application of graphs.

LABORATORY EXPERIMENTS

Course Outcomes:

The student will be able to:

- understand the importance of structure, abstract data type and their basic usability in different applications through different programminglanguages.
- understand the linked implementation and its uses both in linear and non-linear data structure.
- understand various data structures such as stacks, queues, trees, graphs, etc. to solve various computing problems.
- decide a suitable data structure to solve a real world problem.

LIST OF EXPERIMENTS Total hours-30

1. Selection, Bubble, Insertion, Quick and Merge sorting algorithms.
2. Linear and Binary search algorithms.
3. Single linked list, doubly linked list, and circular linked list.
4. Stack using an array and linked list.
5. Queue using an array and linked list.

ACTIVITIES:

- *Design and Implement a School Management System.*
- *Design and Implement a Social Networking Site.*
- *Implement a project to find out the most common words in the articles.*
- *Design and Implement a Library Book Management System.*
- *Design and Implement a CricBuzz Application.*

6. Tree using an array and linked list.
7. Check if given expression is fully parenthesis or not using stack.
8. Tree traversing techniques.
9. BST using an array and linked list.
10. Graph traversal techniques.

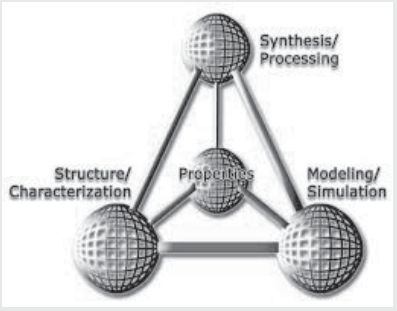
TEXT BOOK:

1. ReemaThareja, “Data Structures Using C”, 2nd edition, Oxford University Press, 2014.

REFERENCE BOOKS :

1. Richard F. Gilberg and Bhrouz A. Forouzan, “Data Structures: A Pseudocode Approach with C”, 2nd edition, Cengage Learning, 2004.
2. Jean Paul Tremblay and Paul G. Sorenson, “An Introduction to Data Structures with Applications”, 2nd edition, Tata Mc-Graw Hill, 2004.
3. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, 2nd edition, Pearson Education, 2006.

16CH102 MATERIALS SCIENCE AND TECHNOLOGY



Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P
45	15	-

WA/RA	SSH/HSH	CS	SA	S	BS
8	60	-	10	-	-

Course Description and Objectives:

This course will emphasize the structure-property relationships of engineering materials. The objective of this course is to provide knowledge in basic principles of material science and also to study structure of materials at all length scales.

Course Outcomes:

The student will be able to:

- understand crystal structure of various materials and techniques used for structure determination.
- understand the influence of defects on the properties of materials.
- understand the fundamentals of equilibrium phase diagrams.
- gain knowledge on various fabrication techniques used for manufacturing common engineering materials.

SKILLS:

- ✓ *Identify the type of material: ceramic, polymer, metal or composite.*
- ✓ *Select materials with suitable properties for a given application.*
- ✓ *Predict the type of fracture/failure in a material.*
- ✓ *Read and draw conclusion from binary phase diagrams.*
- ✓ *Suggest manufacturing methods for metals, ceramics and polymeric materials.*
- ✓ *Determine basic mechanical properties of materials using universal testing machine.*

ACTIVITIES:

- *Testing the type of failures.*
- *"Gee Whiz": Wonder presentations.*
- *Analysis of load test results.*
- *Study of micro structures of materials.*
- *Segregation of the given materials.*
- *Identification of phases in the given phase diagram.*

UNIT - I **L-9, T-3**

BONDING IN SOLIDS : Inter atomic forces and potential energy, Types of bonds: Primary and secondary, Variation in bonding character and resulting properties.

CRYSTAL STRUCTURE : Classification of crystal systems–SC, BCC, FCC & HCP crystal structures with examples, Atomic packing factor, Coordination number, Determination of miller indices of planes and directions of cubic and hexagonal crystals, Linear and planar densities, Separation between successive planes, Crystal structure determination: Bragg law, Powder method.

UNIT - 2 **L-10, T-3**

CRYSTAL DEFECTS : Point defects, Dislocations: Edge, Screw and mixed, Burgers vectors, Energy of dislocation, Motion of dislocation, Dislocation density. Grain boundary, Stacking faults and twin boundary.

PHASE DIAGRAMS : Gibb's phase rule and terms involved–Reduced phase rule, Tie line and lever rules, Two component systems–invariant reactions–Eutectic system and Iron-Carbon system.

UNIT - 3 **L-9, T-3**

MATERIALS FABRICATION TECHNIQUES : Fabrication of Metals: Forming operations, Casting, Fabrication of Ceramics: Particulate forming processes, Cementation. Forming techniques of Plastics: Compression, Transfer and injection molding, Extrusion, Blow molding.

MECHANICAL PROPERTIES : Stress-Strain relations of various solids–Elastic, Anelastic, Visco-elastic and plastic deformations in solids, Creep and fatigue, Fracture: Brittle and Ductile, Fracture toughness, Ductile to brittle transitions.

UNIT - 4 **L-8, T-3**

ELECTRICAL & SEMICONDUCTING PROPERTIES : Ohm's Law, Electrical conductivity, Electronic and Ionic conduction, Energy band structures in Solids, Classification of solids based on band models, Electron mobility, Electrical resistivity of metals, Intrinsic semiconduction, Extrinsic Semiconduction, The temperature dependence of carrier concentration, Factors that affect carrier mobility.

UNIT - 5 **L-8, T-3**

DIELECTRIC AND MAGNETIC PROPERTIES : Dielectric behavior, Capacitance, Polarization, Frequency Dependence of dielectric constant, Dielectric strength. Types of magnetism, Ferromagnetism-Domain theory-hystersis behavior, Ferrimagnetism, Soft and hard magnets–application of magnetic materials.

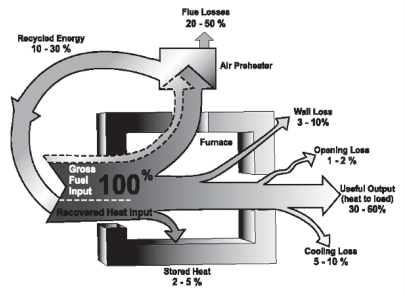
TEXT BOOKS:

1. W. D. Callister, "Materials Science and Engineering: An Introduction," 8th edition, John Wiley & Sons Inc, 2009.
2. V.Raghavan, "Materials Science and Engineering:A First Course", 5th edition, Prentice Hall of India Learing Pvt. Ltd., 2013.

REFERENCE BOOKS:

1. L. H. VanVlack, Elements of Materials Science and Engineering, 6th edition, Addison Wesley, 1989.
2. W.F. Smith and J. Hashemi, "Foundations of Materials Science and Engineering", 4th edition, McGraw-Hill, 2005.
3. N.W. Dowling, "Mechanical Behavior of Materials", 3rd edition, Prentice Hall of India, 2006.
4. J.F. Shackelford, Introduction to Materials Science for Engineers, 6th edition, Prentice Hall of India, 2004.
5. P. Haasen and B. L. Mordike, Physical Metallurgy, 3rd edition, Cambridge University Press, 1996.

16CH201 CHEMICAL PROCESS CALCULATIONS



Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P
45	15	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	50	-	5	5	5

Course Description and Objectives:

This course deals with fundamentals of material and energy balances involved in chemical processes. The objective of this course is to develop basic understanding pertaining to principles of chemical engineering processes and calculations.

Course Outcomes:

The student will be able to:

- use mole concepts and perform calculations involving concentrations.
- apply gas laws to solve problems related to ideal gas mixtures.
- carry out detailed material and energy balance for any chemical plant having different unit operations and unit processes.

SKILLS:

- ✓ *Material balance calculations for different chemical processes.*
- ✓ *Energy balance for any chemical plant.*

ACTIVITIES:

- *Mini project on material and energy balance of a chemical process.*
- *Estimation of physical properties.*

UNIT - 1 **L-10, T-2**

STOICHIOMETRIC RELATIONS : Basis of calculations, Methods of expressing composition of mixtures and solutions, Mole fraction and mole percent, Density and specific gravity, Baume and API gravity scales.

BEHAVIOR OF IDEAL GASES : Kinetic theory of gases, Application of ideal gas law, Gaseous mixtures, Gases in chemical reactions, Gas densities and specific gravities.

UNIT - 2 **L-9, T-2**

VAPOR PRESSURE : Liquefaction and liquid state, Vaporization, Boiling point, Effect of temperature on vapor pressure, Antonie equation, Vapor pressure plots, Vapor pressure of immiscible liquids and ideal solutions, Raoult's law, Non-volatile solutes, Basics of humidification.

UNIT - 3 **L-9, T-3**

MATERIAL BALANCE : Materials balance without reaction, Materials balance with reaction–recycle, purge, bypass.

UNIT - 4 **L-8, T-4**

THERMO PHYSICS : Energy, Energy balances, Heat capacity of gases, Liquid and mixture solutions, Kopp's rule, Latent heats, Heat of fusion and heat of vaporization, Trouton's rule, Kistyakowsky equation for non-polar liquids, Enthalpy and its evaluations.

UNIT - 5 **L-9, T-4**

THERMO CHEMISTRY : Calculation and applications of heat of reaction, Combustion and formation, Kirchoff's equation, Calculation of theoretical and actual flame temperatures, Combustion calculations.

TEXT BOOKS:

1. Hougen O.A., Watson K.M. and Ragatz .R. A., "Chemical Process Principles Part – I: Material and Energy Balance", John Wiley sons, 2nd edition, CBS Publishers & Distributors, 2004.
2. Bhatt B. I., and Vora S. M., "Stoichiometry", 4th edition, Tata McGraw-Hill, New Delhi 2004.

REFERENCE BOOKS:

1. Himmelblau D.H., "Basic Principles and Calculations in Chemical Engineers", 8th edition, Prentice Hall of India, 2011.
2. Richard M.F., and Ronald W.R., "Elementary Principles of Chemical Processes", 3rd edition, John Wiley, 2004.

16CH202 MOMENTUM TRANSFER

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
20	45	-	5	5	5

Course Description and Objectives:

This course deals with fundamentals of fluid flow and its application to chemical process industries including pipe flow, fluid machinery. The objective of this course is to familiarize students with basic concepts of fluid statics, fluid dynamics, compressible and incompressible fluids, fluidization, transportation and metering of fluids.

Course Outcomes:

The student will be able to:

- understand basic principles of fluid mechanics.
- analyze fluid flow problems with the application of the momentum and energy equations.
- analyze pipe flows as well as fluid machinery.

SKILLS:

- ✓ *Application of fluid mechanics concepts to solve real life problems.*
- ✓ *Estimate* physical properties of fluids in motion and at rest.
- ✓ *Measurement of flowing fluids.*
- ✓ *Selection of pumps for engineering applications.*

ACTIVITIES:

- *Calibration of rotameter.*
- *Separation of immiscible liquids using decanter.*
- *Calibration of manometer.*
- *Design of Venturi meter.*
- *Design of Orifice meter.*

UNIT - 1 **L-10**

DEFINITIONS AND PRINCIPLES : Unit operations, Unit systems, Dimensional analysis, Basic concepts. Fluid Statics: Nature of fluids, Hydrostatic equilibrium, Manometers.

FLUID FLOW PHENOMENA : Laminar flow, Shear stress, Viscosity, Turbulence, Eddy viscosity, Flow in boundary layers.

UNIT - 2 **L-9**

BASIC EQUATIONS OF FLUID FLOW : Mass balance, Mass velocity, Momentum balance, Bernoulli equation, Mechanical energy balance equation, Correction factors, Pump work.

UNIT - 3 **L-9**

FLOW OF INCOMPRESSIBLE FLUIDS : Shear stress distribution in pipes, Relation between skin friction parameters, Laminar flow in pipes, Hagen-poiseuille equation, Laminar flow of non-Newtonian liquids, Velocity distribution for turbulent flow, Friction factor chart.

FLOW OF COMPRESSIBLE FLUIDS : Mach number, Basic equations.

UNIT - 4 **L-8**

FLOW PAST IMMERSED BODIES : Drag, Drag Coefficient, Stagnation point, Friction in flow through beds of solids, Motion of particles through fluids, Terminal velocity, Motion of spherical particles. Fluidization: Conditions for fluidization, Minimum fluidization velocity.

UNIT - 5 **L-9**

TRANSPORTATION AND METERING OF FLUIDS : Pipes, Fittings, Valves, Joints, Pumps, Developed head and Power requirement in pumps, Suction lift and cavitation, Positive displacement pumps, Centrifugal pumps, Measurement of flowing fluids: Classification of measuring devices, Venturi meter, Orifice meter, Rotameter.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total Hours-30

1. Identification of laminar and turbulent flows.
2. Verification of Bernoulli's Equation.
3. Measurement of flowing fluid using Venturi meter.
4. Measurement of flowing fluid using Orifice meter.
5. Determination of friction loss in fluid flow through pipes.
6. Determination of friction loss in fluid flow through fittings.
7. Determination of pressure drop in packed bed.
8. Determination of pressure drop in fluidized bed.
9. Determination of characteristics of centrifugal pump.
10. Determination of characteristics of reciprocating pump.

TEXT BOOKS:

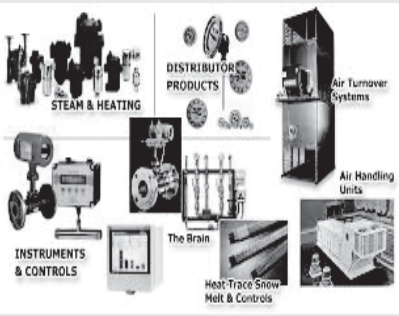
1. W.L. McCabe, J.C. Smith and P. Harriot, “Unit Operations of Chemical Engineering”, 7th edition, McGraw-Hill, 2005.

2. Chattopadhyay. P, “Unit Operations of Chemical Engineering Vol-1 “, 1st edition, Khanna Publishers, 2012.

REFERENCE BOOKS:

1. C. J. Geankoplis, “Transport Processes and Unit Operations”, 3rd edition, Prentice Hall of India, 1993.

2. A.S. Foust, “Principles of Unit Operations”, 2nd edition, John Wiley & Sons, 1981.



16CH203 PROCESS INSTRUMENTATION

Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P
45	15	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	48	-	-	5	5

Course Description and Objectives:

The course provides insight into instruments that are used to measure physical properties in chemical process industries. The objective of this course is to familiarize student with the working principles of standard measurement devices used in engineering applications.

Course Outcomes:

The Student will be able to:

- discuss principles involved in the measurement and control of industrial processes.
- understand instruments and devices used for designing process control systems.

SKILLS:

- ✓ *Temperature measurement with electrical systems.*
- ✓ *Flow measurement with different devices.*
- ✓ *Select a suitable measurement device for a given application.*

UNIT - 1 **L-9, T-2**

QUALITIES OF MEASUREMENT : Elements of Instruments, Static and dynamic characteristics, Response of first order instruments.

TEMPERATURE MEASUREMENTS : Expansion thermometer- Thermoelectric temperature measurements.

UNIT - 2 **L-10, T-3**

TEMPERATURE MEASUREMENT : Resistance and radiation, Thermal coefficients of resistance, Industrial resistance thermometer bulbs and circuits, Radiation, Photoelectric and optical pyrometers.

COMPOSITION ANALYSIS : Spectroscopic analysis, Chromatography (GC, HPLC, GCMS/LCMS), Color measurement spectrometers.

UNIT - 3 **L-9, T-4**

MEASUREMENT OF PRESSURE AND VACUUM : Liquid column manometers, Gauge pressure and vacuum measurement, Indicating elements for pressure gauges, Measurement of absolute pressure, Corrosive liquids, Static accuracy and response of pressure gauges.

UNIT - 4 **L-8, T-3**

MEASUREMENT OF HEAD AND LEVEL : Head, Density and specific gravity measurement, Direct measurement of liquid level, Pressure measurement in open vessels measurement of interface level, Density measurement.

UNIT- 5 **L-9, T-3**

FLOW METERING : Head Flow and area flow meters, Open channel meters, Viscosity measurements, Quantity meters, Flow of dry materials. Recording, Indicating and signaling Instruments. PI Diagrams, Control center.

TEXT BOOKS :

1. Donald P. Eckman, “Industrial Instrumentation”, 1st edition, Wiley Eastern, 2004.
2. Patranabis, “Principles of Industrial Instrumentation”, 2nd edition, Tata McGraw-Hill, 2007.

REFERENCE BOOKS :

1. D.M.Considine, “Hand Book of Instrumentation”, 2nd edition, McGraw-Hill, 1957.
2. Norman Anderson, “Instrumentation for Process Measurement and Control”, 3rd edition, CRC Press, 1997.

ACTIVITIES:

- *Calibration of spectro photometer.*
- *Measurement of flow rate in open channels.*
- *Calibration of head and flow meters.*

16EL103 PROFESSIONAL COMMUNICATION LABORATORY

Hours Per Week :

L	T	P	C
-	-	2	1

Total Hours :

L	T	P
-	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
-	-	-	-	-	-

Course Description and Objectives:

The Professional Communication Laboratory course is aimed at improving professional communication skills (LSRW – Listening, Speaking, Reading and Writing) of undergraduate students and preparing them for their profession as engineers and managers. This course will help students to understand professional communication and personality as two interlinked spheres of influence, and provide them with exposure to conventions of corporate communication involved in the functioning of the business world.

Course Outcomes:

The student will be able to:

- be equipped to clear industry recognized certification such as BEC Vantage by the University of Cambridge.
- equip them to stand out both in the professional setting as well as for further pursuits in the academic world.
- since this certification looks at LSRW (Listening, Speaking, Reading and Writing) components in great detail, we hope to equip students to confidently and successfully attempt all the 4 critical components.

SKILLS:

- ✓ *Understand and use grammar rules in writing; sentences, paragraphs, paraphrasing.*
- ✓ *Write business emails, memos, letters, reports and proposals.*
- ✓ *Comprehend business articles, and documents.*
- ✓ *Use expressions in Professional context, and acquire presentation skills like one minute talk and pair discussion in professional context.*
- ✓ *Familiarize and comprehend British accent by listening to recorded speeches and discussions.*

UNIT - 1 **P-6**

BUSINESS ENGLISH VOCABULARY: Glossary of most commonly used words (formal and informal usage), Elements of technical writing - Sentence structure, Reducing verbosity, Arranging ideas logically, Building coherence, Paragraph level and document level, Topic sentence, Cohesive devices, Transitional words, Paraphrasing and précis-writing; Mechanics of writing - Stylistic elements, The rapporteur, The purpose, The reader's viewpoint (audience), Elementary rules of grammar, Choice of diction, Elementary principles of composition, Matters of form, Punctuation, Conventions of business communication, Language and professional tone, Weak links in business correspondence, Ethical concerns in business writing, Code of conduct (not sending illegal, Offensive, Disparaging personal remarks or comments) in written business communication.

UNIT - 2 **P-6**

BUSINESS CORRESPONDENCE: E-mail - Nature and scope, E-mail etiquette, Clear call for action, Common errors in composing e-mails, Office communication such as meeting agenda and minutes of the meeting, Notice, Circular and memo; Letter-Writing - Formal and informal letters, Structure of formal letters, Expressions of salutations, Different types of letters [Such as sales letter, Complaint letter, Response to the complaint letter (dispute resolution), Letter of permission, Letter of enquiring, claim letter, Letter of apology etc], Introductory and concluding paragraphs and clear call for action.

PROFESSIONAL PROPOSAL/REPORT: Differentiating proposals and reports, Drafting formal business proposals, Types of reports such as factual reports, Feasibility reports and survey reports, Parts ofa report (Such as title page, Declaration, Acknowledgements, Table of contents, Abstract, Introduction, Findings, Conclusion and recommendations, Citations, References and appendices).

UNIT - 3 **P-6**

SPEAKING: Speaking in business context, Assertiveness, Politeness, Making requests, Queries and questions, Negotiations, Asking for information, Offering suggestions, Conflict resolution, Contacting clients, Initiating, Addressing delegates (in public), Features of a good power point presentation (making the PPT), Delivering the presentation effectively, Telephone etiquettes, Delivering seminar/proposal/report effectively, Team meeting etiquettes (face to face and conference call), Making effective one minute presentations.

UNIT - 4 **P-6**

READING: Reading and comprehending business documents, Learning business register, Regularizing the habit of reading business news, Suitable vocabulary, Skimming and scanning text for effective and speedy reading and dealing with ideas from different sectors of corporate world in different business contexts.

UNIT - 5 **P-6**

LISTENING: Specific information in business context, Listening to telephonic conversations/messages and understanding the correct intended meaning, Understanding the questions asked in interviews or in professional settings, Summarizing speaker's opinion or suggestion, Enable active listening.

TEXT BOOKS:

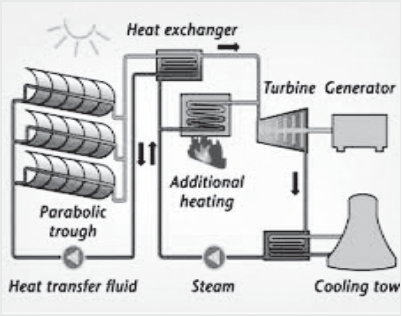
1. Guy Brook Hart, "Cambridge English Business Bench Mark: Upper Intermediate", 2nd edition: CUP, 2014.
2. Cambridge: BEC VANTAGE: Practice Tests, CUP, 2002.

ONLINE REFERENCES:

1. http://www.cambridgeenglish.org/exams/business-certificates/business vantage/preparation/
2. https://www.youtube.com/watch?v=qxFtn9pGaTI.

ACTIVITIES:

- *Basic grammar practice, Framing paragraphs on topics allocated.*
- *Paraphrase an article or a video in your own words Finding topic sentences in newspaper articles.*
- *Find out new words from a professional viewpoint Understanding the meaning and its usage.*
- *Peruse samples of well prepared proposals and reports.*
- *Draft different proposals/reports on topics assigned.*
- *Watch videos/ listening to audios of business presentations.*
- *Classroom activities of team and individual presentations.*
- *Use PPTs, mock exercises for BEC speaking.*
- *Present (speaking) the written components completed in Unit 1.*
- *Hand-outs; matching the statements with texts.*
- *Find the missing appropriate sentence in the text from multiple choice, multiple choices.*
- *Use right vocabulary as per the given context and editing a paragraph.*



16CH204 CHEMICAL ENGINEERING THERMODYNAMICS-I

Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P
45	15	-

WA/RA	SSH/HSH	CS	SA	S	BS
25	50	-	-	5	5

Course Description and Objectives:

This course deals with first, second and third laws of thermodynamics, volumetric properties, refrigeration and liquefaction processes. The objective of this course is to provide understanding in the theory and applications of classical thermodynamics, thermodynamic properties and equations of state.

Course Outcomes:

The student will be able to :

- apply fundamental concepts of thermodynamics to engineering applications.
- estimate thermodynamic properties of substances in gas and liquid states.
- determine thermodynamic efficiency of various energy related processes.

SKILLS:

- ✓ *Estimation of thermodynamic properties.*
- ✓ *Determination of heat engine and pump efficiency.*
- ✓ *Identification of reversible and irreversible processes.*
- ✓ *Selection of refrigeration process and refrigerant.*

UNIT- 1 **L-9, T-3**

BASIC CONCEPTS : The scope of thermodynamics, Dimensions and units, Measures of amount or size, Force, Temperature, Pressure, Work, Energy, Heat, Zeroth law.

UNIT - 2 **L-9, T-3**

FIRST LAW OF THERMODYNAMICS : Joule's experiment, Internal energy, Statement of first law, Energy balance for closed system, Thermodynamic state and state functions, Equilibrium, Phase rule, Reversible processes, Constant-v and constant-p processes, Enthalpy, Heat capacity.

UNIT - 3 **L-9, T-3**

VOLUMETRIC PROPERTIES OF PURE FLUIDS : PVT behaviour of pure substances, Virial equations of state, Ideal gas, Applications of the virial equations, Cubic equations of state.

UNIT - 4 **L-9, T-3**

THE SECOND LAW OF THERMODYNAMICS : Statements of the second law, Heat engines, Thermodynamic temperature scales, Entropy, Mathematical statement of the second law, Third law of thermodynamics (statement).

UNIT - 5 **L-9, T-3**

REFRIGERATION AND LIQUEFACTION : Carnot refrigerator, Vapor compression cycle, Choice of refrigerant, Absorption refrigeration, Liquefaction processes.

Production of Power from Heat: Steam power plant, Rankine cycle, Otto engine, Diesel engine.

TEXT BOOKS:

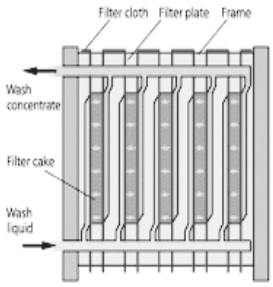
1. J.M.Smith, H.C,Vanness and M.M.Abbot, "Introduction to Chemical Engineering Thermodynamics", 6th edition, McGraw-Hill, 2005.
2. Y.V.C.Rao, "Chemical Engineering Thermodynamics", 1st edition, Universities Press, 2004.

REFERENCE BOOKS:

1. Dodge B.F., "Chemical Engineering Thermodynamics", 1st edition, McGraw-Hill, 1944.
2. Kyle B.G., "Chemical and Process Thermodynamics", 1st edition, Prentice Hall of India,1999.

ACTIVITIES:

- *Calibration of thermometer.*
- *Conversion of work into heat using Joule's experiment.*
- *Expansion of gas using Joule-Thomson effect.*



16CH205 MECHANICAL UNIT OPERATIONS

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
20	30	-	-	5	5

Course Description and Objectives:

This course provides knowledge in the basics of unit operations employed in chemical process industries. The objective of this course is to familiarize student on the principles and practices involved in transporting, separating and storing of solids and associated unit operations.

Course Outcomes:

The student will be able to :

- understand and apply the basic methods of characterization of particles and bulk solids.
- carry size reduction and separation of solid materials.
- explain applications of unit operations and their operational principles.

SKILLS:

- ✓ *Perform cumulative and differential particle size analysis.*
- ✓ *Identify the suitable mixer required for mixing cohesive and non cohesive solids.*
- ✓ *Recognize the required specifications of the size reduction equipment for a given feed.*
- ✓ *Identify the filtration equipment required for a specific application.*
- ✓ *Compare the efficiency of separation equipment.*

UNIT - 1 **L-9**

PROPERTIES AND CHARACTERIZATION OF SOLIDS : Properties of particulate masses, Characterization of solid-particles, Particle Shape, Particle size, Mixed particle sizes and size analysis, Screen analysis, Standard screen series, Properties of particulate masses, Pressures in masses of particles, Storage of solids, Pressures in bins and silos, Flow out of bins.

UNIT - 2 **L-9**

MIXING AND CONVEYING OF SOLIDS : Mixing of solids, Types of mixers, Mixers for cohesive solids, Criteria of mixing effectiveness - mixing index ,Mixers for free flowing solids, Mixing index in blending granular solids, Mixing index at zero time, Rate of mixing, Conveying of solids-Belt conveyor, Screw conveyor, Pneumatic conveyor, Bucket elevator.

UNIT - 3 **L-9**

PRINCIPLES OF COMMINUTION : Criteria for comminution, Characteristics of comminuted products, Energy and power requirements in comminution, Empirical relationships, Size reduction equipment-Crushers, Grinders, Ultrafine Grinders, Cutting machines.

PARTICLE SIZE ANALYSIS : Screening, Screening equipment, Screen effectiveness.

UNIT - 4 **L-9**

FILTRATION : Introduction to filtration, Types of filters–pressure filters, Vacuum filters, Centrifugal filters, Filter media, filter aids, Principles of cake filtration, Pressure drop through filter cake, Continuous filtration, Principles of centrifugal filtration, Clarifying filters, Liquid clarification, Cross flow filtration.

UNIT - 5 **L-9**

PARTICLE SEPARATION TECHNIQUES : Separations based on motion of particles through fluids, Gravity settling processes, Gravity classifiers, Sorting classifiers, Clarifiers and thickeners, Flocculation, Batch sedimentation, Clarifier and thickener design, Centrifugal settling processes, Electrostatic precipitators, Cyclones and hydro clones.

ACTIVITIES:

- *To compare the working of different types of crushers.*
- *To find the optimum time of sieving.*
- *To compare the working of leaf filter and plate and frame filter press.*

LABORATORY EXPERIMENTS

Total hours: 30

LIST OF EXPERIMENTS

1. Determination of particle size using screen analysis.
2. Finding the effectiveness of a screen.
3. Verification of size reduction laws using jaw crusher.
4. Verification of size reduction laws using ball mill.
5. Verification of size reduction laws and finding efficiency using roll crusher.
6. Determination of compressibility coefficient using sedimentation process.
7. Determination of filter medium resistance and cake resistance using plate and frame filter press.
8. Determination of percent recovery of coal from coal-sand mixture using froth flotation cell.
9. Determination of the efficiency of leaf filter.
10. Determination of the efficiency of cyclone separator.

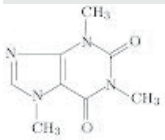
TEXT BOOKS:

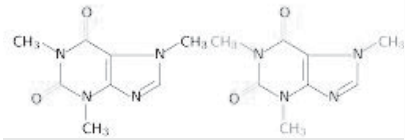
1. Mc Cabe, W. L., Smith J.C. and Peter Harriot, “Unit Operations of Chemical Engineering”, 7th edition, McGraw-Hill, 2005.
2. Foust et.al, “Principles of Unit Operations” 2nd edition, Wiley, New York, 2004.

REFERENCE BOOK:

1. Perry R.H, and Green, D.W. “Chemical Engineer’s Hand book”, 8th edition, McGraw-Hill, New York, 2007.

16CH206 ORGANIC CHEMISTRY





Hours Per Week :

L	T	P	C
3	1	2	4

Total Hours :

L	T	P
45	12	30

WA/RA	SSH/HSH	CS	SA	S	BS
20	45	-	10	-	-

Course Description and Objectives:

This course offers fundamental concepts and preparation of most organic compounds and pharmaceuticals and also reaction mechanism and stereo chemical aspects. The objective of this course is to familarise the student about the reaction mechanisms involved in organic synthesis.

Course Outcomes:

The student will be able to :

- write reaction mechanism.
- understand different named reactions.
- know characteristics and properties of various functional groups.
- understand stereochemical aspects.
- know medicinal aspects of heterocyclic chemistry.
- estimate retrosynthetic stratergy.

SKILLS:

- ✓ *Identify the purity of solid and liquid compounds.*
- ✓ *Detection of unknown functional group present in the given organic compound.*
- ✓ *Identify pharmaceutical intermediates.*
- ✓ *Preparation of organic compounds.*

ACTIVITIES:

- *Perform preliminary tests.*
- *Identification of extra elements present in organic compounds.*
- *Properties of various functional groups.*
- *Medicinally important reactions.*
- *Concentrate organic liquids obtained from plant extracts.*
- *Fractional distillation / column purification of plants extracts.*

UNIT - 1 **L-9, T-2**

(A) REACTION INTERMEDIATES : Bond fissions, Carbanions, carbonium ions, Free radicals, Nitrenes, Carbenes, Benzyne, Nucleophiles and electrophiles.

(B) **POLAR EFFECTS :** Inductive effect, Resonance, Hyper conjugation, Electromeric effect, Mesomeric effect.

UNIT - 2 **L-9, T-3**

(A) **TYPES OF ORGANIC REACTIONS** : Electrophilic reactions: Friedal - Craft's reactions, Fries Rearrrangement, Reimer - Tiemann reaction, Nucleophilic reactions: Aldol condensation, Cannizaro reaction.

(B) FREE RADICAL REACTIONS : Halogenation of alkane, Addition of HBr to alkene in presence of peroxide, Anti-Markovnikov's rule.

UNIT - 3 **L-9, T-2**

PREPARATIONS AND REACTIONS : Preparations and reactions of alcohols, Phenols, Carboxylic acids, Aldehydes, Ketones, Amines.

UNIT - 4 **L-9, T-3**

STEREO CHEMISTRY : Stereo isomerism, Optical isomerism, Symmetry, Optical Rotation, Chirality,

Lactic acid, Tartaric acid, Enantiomers, Diastereomers, R and S nomenclature, Racemic mixture and resolution methods. Geometrical Isomerism, E and Z nomenclature.

UNIT - 5 **L-9, T-2**

HETEROCYCLIC COMPOUNDS : Preparation and reactions of 1) Furan 2) Thiophene 3) Pyrrole 4) Pyridine.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total hours: 30

I. Criteria of purity of solid and liquid compounds

a. Determination of Melting point

b. Determination of Boiling point

II. Detection of extra elements in organic compounds

c. Nitrogen

d. Sulphur

e. Halogens

III. Identification of an unknown substance from the following organic compounds

f. Acids

g. Alcohols

h. Aldehydes

i. Amides

j. Amines

k. Carbohydrates

l. Esters

m. Ketones

n. Nitro Group

o. Phenols

IV. Preparations

a. Asprin

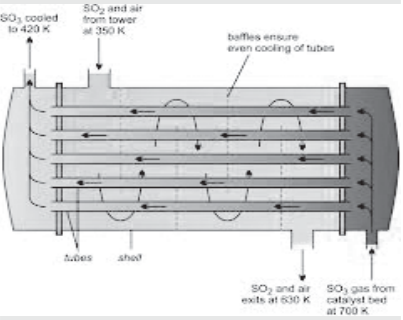
b. Preparation of DA Adduct

TEXT BOOK :

1. Arun Bahl and B.S. Bahl , "Text Book to Organic Chemistry", 18th edition, S. Chand, 2009.

REFERENCE BOOKS :

1. I. L. Finar; "Organic Chemistry, Vol – I, 6th edition, Longman Scientific Publications, 2006.
2. Somendra Nadh Sanyal, "Named Reactions, Rearrangements and Reagents", Bharathi Bhavan Publications, 2003.
3 O.P. Agarwal, "Reactions and Reagents", 46th edition, Goel Publications, 2005.
4 R.T Morrison and R.M. Boyd, "Organic Chemistry", 6th edition, Pearson Publications, 2008.



16CH207 PROCESS HEAT TRANSFER

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
25	50	-	5	5	5

Course Description and Objectives:

This course deals with the phenomena of heat transfer and methodologies applied for solving a wide variety of practical engineering problems. The objective of this course is to provide theoretical and practical knowledge in various modes of heat transfer and its application for designing of process equipments.

Course Outcomes:

The student will be able to :

- understand the basic laws of heat transfer.
- account for the consequence of heat transfer in thermal analyses of engineering systems.
- analyze problems involving steady state heat conduction in simple geometries.
- obtain numerical solutions for conduction and radiation heat transfer problems.
- understand the fundamentals of convective heat transfer process.
- evaluate heat transfer coefficients for natural and forced convection.
- understand the basic mechanism behind boiling and condensation processes.
- analyze heat exchanger performance by using the method of log mean temperature difference.
- calculate radiation heat transfer between black and gray surfaces.

SKILLS:

- ✓ *Estimate the rate of heat flow through a wall, cylinder or sphere*
- ✓ *Calculate the insulation thickness for a specified heat loss target.*
- ✓ *Determine heat transfer coefficient in simple geometries for forced and natural convection.*
- ✓ *Estimate area of heat exchanger required for specified conditions.*
- ✓ *Design of heat exchanger.*
- ✓ *Determine the emissivity of a given body.*

UNIT - 1 **L-9**

HEAT TRANSFER AND ITS APPLICATIONS : Nature of heat flow, Conduction, Convection, Radiation Heat transfer by conduction: Fourier's law of conduction, Thermal conductivity, Steady state conduction, Compound resistances in series, Heat flow through cylinder, Principles of heat flow in fluids: Heat exchange equipment, Counter current & parallel current flows, Energy balances, Rate of heat transfer, LMTD, Individual heat transfer coefficients, Overall heat transfer coefficient.

UNIT - 2 **L-9**

HEAT TRANSFER TO FLUIDS WITHOUT PHASE CHANGE : Regimes of heat transfer, Thermal boundary layer, Heat transfer by forced convection in laminar flow, Heat transfer by forced convection in turbulent flow, Analogy between transfer of momentum and heat, Reynolds analogy, Colburn analogy, Interpretation of dimensionless groups. Natural Convection: Dimensional analysis, Natural convection to vertical shapes and horizontal planes**.**

UNIT - 3 **L-9**

HEAT TRANSFER TO FLUIDS WITH PHASE CHANGE : Drop wise and film type condensation, Coefficients for film type condensation, Practical use of nusselt equations, Condensation of super heated vapors,Pool boiling of saturated liquid, Maximum flux and critical temperature drop.

UNIT - 4 **L-9**

RADIATION HEAT TRANSFER : Fundamental facts concerning radiation, Emission of radiation, Black body radiation, Laws of black body radiation, Absorption of radiation by opaque solids, Radiation between surfaces, Non black surfaces.

UNIT - 5 **L-9**

HEAT EXCHANGE EQUIPMENT : General design of heat exchange equipment, Heat exchangers, Condensers, Boilers. Evaporation: Liquid characteristics, Types of evaporators, Performance of tubular evaporators, Multiple effect evaporators.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total hours: 30

1. Estimation of natural convection heat transfer coefficient.
2. Determination of overall resistance in composite wall.
3. Estimation of emissivity of a test plate.
4. Verification of Stefan-Boltzmann's law of radiation.
5. Determination of heat transfer coefficients of double pipe heat exchanger.
6. Estimation of heat transfer coefficient in forced convection.
7. Determination of thermal conductivity of liquid sample.
8. Determination of thermal conductivity of solid sample.
9. Determination of critical heat flux points of nichrome wire.
10. Determination of overall heat transfer coefficient of a given coil.

ACTIVITIES:

- *Mix the heat.*
- *Feel the heat.*
- *Identification of heat exchangers.*
- *Fabrication of double pipe heat exchanger.*
- *Connecting shell and tube heat exchanger setup.*

TEXT BOOKS :

1. W. L. McCabe, J. C. Smith and P. Harriott, “Unit Operations of Chemical Engineering”, 6th edition, McGraw-Hill, Inc., 2005.

2. D. Q. Kern, “Process Heat Transfer”, 1st edition, Tata McGraw-Hill, 2002.

REFERENCE BOOKS :

1. J. P. Holman, “Heat Transfer”, 8th edition, McGraw-Hill, New York, 1997.

2. Y. V. C. Rao, “Heat Transfer”, 1st edition., University Press, 2001.

3. D. Pitts, E. Leighton and Sissom, “Schaum’s Outline of Heat Transfer”, 2nd edition., McGraw-Hill publications, 1998.

4. J.M. Coulson and J. F. Richardson, “Chemical Engineering,Vol-1”, Oxford, Pergamon Press,1968.

III

YEAR

CHEMICAL ENGINEERING

B.Tech.

I SEMESTER

- 16CH301 - Chemical Engineering Thermodynamics-II
- 16CH302 - Chemical Reaction Engineering-I
- 16CH303 - Mass Transfer Operations-I
- 16CH304 - Process Dynamics and Control
- - Department Elective
- - Department / Open Elective
- - Employability and Life Skills

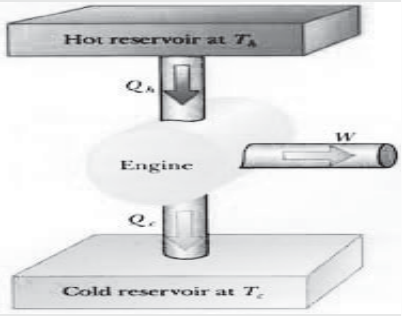
II SEMESTER

- 16HS301 - Professional Ethics
- 16CH305 - Chemical Reaction Engineering-II
- 16CH306 - Chemical Technology
- 16CH307 - Mass Transfer Operations-II
- 16CH308 - Process Modeling and Simulation
- - Department Elective
- - Department / Open Elective
- - Employability and Life Skills

COURSE CONTENTS

I SEM & II SEM

16CH301 CHEMICAL ENGINEERING THERMODYNAMICS-II



Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P
45	15	-

WA/RA	SSH/HSH	CS	SA	S	BS
25	45	-	-	5	5

Course Description and Objectives:

This course deals with the theory and applications of classical thermodynamics. The objective of this course is to familiarize student with solution thermodynamics, thermodynamic properties, equations of state and methods used to describe and predict the vapor liquid equilibria and chemical reaction equilibria.

Course Outcomes:

The student will be able to :

- calculate energy requirement during the course of reaction.
- analyze and calculate thermodynamic properties for a given system or process at specified conditions.
- use vapor liquid equilibrium relations to solve the process separation problems.
- evaluate the chemical reaction equilibrium for conversion/composition calculations.

SKILLS:

- ✓ *Energy calculations for a given chemical process.*
- ✓ *Estimation of solution thermodynamic properties.*
- ✓ *Modeling of vapor liquid equilibria.*
- ✓ *Equilibrium conversions.*

ACTIVITIES:

- *Extracting equilibrium data.*
- *Identification of ideal and non-ideal behavior.*
- *Modeling of vapor liquid equilibrium.*

UNIT - 1 **L- 9, T-3**

HEAT EFFECTS : Sensible heat effects, Latent heats of pure substances, Standard heat of reaction, Standard heat of formation, Standard heat of combustion, Temperature dependency of ΔH^0, Heat effects of industrial reactions.

UNIT - 2 **L-9, T-3**

SOLUTION THERMODYNAMICS THEORY : Fundamental property relation, Chemical potential and phase equilibria, Partial properties, Ideal gas mixtures, Fugacity and fugacity coefficient: pure species, Fugacity and fugacity coefficient: species in solution, Generalized correlations for the fugacity coefficient, Ideal solution, Excess properties.

UNIT - 3 **L-9, T-3**

SOLUTION THERMODYNAMICS APPLICATIONS : Liquid phase properties from VLE data, Models for the excess gibbs energy, Property changes of mixing, Heat effects of mixing processes.

UNIT - 4 **L-9, T-3**

VAPOR / LIQUID EQUILIBRIUM : Nature of equilibrium, Phase rule. Duhem's theorem, VLE: Qualitative behaviour, Simple models for VLE, VLE by modified Raoult's law, VLE from K-value correlations.

UNIT - 5 **L-9, T-3**

CHEMICAL REACTION EQUILIBRIA : Reaction coordinate, Application of equilibrium criteria to chemical reactions, Standard gibbs energy change and equilibrium constant, Effect of temperature on equilibrium constant, Evaluation of equilibrium constants, Relation of equilibrium constants to composition.

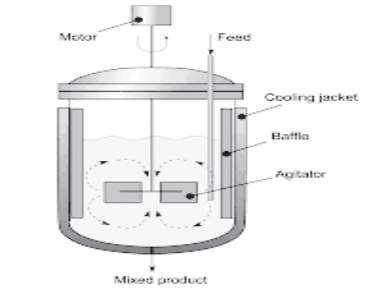
TEXT BOOKS:

1. J.M.Smith, and H.C.Vanness, "Introduction to Chemical Engineering Thermodynamics", 6th edition, Tata McGraw-Hill, 2003.
2. Kyle.B.G. "Chemical and Process Thermodynamics", 2nd edition, Prentice Hall of India, 1990.

REFERENCE BOOKS:

1. Dodge B.F "Chemical Engineering Thermodynamics", 1st edition, Tata McGraw-Hill, 1960.
2. Sandler, S.I "Chemical and Engineering Thermodynamics", 4th edition, John Wiley & Sons, 2006.

16CH302 CHEMICAL REACTION ENGINEERING-I



Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
20	45	1	3	5	5

Course Description and Objectives:

This course encompasses methodologies to design chemical reactors and also to solve related problems in process industries. The objective of this course is to train students to apply knowledge from calculus, differential equations, thermodynamics, chemistry and process calculations for designing chemical reactors.

Course Outcomes:

The student will be able to :

- develop rate laws for homogeneous reactions.
- develop the mechanism for non-elementary reactions.
- estimate the kinetics of the given reaction from the experimental data.
- design ideal reactors for simple and complex reactions.
- choose the right reactor among single and multiple reactors.

SKILLS:

- ✓ *Estimate the temperature and concentration dependency of rate equation.*
- ✓ *Carry out experiments to obtain the kinetic data.*
- ✓ *Determine the kinetic model parameters.*
- ✓ *Design ideal reactor for the given duty.*

ACTIVITIES:

- *Analyzing kinetic data using excel.*
- *Estimate Kinetic parameters using excel.*
- *Case study on Industrial applications of reactors.*

UNIT - 1 **L-9**

KINETICS OF HOMOGENEOUS REACTIONS : Rate equation. Concentration dependency of rate equation: Elementary and non-elementary reactions, Kinetic models for elementary and non-elementary reactions, Testing of kinetic models. Temperature dependency of rate equation: Arrhenius Law, Activation energy and temperature dependency.

UNIT - 2 **L-10**

INTERPRETATION OF BATCH REACTOR DATA : Constant volume batch reactor, Analysis of pressure data. Integral method of analysis: Irreversible zero, First, Second order reactions, Parallel and series reactions, Reversible first and second order reactions. Differential method of analysis.

VARIABLE VOLUME BATCH REACTOR : Analysis of pressure data. Integral method of analysis: Integral analysis of zero, First, Second order reactions.

UNIT - 3 **L-8**

IDEAL REACTORS : Performance of ideal batch reactor, Steady state mixed flow reactors, Steady state plug flow reactor.

UNIT - 4 **L-9**

MULTIPLE REACTIONS: Parallel reactions, Series reactions, Series – parallel reactions, Maximizing the productivity of desired reactant. An alternative approach to use fractional conversion, Net reaction rates and stoichiometry.

UNIT - 5 **L-9**

TEMPERATURE AND PRESSURE EFFECTS : Single reactions, Heat of reactions from thermodynamics, Heat of reaction and temperature, Equilibrium constant from thermodynamics, Conversion, Graphical design procedure.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total hours: 30

1. Kinetic studies in batch reactor with equimolar feed.
2. Kinetic studies batch reactor with using non equimolar feed.
3. Kinetic studies in C.S.T.R.
4. Kinetic studies in PFR.
5. Kinetic studies in adiabatic batch reactor.
6. Estimation of activation energy and frequency factor.
7. Kinetic studies of first order reaction in batch reactor.
8. Determination of best pattern.
9. Simulation of product distribution in series reactions.
10. Simulation of product distribution in parallel reactions.

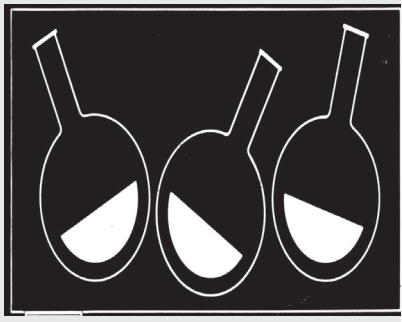
TEXT BOOK:

1. Octave Levenspiel, “Chemical Reaction Engineering”, 3rd edition, John Wiley & Sons, 2012.

REFERENCE BOOKS :

1. Fogler H. S., “Elements of Chemical Reaction Engineering”, 3rd edition, PHS Publishers, 2014.
2. Simth J. M., “Chemical Engineering Kinetics’, 3rd edition, McGraw-Hill, 2014.

16CH303 MASS TRANSFER OPERATIONS-I



Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
25	48	-	5	5	5

Course Description and Objectives:

The course deals with mass transfer phenomena and its usage for engineering application. The objective of this course is to familiarize the student on various mass transfer operations, such as absorption, stripping, humidification and drying, and design of various mass transfer equipments.

Course Outcomes:

The student will be able to :

- recognize the various modes of mass transfer.
- understand the principles behind mass transfer operations.
- determine the rate of mass transfer.
- estimate mass transfer diffusion coefficient.
- solve unsteady state diffusion problems.

SKILLS:

- ✓ *Estimate the diffusion coefficients for binary and ternary mixtures.*
- ✓ *Suggest specifications for designing mass transfer equipments.*
- ✓ *Test the working condition of the humidifier and dehumidifier.*
- ✓ *Test and design of gas-liquid contact equipments.*
- ✓ *Test the virtual mass transfer operations.*

ACTIVITIES:

- *Estimation of diffusivity coefficient using virtual operations.*
- *Estimation of drying properties like critical moisture and equilibrium moisture using Matlab.*
- *Estimation of mass transfer coefficient for gases and liquids using Matlab.*

UNIT - 1 **L-9**

DIFFUSION AND MASS TRANSFER : Mass transfer operations, Molecular diffusion in fluids, Binary solutions, Fick's Law, Equation of continuity, Steady state equimolar counter current diffusion, Application of molecular diffusion, Theories of mass transfer, Diffusion in fluids, Reynolds analogy, Heat and mass transfer coefficients in laminar and turbulent flow, Diffusion through solids.

UNIT - 2 **L-9**

INTERPHASE MASS TRANSFER : Concept of equilibrium, Diffusion between phases, Material balances in steady state, Co–current and counter current stage processes, Sparged vessels mechanically agitated vessels for liquid gas (single phase), Venturi scrubbers, Sieve tray design for absorption tray tower verses packed tower.

UNIT - 3 **L-9**

ABSORPTION AND STRIPPING : Introduction, Counter and co–current isothermal absorption and stripping of single component, Operating lines, Minimum flow rate, Determination of number of transfer units and height of continuous absorber, Determination of no. of plates, Absorption factor, Kremser-Brown equations.

UNIT - 4 **L-9**

HUMIDIFICATION : Introduction, Vapor– pressure curve, Definitions, Psychometric charts, Enthalpy of vapor–gas mixtures, Humidification and dehumidification, Operating lines and design of packed humidifiers, Cooling towers.

UNIT - 5 **L-9**

DRYING : Introduction, Definitions of various moisture contents, Drying conditions, Rate of Batch drying under constant drying conditions, Mechanism of batch drying, Drying time through circulation drying, Batch and continuous drying.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total hours: 30

1. Estimation of diffusivity in gas phase.
2. Estimation of diffusivity in liquid phase.
3. Determination of batch drying characteristics using tray dryer.
4. Determination of batch drying characteristics using vacuum dryer.
5. HTU determination.
6. Verification of Himus equation.
7. Estimation of solid diffusion coefficient.
8. Estimation of distribution coefficient.
9. Determination of solubility of a ternary system.
10. Oil extraction by soxhelet apparatus.

TEXT BOOKS:

1. Treybal R. E., "Mass Transfer Operations", 3rd edition, McGraw-Hill, 2005.
2. Binay. K. Dutta, "Principles of Mass Transfer and Separation Processes", Prentice Hall of India, New Delhi, 2007.

REFERENCE BOOKS :

1. Judson King C., "Separation Processes", 2nd edition, McGraw-Hill, 2005.
2. Seader J.D., Henley E.J, and Keith Roper D., "Seperation Process Principles" John Wiley & Sons, New York, 2010.
3. Alapati Suryanarayana, "Mass Transfer Operations", 1st edition, New Age International, 2006.

16CH304 PROCESS DYNAMICS AND CONTROL

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
15	45	-	5	5	2

Course Description and Objectives:

This course deals with fundamental concepts in process control and its industrial application. The objective of this course is to provide knowledge on various control mechanisms and strategies used in chemical process industries.

Course Outcomes:

The student will be able to :

- understand the concepts of phase plane, laplace domain, and frequency domain.
- analyze nonlinear distributed and multivariable system.
- perform basic calculations for design of controllers.
- gain knowledge on advanced control strategies.

SKILLS:

- ✓ *Solve ODE using laplace transforms.*
- ✓ *Analyze dynamic behavior of physical systems.*
- ✓ *Select and design a suitable controller for a given application.*

UNIT - 1 **L-9**

FIRST ORDER SYSTEM : Introduction to process dynamics and control, Response of first order systems, Physical examples of first order systems, Response of first order systems in series. Higher order systems, Second order systems and transportation lag.

UNIT - 2 **L-9**

CONTROL SYSTEM : Controllers and final control elements, Block diagram of a chemical reactor, Control Systems, Closed loop transfer functions, Transient response of simple control systems.

UNIT - 3 **L-9**

STABILITY CRITERIA : Stability, Routh array, Root locus, Application of Root locus to control systems.

UNIT - 4 **L-9**

FREQUENCY RESPONSE ANALYSIS : Introduction to frequency response, Control systems design by frequency response, Bode diagrams.

UNIT - 5 **L-9**

ADVANCED CONTROL STRATEGIES : Advanced control strategies, Cascade control, Feed Forward control, Ratio control, Smith predictor, Dead time compensation, Internal mode control. Controller tuning, Process Identification, Different types of control valves and their characteristics.

ACTIVITIES:

- *Using matlab plot the root locus and Bode diagrams.*
- *Block diagram construction for a process.*
- *Effect of controller parameters on system stability.*

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total hours: 30

1. Dynamics of 1st order systems [Thermometer].
2. Response of 2nd order system [Manometer].
3. Reponse of single tank system.
4. Response of interacting & non-interacting system for step input.
5. Response of interacting & non-interacting system for pulse input.
6. Control of pressure by using pressure control trainer.
7. Response of control valves.
8. Response of 1st and 2nd order system using Mat Lab.
9. Temperature control by using temperature control trainer.
10. Control of level by using level control trainer.

TEXT BOOKS:

1. Donald R Coughanowr, “Process System Analysis and Control” 3rd edition, McGraw-Hill, 2011.
2. G. Stephanepolous, “Chemical Process Control”, 1st edition, Prentice Hall of India, 1998.

REFERENCE BOOK:

1. Peter Harriott, “Process Control”, Tata McGraw-Hill, 2008.

16HS301 PROFESSIONAL ETHICS

Hours Per Week :

L	T	P	C
2	-	-	2

Total Hours :

L	T	P
30	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
5	30	-	5	-	2

Course Description and Objectives:

This course offers insight into workplace rights of people, their safety concerns and more importantly the ethics that are to be followed by professionals and corporates. The objective of the course is to bring in awareness among the students about human values, social responsibility and the ethics to be followed by engineering professionals.

Course Outcomes:

The student will be able to:

- understand professional responsibilities and ethics in the workplace.
- have knowledge of contemporary issues related to personal and professional interactions at the workplace.
- understand the impact of engineering solutions in global and societal context.

SKILLS:

- ✓ *Analyze the issues faced by society and business world related to safe technologies/ practices, employee rights, resource sharing and allocation, team work, organizational dynamics, legislations related to business and technology, discrimination.*
- ✓ *Appreciate the need for workplace etiquette and proper code of conduct.*
- ✓ *Construct and evaluate arguments during decision making by considering viewpoints of all the stakeholders.*
- ✓ *Analyze one's own beliefs and values during interpersonal and intra-organizational conflicts.*
- ✓ *Detect inconsistencies and common errors in reasoning during discussions and practices.*

UNIT - 1 **L-6**

HUMAN VALUES: Morals, Values and ethics, Integrity, Work ethics, Service learning, Civic virtue, Respect for others, Living peacefully, Caring, Sharing, Honesty, Courage, Valuing time, Co-operation, Commitment, Empathy, Self-confidence, Character, Spirituality.

UNIT - 2 **L-6**

ENGINEERING ETHICS & **ENGINEERING AS SOCIAL EXPERIMENTATION:** Engineering ethics - Variety of moral issues, Types of inquiry moral dilemmas, Moral autonomy, Kohlburg's theory, Gilligan's theory impediments to responsible action; Engineering as social experimentation - Codes of ethics, A balanced outlook on law, The challenger case study.

UNIT - 3 **L-6**

ENGINEER'S RESPONSIBILITY FOR SAFETY: Safety and risk, Assessment of safety and risk, Risk benefit analysis and reducing risk, The government regulator's approach to risk, Case studies - The three mile islands, Chernobyl and Bhopal tragedy.

UNIT - 4 **L-6**

WORKPLACE RIGHTS, RESPONSIBILITIES AND WORK ENVIRONMENT: Workplace rights and responsibilities, Engineers and managers, Oganizational complaint procedures, Government agencies, Resolving employee concerns, Limits on acceptable behaviour in large corporation, Work environment, Ethical and legal considerations, Organizational responses to offensive behaviour and harassment, Ethics in a global context.

UNIT - 5 **L-6**

GLOBAL ISSUES: Multinational corporations, Business ethics, Environmental ethics, Computer ethics, Role in technological development, Weapons development, Engineers as managers, Consulting engineers, Engineers as expert witnesses and advisors, Honesty, Moral leadership, Sample code of conduct.

TEXT BOOK:

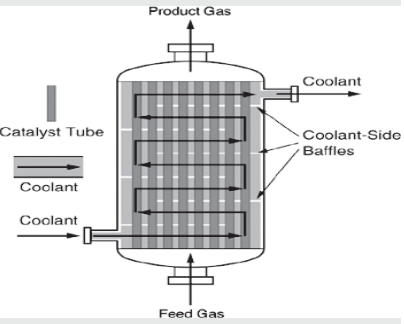
1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", 3rd edition, Tata McGraw Hill, 2003.

REFERENCE BOOKS:

1. Prof. (Col) P S Bajaj and Dr. Raj Agrawal, "Business Ethics – An Indian Perspective", Biztantra, New Delhi, 2004.
2. Charles E Harris, Michael S. Protchard and Michael J Rabins, "Engineering Ethics – Concepts and Cases", Wadsworth Thompson Learning, United States, 2000.
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, 2001.

ACTIVITIES:

- *Discuss a typical case study on workers strike and analyze the conflict of interest among different stakeholders.*
- *Reading and analyzing a prisoner's narrative of police abuse in custody.*
- *Watch and discuss a video report on mishaps such as space shuttle mishap.*
- *Analyze and comment on disasters such as Chernobyl, Bhopal etc.*
- *Analyze the HR policies documents of a typical company on issues such as working hours, employee security and health care.*



16CH305 CHEMICAL REACTION ENGINEERING-II

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
10	40	-	3	5	5

Course Description and Objectives:

This course encompasses methodologies to design chemical reactors and also to solve related problems in process industries. The objective of this course is to train the student to estimate non idealities of real reactors, and design of reactor for hetrogeneous catalytic and noncatalytic reactions.

Course Outcomes:

The student will be able to :

- identify the non idealities of the reactor.
- model the non ideal reactors using experimental data.
- design fluid particle reactor.
- design catalytic reactor.

SKILLS:

- ✓ *Carry out experiments for estimation of non-idealities.*
- ✓ *Modeling non-ideal reactors.*
- ✓ *Identify the rate control mechanism in non catalytic reactions.*
- ✓ *Identify the mechanism in catalytic reactions.*

UNIT - 1 **L-9**

NON IDEAL FLOW : E curve, Age distribution of fluid, RTD studies, Conversion in non ideal flow reactors, Dispersion model, Axial dispersion, Correlations of axial dispersion, Problems.

UNIT - 2 **L-9**

TANKS IN SERIES MODEL : Pulse response experiments and the RTD, Chemical conversion, Conversion model in laminar flow reactors, Earliness of mixing, Segregation and RTD:Self mixing of a single fluid.

UNIT - 3 **L-9**

FLUID - PARTICLE REACTIONS KINETICS : Rate equation: Fluid particle reactions: Kinetics - selection of a model, Shrinking core model for spherical particles of unchanging size, Rate of reaction for shrinking spherical particles, Determination of rate controlling step.

UNIT - 4 **L-9**

HETEROGENEOUS REACTIONS : Introduction, Solid catalyzed reactions -pore diffusion resistance combined with surface kinetics, Porous catalyst particles, Performance equations for reactors containing porous catalyst particles**.**

UNIT - 5 **L-9**

DEACTIVATING CATALYSTS : Mechanisms of catalyst deactivation, Rate and performance equations.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total Hours-30

1. R.T.D studies in C.S.T.R.
2. R T D studies in C.S.T.R's in series.
3. R.T.D studies in plug flow reactor.
4. R.T.D studies in combined reactor.
5. R.T.D studies in fluidized bed reactor.
6. R.T.D studies in packed bed reactor.
7. Kinetic studies of homogeneous catalytic reactions.
8. Kinetic studies of heterogeneous catalytic reactions.
9. Kinetic studies of deactivation of catalyst.
10. Compartment of modeling of non-ideal reactors.

TEXT BOOK:

1. O. Levenspiel, "Chemical Reaction Engineering", 3rd edition, John Wiley & Sons, 2012.

REFERENCE BOOKS:

1. Fogler H. S.,, "Elements of Chemical Reaction Engineering", 3rd edition, PHS Publishers, 2014.
2. Simth J. M., "Chemical Engineering Kinetics', 3rd edition, McGraw-Hill, 2014.

ACTIVITIES:

- *Modeling of non-ideal reactors using MAT Lab.*
- *Simulation of compartment model using MAT Lab.*
- *Products and reactants concentration profiles in heterogeneous reactions.*

16CH306 CHEMICAL TECHNOLOGY

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
20	15	-	2	5	5

Course Description and Objectives:

This course comprises of detailed industrial processes and process flow sheets employed for manufacturing of various types of chemical products. The objective of this course is to provide exposure to the students on process flow and equipments used in large scale production of chemical products.

Course Outcomes:

The student will be able to:

- explain unit operations and unit processes involved in large scale manufacturing process, such as chloro alkali, cement, rubber, pulp and paper industries.

SKILLS:

- ✓ *Draw process flow sheet of chemical process industries.*
- ✓ *Constructing standardized flow sheet for new product development.*
- ✓ *Identify processing equipments in a process flow sheet.*

UNIT - 1 **L-9**

CHLOR - ALKALI INDUSTRIES : Manufacture of soda ash, Caustic soda, Chlorine. Manufacture of special glass, Manufacture of carbon dioxide, Water gas, Producer gas, Manufacture of ammonia, Urea and complex fertilizers.

UNIT - 2 **L-9**

SULFURIC ACID, HYDROCHLORIC ACID AND INORGANIC CHEMICALS : Manufacture of sulphuric acid, Hydrochloric acid and other chemicals, Manufacture of aluminum sulphate and alum, Barium salts and rare earth compounds.

UNIT - 3 **L-9**

CEMENT AND RUBBER INDUSTRIES : Manufacture of cement, Portland cement, Miscellaneous calcium compounds, Magnesium compounds, Phenol formaldehyde, Vinyl chloride, Manufacture of PVC & SBR.

UNIT - 4 **L-9**

SOAPS AND DETERGENTS : Production and extraction of vegetable oils, Hydrogenation of oils, Refining of oils, Continuous process of production of fatty acids, Glycerin and soap, Production of detergents.

UNIT - 5 **L-9**

PULP AND PAPER INDUSTRIES : Methods of pulping, Production of sulphate and sulphite pulp, Production of paper–wet process.

ACTIVITIES:

- *Mini project on production of any one chemical product.*

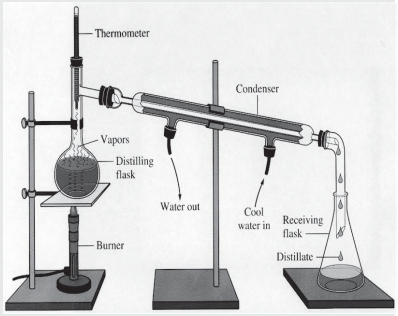
LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total hours: 30

1. Estimation of glucose/sucrose.
2. Estimation of Iodine value of oil.
3. Estimation of saponification value of oil.
4. Estimation of acid value of oil.
5. Preparation of acetanilide.
6. Preparation of aspirin (acetyl salicylic acid).
7. Preparation of nitrobenzene from benzene.
8. Preparation of meta dinitro benzene from nitro benzene.
9. Preparation of diammonium phosphate.
10. Extraction of casene from milk.
11. Preparation of soap and detergent.

TEXT BOOKS:

1. M. Gopal Rao and M. Sittig, “Dryden’s outlines of Chemical Technology”, 2nd edition, East West Press, 2000.
2. Shreve. J. “Chemical Process Industries”, 5th edition, McGraw-Hill, 1999.



16CH307 MASS TRANSFER OPERATIONS-II

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
20	50	-	5	5	5

Course Description and Objectives:

The course deals about mass transfer phenomena and its usage for engineering application. The objective of this course is to familiarize students on various mass transfer operations such as distillation, extraction, adsorption, and leaching.

Course Outcomes:

The student will be able to :

- construct operating line equation for a fractionating column.
- understand and apply Mc Cabe –Theile and Ponchan-Savarit methods for distillation column design.
- develop a model for the co-current and counter current extractors,
- design adsorption and leaching equipments.

SKILLS:

- ✓ *Verify the Rayleigh's equation for binary and ternary liquid mixtures.*
- ✓ *Estimation of equilibrium data.*
- ✓ *Design of distillation column.*
- ✓ *Test the working condition of the fractionating column with varying reflux ratio.*
- ✓ *Design of multistage extractor.*

UNIT - 1 **L-9**

DISTILLATION - I : Introduction, Fields of application, VLE for miscible liquids, Immiscible liquids, VLE phase diagrams, Tie lines, Mixture rules, Flash vaporization and differential distillation for binary and multicomponent mixtures.

UNIT - 2 **L-9**

DISTILLATION - II : Continuous fractionation of binary mixtures, Mc – Cabe Thiele method, Ponchon – Savarit method ,Determination of no of ideal plates for binary mixtures, Optimum reflux ratio, Plate efficiencies, Condenser and reboiler duties, Principles of azeotropic and extractive distillation.

UNIT - 3 **L-9**

LIQUID-LIQUID EXTRACTION : Fields of application of ternary liquid systems, Triangular and solvent free coordinate systems, Choice of solvent and selectivity, Extraction with insoluble and partially soluble systems,Single and multi stage cross and counter current extraction with reflux, Continuous contact extraction (packed beds) equipment for liquid – liquid extraction.

UNIT - 4 **L-9**

LEACHING : Introduction, Fields of application, Preparation of solid for leaching, Types of leaching, Leaching equilibria, Constant under flow conditions, Equipment for leaching operation.

MEMBRANE SEPARATION : Introduction, Types of membranes, Principles and applications.

UNIT - 5 **L-9**

ADSORPTION AND ION – EXCHANGE : Principles and applications, Types of adsorption, Use of adsorbents, Adsorption equilibria, Adsorption isotherms for vapor and dilute solutions, Design of steady state moving bed adsorber for one component, Un steady state adsorption, Break through curve, Fixed bed adsorber.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total Hours-30

1. Verification of Rayleigh's equation using batch distillation.
2. Determination of steam distillation temperature and vaporisation efficiency.
3. Estimation of capacity coefficient of packing in a packed bed distillation column under total reflux condition.
4. Determination of solubility characterisitics of given ternary system.
5. Determination of VLE data for a binary mixture.
6. Determination of percentage adsorption of ternary system.
7. Estimation of number of equilibrium trays in distillation.
8. Estimation of NTU, HTU & height of packed column
9. Adsorption studies on a binary mixture.
10. Leaching studies on a ternary mixture.

ACTIVITIES:

- *Verify the Rayleigh's equation using Mat Lab.*
- *Selection of best method for separation of a given binary or ternary mixture.*
- *Application of appropriate mass transfer operation using C Language.*

TEXT BOOKS:

1. Treybal R. E., “Mass Transfer Operations” 3rd edition, McGraw-Hill, 2005.

2. Binay. K.Dutta, “Principles of Mass Transfer and Separation Processes”, Prentice Hall of India, New Delhi, 2007.

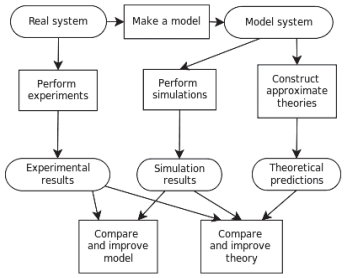
REFERENCE BOOKS:

1. Judson King C., “Separation Processes”, 2nd edition, McGraw-Hill, 2005.

2. Seader. J. D, Henley E. J. and Keith Roper D., “Separation Processes Principles”, John Wiley & Sons, New York, 2010.

3. Alapati Suryanarayana “Mass Transfer Operations”, 1st edition, New-Age International, 2006.

16CH308 PROCESS MODELING AND SIMULATION



Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
15	45	-	5	5	5

Course Description and Objectives:

This course deals with understanding physical systems in chemical engineering and to develop their mathematical models. The objective of this course is to train the student on the modeling and simulation techniques and their applications in chemical engineering systems.

Course Outcomes:

The student will be able to :

- develop model equations for a given system.
- solve models of various processes and unit operations using numerical methods.
- use process simulation as a tool for understanding a chemical process.

SKILLS:

- ✓ *Model development for a given engineering system.*
- ✓ *Write programs using Matlab.*
- ✓ *Solve process model equations using numerical techniques.*

ACTIVITIES:

- *Simulate modeling equations for a given system.*

UNIT - 1 **L-9**

FUNDAMENTALS : Mathematical models for chemical engineering systems, Fundamentals, Introduction to fundamental laws.

EXAMPLES OF MATHEMATICAL MODELS OF CHEMICAL ENGINEERING SYSTEMS : Constant and variable volume CSTRs in series, Two heated tanks.

UNIT - 2 **L-9**

EXAMPLES OF MATHEMATICAL MODELS OF CHEMICAL ENGINEERING SYSTEMS : Gas phase pressurized CSTR, Non-isothermal CSTR, Single component vaporizer, Batch reactor, Reactor with mass transfer, Ideal binary distillation column, Batch distillation with holdup.

UNIT - 3 **L-9**

NUMERICAL METHODS : Newton–Raphson method, False position method.

NUMERICAL INTEGRATION OF ODES : Euler method, Runge-Kutta fourth order method.

CLASSIFICATION OF MATHEMATICAL MODELING : Independent, Dependent variables and parameters, Classification based on variation of independent variables, Classification based on the state of the process, Classification based on type of the process, Boundary conditions.

UNIT - 4 **L-9**

MODELS IN REACTION ENGINEERING : Chemical reaction with diffusion in a tubular reactor, Chemical reaction with heat transfer in a packed bed reactor.

MODELS IN HEAT TRANSFER OPERATIONS : Steady state heat conduction through a hollow cylindrical pipe, Heat transfer in a thermometer system, Unsteady state heat transfer by conduction.

UNIT - 5 **L-9**

COMPUTER SIMULATION EXAMPLES : Gravity flow tank, Three CSTRs in series, Binary distillation column, Batch reactor, Non-isothermal CSTR, VLE dew point, Bubble point calculations, Countercurrent heat exchanger.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS: Total Hours-30

1. Simulation of gravity flow tank system.
2. Simulation of three constant holdup CSTRs in series.
3. Simulation of three variable holdup CSTRs in series.
4. Bubble point calculations.
5. Dew point calculations.
6. Simulation of interacting two tank liquid level systems.
7. Simulation of non – interacting two tank liquid level system.
8. Simulation of cone shaped tank.
9. Simulation of non-isothermal C.S.T.R.
10. Simulation of counter-current heat exchanger.

TEXT BOOKS:

1. W. L. Luyben, “Process Modeling, Simulation and Control for Chemical Engineers”, 2nd edition, McGraw-Hill, 1990.
2. B. V. Babu, “Process Plant Simulation”, Oxford University Press, 2004.

REFERENCE BOOKS:

1. K.Balu and K.Padmanabhan, “Modeling and Analysis of Chemical Engineering Processes”, IK International Private Limited, 2007.
2. Santosh.K. Gupta, “Numerical Methods in Engineering”, 2nd edition, New Age International (P) Ltd., 2003.

IV

YEAR

CHEMICAL ENGINEERING

B.Tech.

I SEMESTER

- 16MS201 - Management Science
- 16CH401 - Chemical Engineering Plant Design and Economics
- 16CH402 - Chemical Process Equipment Design
- 16CH403 - Optimization of Chemical Processes
- 16CH404 - Transport Phenomena
- \- Department Elective
- \- Department / Open Elective
- \- Employability and Life Skills Elective

II SEMESTER

- 16CH411 - Project Work
- 16CH412 - Internship

COURSE CONTENTS

I SEM & II SEM

16MS201 MANAGEMENT SCIENCE

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
10	20	5	5	-	-

Course Description and Objectives:

This course provides an introduction to the evolution of management along with the framework of managerial functions related to organization structure, production, operations, marketing, human resource management, strategy etc. The objective of the course is to introduce the students and make them well versed with the operational functions of management.

Course Outcomes:

The student will be able to:

- understand the nature, importance and evolution of management.
- identify the significance of operations management.
- carry out production operations through work study.
- understand the markets, customers and competition.
- plan and control the HR function.

SKILLS :

- ✓ *Analyze and improve productivity.*
- ✓ *Analyze the customer needs, wants and demand.*
- ✓ *Recognize the need of different types/qualities of human resources.*
- ✓ *Analyze the reasons for the evolution of management.*
- ✓ *Analyze the philosophies of different management thinkers.*

ACTIVITIES:

- *Solve a test case to identify the various operational functions of management .*
- *Solve a test case to know the importance of marketing.*
- *Solve a test case to know the importance of human resources.*
- *Solve a test case to know the importance and evolution of management discipline.*

UNIT - 1 **L-9**

INTRODUCTION TO MANAGEMENT : Concepts of management and organization; Nature, Importance and functions of management; Systems approach to management; Taylor's Scientific management theory, Fayol's principles of management, Mayo's hawthorne experiments, Maslow's theory of human needs, Douglas McGregor's theory X and theory Y, Herzberg's two-factor theory of motivation, Leadership styles, Social responsibilities of management.

UNIT - 2 **L-9**

OPERATIONS MANAGEMENT : Principles and types of plant layout; Methods of production (Job, batch and mass production), Work study - basic procedure involved in method study and work measurement.

UNIT - 3 **L-9**

MATERIALS MANAGEMENT : Objectives, Need for Inventory control, EOQ, ABC analysis, Purchase Procedure, Stores management and stores records.

STATISTICAL QUALITY CONTROL : Control charts for variables and attributes (simple problems), Acceptance sampling.

UNIT - 4 **L-9**

HUMAN RESOURCES MANAGEMENT (HRM) : Concepts of HRM, Basic functions of HR manager; Manpower planning, Recruitment, Selection, Training and development, Placement, Wage and salary administration, Promotion, Transfer, Separation, Performance appraisal, Grievance handling and welfare administration, Job evaluation and merit rating.

UNIT - 5 **L-9**

MARKETING MANAGEMENT : Evolution of marketing, Functions of marketing selling Vs marketing; 4 P's of marketing – Product mix, Product life cycle, Place mix – Channels of distribution, Price mix – Pricing methods, Promotion mix, Tools of promotions.

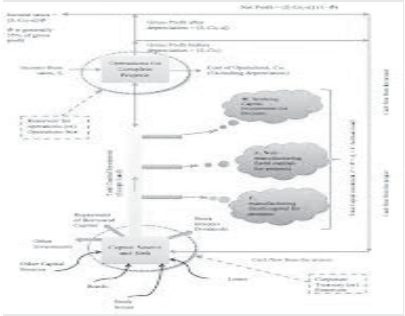
TEXT BOOKS:

1. P. Vijay Kumar, N. Appa Rao, Ashnab and Chnalill, "Introduction to Management Science", 6th edition, Cengage Learning India, 2012.
2. Stoner, Freeman and Gilbert, "Management", 6th edition, Pearson Education, New Delhi, 2004.

REFERENCE BOOKS:

1. Kotler Philip and Keller Kevin Lane, "Marketing Mangement", 12th edition, Prentice Hall of India, 2005.
2. Koontz and Weihrich, "Essentials of Management", 6th edition, Tata McGraw-Hill, 2005.

16CH401 CHEMICAL ENGINEERING PLANT DESIGN AND ECONOMICS



Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P
45	15	-

WA/RA	SSH/HSH	CS	SA	S	BS
15	45	-	-	5	5

Course Description and Objectives:

This course deals with fundamental concepts of process design and economics. The objective of this course is to familirise the student with estimation of capital investments, Interest, investment cost, taxes, insurance, depreciation, profitability and optimum design in chemical process industries.

Course outcomes:

The student will be able to:

- compare projects using the methods of net present value, discounted cash flow and equivalent minimum investment period.
- estimate plant capital cost based on published data.
- determine the impact of taxation, depreciation and investment incentives on the economic viability of a project.
- understand the procedures involved in optimum designing.

SKILLS:

- ✓ *Analyze, synthesize and design processes for manufacturing products commercially.*
- ✓ *Use commercial flowsheeting software to simulate processes and design process equipment.*
- ✓ *Recognize economic, construction, safety, operability and other design constraints.*
- ✓ *Estimate fixed and working capitals and operating costs for process plants.*
- ✓ *Evaluate the profitability of process industrial projects.*

ACTIVITIES:

- *Identify a location for establishing a particular type of industry.*
- *Design a typical master plot plan for a particular plant.*
- *Perform the cost and profit analysis for a given type of plant.*
- *Prepare the list of safety and loss prevention factors for a given plant.*
- *Draw the combined detailed flow diagram for a given manufacturing process.*

UNIT - 1 **L-9, T-3**

INTRODUCTION TO PROCESS DESIGN : Introduction – Process design development, Design project procedure, General design considerations, Health and safety hazards, HAZOP study, Environmental protection, Plant location, Plant layout, Cost and asset accounting.

UNIT - 2 **L-9, T-3**

ESTIMATION OF CAPITAL INVESTMENT : Cash flow for industrial operations, Cumulative cash position, Factors effecting investment and production costs, Estimation of capital investments, Cost indexes, Cost factors in capital investment, Methods for estimating capital investment, Estimation of total product cost.

UNIT - 3 **L-9, T-3**

INTEREST AND INVESTMENT COSTS : Types of interest, Simple interest, Compound interest, Nominal and effective interest rates, Continuous interest, Present worth and discount, Annuities, Perpetuities and capitalized costs, Costs due to interest on investment.

UNIT - 4 **L-9, T-3**

TAXES, INSURANCE & DEPRECIATION : Types of taxes , Federal income taxes, Carry back and carry forward of losses, Taxes and depreciation, Excess profits tax, Tax returns, Insurance – Types of insurance, Self insurance.

DEPRECIATION : Types of depreciation, Service life, Salvage value, Present Value, Methods for determining depreciation, Single unit and group depreciation.

UNIT - 5 **L-9, T-3**

PROFITABILITY & OPTIMUM DESIGN : Profitability standards, Mathematical methods for profitability evaluation, Rate of return on investment, Discounted cash flow, Net present worth, Capitalized costs, Payout period, Alternative investments, Replacements

OPTIMUM DESIGN : General procedure for determining optimum conditions - Procedure with one variable, Procedure with two or more variables, Optimum production rates.

TEXT BOOKS:

1. Timmerhaus K. D and Peters M. S, “Plant Design and Economics for Chemical Engineers”, 4th edition, McGraw-Hill, 2004.
2. Gavin Towler and Ray Sinnott, "Chemical Engineering Design - Principles, Practice and Economics of Plant and Process Design", 2nd edition, Elsevier Science, 2012.

REFERENCE BOOK:

1. Gavin Towler and Ray Sinnott, “Chemical Engineering Design”, 2nd edition, Butterworth-Heinemann, 2013.

16CH402 CHEMICAL PROCESS EQUIPMENT DESIGN

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
15	10	-	12	3	5

Course Description and Objectives:

This course deals with the selection and design of chemical process equipments. The objective of this course is to acquire basic understanding of design parameters, complete knowledge of design procedures for commonly used process equipment and their attachments (e.g. internal and external pressure vessels, tall vessels, high pressure vessels, supports etc.).

Course Outcomes:

The student will be able to:

- design heat transfer equipment and mass transfer equipment.
- understand internal pressure vessels and external pressure vessels.
- design cooling towers.

SKILLS:

- ✓ *Design shell and tube heat exchanger.*
- ✓ *Analyze pressure vessels.*
- ✓ *Design dryers and sieve tray column.*
- ✓ *Design cooling towers.*

ACTIVITIES:

- *Draw shell and tube heat exchanger.*
- *Calculate design parameters.*
- *Calibration of Psychometer.*

UNIT - 1 **L-9**

DESIGN OF SHELL AND TUBE HEAT EXCHANGERS : 1-2 heat exchanger, Arrangements for increased heat recovery, Calculations for process conditions. Design calculations of a double-pipe heat exchanger, Double pipe exchangers in series-parallel arrangement.

UNIT - 2 **L-9**

PRESSURE VESSELS : Introduction, Vessels subjected to internal pressure & combined loading, Stresses induced in vessels, Optimum proportions of a vessel, Optimum vessel size.

UNIT - 3 **L-9**

DESIGN OF DRYERS : Design of rotary dryer, Tray dryer and spray dryer.

DESIGN OF PACKED TOWERS FOR ABSORPTION : Flow of liquid over packing's, Limiting gas velocities, Pressure-drop calculations, Design of packed towers using absorption coefficients, Design of packed tower using transfer-unit method.

UNIT - 4 **L-9**

DESIGN OF SIEVE TRAY TOWER FOR DISTILLATION : Introduction, Sieve tray, Tower diameter, Plate spacing, Entrainment, Flooding, Weepage, Tray layout, Hydraulic parameters.

UNIT - 5 **L-9**

COOLING TOWER PRACTICE : Mechanism, Types, Rating duty and physical size of cooling towers, Cooling tower components, Construction material, Practical aspects of tower selection

COOLING TOWER DESIGN CALCULATIONS : Heat transfer calculations, Selection of tower size for a given duty, Corrections for altitude, Use of charts for calculation of cooling tower duties.

LABORATORY EXPERIMENTS

List of Experiments : Total hours : 30

1. Drawing of flow sheet symbols.
2. Drawing of instrumentation symbols.
3. Drawing of chemical process flow diagarms.
4. Mechanical aspects of chemical equipment design and drawing of 1-2 shell and tube heat exchanger.
5. Mechanical aspects of chemical equipment design and drawing of 2-4 shell and tube heat exchanger.
6. Design and drawing of feed forward evaporator.
7. Drawing of distillation column by using McCabe-Thiele method.
8. Design of absorption column.

TEXT BOOKS:

1. D.Q. Kern, "Process Heat Transfer", 1st edition, Tata McGraw-Hill, 2001.

2. S. D. Dawande, "Process Equipment Design-Vol 1 & 2", 4th edition, Central Techno Publishers, 2005.

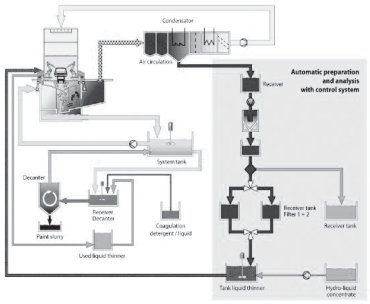
REFERENCE BOOKS:

1. Robert E. Treybal, "Mass Transfer Operations", 3rd edition, McGraw-Hill, 2003.

2. Morris and Jackson, "Absorption Towers", Butter Worth's Scientific Publications, 1985.

3. Pring and Osborn Butter Worth, "Cooling Tower Principles and Practice", Heinemann-Hill, 1986.

4. R. K. Sinnott, "Coulson & Richardson's Chemical Engineering", Vol.6, Butterworth Heinemann, Oxford, 1996



16CH403 OPTIMIZATION OF CHEMICAL PROCESSES

Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P
45	15	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	-	-	5	5

Course Description and Objectives:

This course deals with optimization algorithms, modeling skills to describe and formulate optimization problems. The objective of this course is to familiarize the student with formulation of optimization problems, single and multivariable optimization, linear programming and optimization of chemical processes.

Course Outcomes:

The student will be able to:

- identify different types of optimization problems.
- understand different optimization techniques.
- solve single and multivariable optimization problems.
- solve problems by using least square analysis.

SKILLS:

- ✓ *Formulation of optimization problems.*
- ✓ *Usage of commercial flow sheeting software to simulate processes and design process equipment.*
- ✓ *Integrate process design and simulation with the optimization techniques to achieve the best flow diagram of a process plant.*
- ✓ *Estimate minimum cost for process operations.*
- ✓ *Estimate maximum profit from process industries.*
- ✓ *Optimize process industries.*

UNIT - 1 **L-10, T-3**

NATURE AND ORGANIZATION OF OPTIMIZATION PROBLEMS : What optimization is all about, Why optimize, Scope and hierarchy of optimization, Examples of applications of optimization, Essential features of optimization problems, General procedure for solving optimization problems.

FITTING MODELS TO DATA : Classification of models, How to build a model, Fitting functions to empirical data, Method of least squares, Factorial experimental designs, Fitting a model to data subject to constraints.

UNIT - 2 **L-9, T-3**

BASIC CONCEPTS OF OPTIMIZATION : Continuity of functions, Unimodel versus multimodel functions. Convex and concave functions, Convex region.

OPTIMIZATION OF UNCONSTRAINED FUNCTIONS ONE-DIMENSIONAL SEARCH : Numerical methods for optimizing a function of one variable, Scanning and bracketing procedures, Newton's, Quasi-Newton's and secant methods of uni-dimensional search, Region elimination methods.

UNIT - 3 **L-8, T-3**

UNCONSTRAINED MULTIVARIABLE OPTIMIZATION : Direct methods - Random search, Grid search, Univariate search, Simplex method, Conjugate search, Powell's methods. Indirect methods - first order: Gradient method, Conjugate method. Indirect methods - second order: Newton's method.

UNIT - 4 **L-9, T-3**

LINEAR PROGRAMMING AND APPLICATIONS : Basic concepts in linear programming, Degenerate LP's – graphical solution, Natural occurrence of linear constraints, Simplex method of solving linear programming problems, Standard LP form, Obtaining a first feasible solution, Sensitivity analysis, Duality in linear programming, LP applications.

UNIT - 5 **L-9, T-3**

OPTIMIZATION OF UNIT OPERATIONS : Recovery of waste heat, Shell and tube heat exchangers, Evaporator design, Liquid-liquid extraction process, Optimal design of staged distillation column, Optimal pipe diameter, Optimal residence time for maximum yield in an ideal isothermal batch reactor, Optimization of thermal cracker using liner programming.

TEXT BOOK:

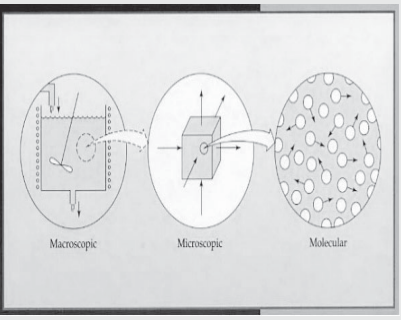
1. T. F. Edgar and Himmelblau D.M, "Optimization of Chemical Processes", 2nd edtion, McGraw-Hill, 2001.

REFERENCE BOOK:

1. K. M. Deb, "Optimization for Engineering Design", 2nd edition, Prentice Hall of India, 2012.

ACTIVITIES:

- *Formulation of objective functions.*
- *Simulation using numerical methods and computer programming.*
- *Graphical method using computational tool.*
- *Simplex method using computational tool.*



16CH404 TRANSPORT PHENOMENA

Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P
45	15	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	50	-	-	5	5

Course Description and Objectives:

The course provides fundamental understanding of various transport processes occurring in process industries. The objective of this course is to train the student in momentum transfer, heat transfer and mass transfer phenomena and their applications.

Course Outcomes:

The student will be able to:

- understand transport processes occurring in engineering applications.
- derive a constitutive equation for determining the transport characterstics of a given scenario.

SKILLS:

- ✓ *Estimation of transport properties.*
- ✓ *Predict appropriate boundary conditions for fluid flow.*
- ✓ *Determine flow characteristics.*
- ✓ *Develop velocity distribution profile for simple geometries.*

UNIT - 1 **L-9, T-3**

TRANSPORT PROPERTIES : Introduction, Newton's law of viscosity, Estimation of transport properties and their dependency on Pressure, Temperature and Concentration.

UNIT - 2 **L-9, T-3**

MOMENTUM BALANCE : Boundary conditions, Flow problems, Flat plate, Circular pipe, Annulus, Creeping flow.

UNIT - 3 **L-9, T-3**

ENERGY BALANCE : Boundary conditions, Fourier's law of conduction, Composite wall, Extended fin surface, Viscous heat source, Chemical heat source, Electric heat source.

UNIT - 4 **L-9, T-3**

MASS BALANCE : Boundary conditions, Diffusion through a stagnant gas film, Homogeneous, Heterogeneous reactions, Falling liquid film, Chemical reaction inside a porous catalyst.

UNIT - 5 **L-9, T-3**

FLOW PROBLEMS : Equation of change for isothermal, Non isothermal systems, Use of equation of change to solve flow problems, Introduction to turbulent flow.

TEXT BOOKS:

1. Bird R. B., Stewart W.E. and Lightfoot, B., "Transport Phenomena", 3rd edition, McGraw-Hill, 2003.

REFERENCE BOOKS:

1. James. R. Welty, Robert. E. E. Wilson, "Fundamentals of Momentum, Heat and Mass Transfer", 2nd edition, John Wiley & Sons, 2002.
2. Theodore L., "Transport Phenomena", 2nd edition, John Wiley & Sons, 2002.
3. Geankoplis J., "Transport Processes & Unit Operations", 3rd edition, Prentice Hall of India, 2003.

ACTIVITIES:

- *Estimation of transport properties like viscosity, conductivityand diffusivity using MAT Lab.*
- *Property estimation using ASPEN Plus.*
- *Velocity, temperature and concentration distributions using MAT Lab.*

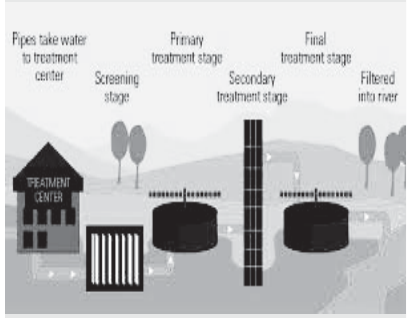
CHEMICAL ENGINEERING

B.Tech.

DEPARTMENT ELECTIVE COURSES

- STREAM-1 - Environmental and Safety Engineering
- STREAM-2 - Mineral Processing
- STREAM-3 - Pharmaceutical and Fine Chemicals
- STREAM-4 - Polymer and Plastics Engineering
- STREAM-5 - Petroleum Engineering
- - Individual Elective Courses

COURSE CONTENTS



16CH240 EFFLUENT TREATMENT METHODS

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	48	6	-	5	5

Course Description and Objectives:

This course deals with air pollution, industrial wastewater treatment, toxicity and sludge management. The objective of this course is to impart knowledge in pollution prevention through planning and treatment technologies.

Course Outcomes:

The student will be able to :

- familiarize with major pollutants and abatement devices for environmental management.
- identify environmental problems arising due to technological activities.
- know the scientific principles behind environmental problems.

SKILLS :

- ✓ *Implement industrial management strategies for pollution prevention.*
- ✓ *Analyze and determine effluent toxicity.*
- ✓ *Develop solutions for industrial effluent toxicity.*

ACTIVITIES:

- *Case study on effluent treatment in a process industry.*

UNIT - 1 **L-8**

EFFLUENTS AND THEIR REGULATIONS : Types of waste from chemical industries and effects on environment, Environment legislation, Types of pollution, Sources of wastewater, Effluent guidelines and standards.

UNIT - 2 **L-9**

CHARACTERIZATION OF EFFLUENT STREAMS : Oxygen demands and their determination (BOD, COD, and TOC), Oxygen sag curve, BOD curve mathematical, Controlling of BOD curve, Self purification of running streams, Sources and characteristics of pollutants in fertilizer, Paper and pulp industry.

UNIT - 3 **L-8**

TREATMENT METHODS : General methods of control and removal of sulfur dioxide, Oxides of nitrogen and organic vapors from gaseous effluent, Treatment of liquid and gaseous effluent in fertilizer industry.

UNIT - 4 **L-10**

AIR POLLUTION SAMPLING AND MEASUREMENT : Types of pollutant and sampling and measurement, Ambient air sampling: Collection of gaseous air pollutants, Collection of particulate air pollutants. Stack sampling : Sampling system, Particulate sampling, and gaseous sampling. Analysis of air pollutants: Sulphur dioxide, Nitrogen oxides, Carbon monoxide, Oxidants and ozones, Hydrocarbons, Particulatematter.

UNIT - 5 **L-10**

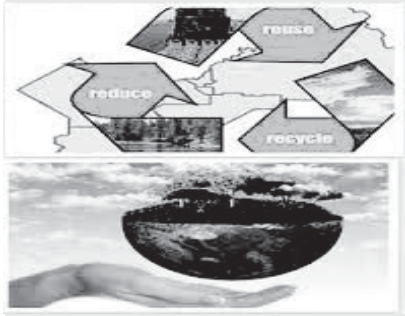
AIR POLLUTION CONTROL METHODS AND EQUIPMENTS : Source collection methods: Raw material changes, Process changes, and equipment modification. Cleaning of gaseous equipments particulate emission control: Collection efficiency, Control equipment like gravitational settling chambers, Cyclone separators, Fabric filters, Scrubbers, Packed beds and plate columns, Venturi scrubbers, their design aspects. Control of gaseous emissions: Absorption by liquids, Absorption equipments, Adsorption by solids.

TEXT BOOKS:

1. G.L. Karia,"Wastewater Treatment: Concepts and Design Approach", Prentice Hall of India, 2013.
2. A.D.Patwardhan, "Industrial Waste Water Treatment", Prentice Hall of India, 2009.
3. C.S. Rao, "Environmental Pollution Control Engineering", 2nd Edition, New Age International Publishers, New Delhi, 2006.

REFERENCE BOOKS:

1. Mahajan S.P, "Pollution Control in Process Industries", Tata McGraw-Hill Education Private Ltd., New Delhi, 2004.
2. Murali Krishna K.V.S.G., "Air Pollution and Control", Kaushal Company, 1995.



16CH340 SOLID WASTE MANAGEMENT AND TREATMENT

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	48	-	5	5	5

Course Description and Objectives:

The course deals with waste disposal and conversion techniques. The Objective of this course is to identify key sources, typical quantities generated, composition, and properties of solid and hazardous waste, the relevant regulations that apply for disposal, and destruction of waste.

Course Outcomes:

The student will be able to :

- identify the physical and chemical composition of waste.
- understand the techniques and methods used in conversion and recovery of materials from solid waste.

SKILLS :

- ✓ *Analyze the functional elements for solid waste management.*
- ✓ *Design waste management systems.*

ACTIVITIES:

- *Miniproject on solid waste management.*

UNIT - 1 **L-10**

SOURCES AND TYPES OF MUNICIPAL SOLID WASTES : Sources and types of solid wastes - Quantity –factors affecting generation of solid wastes, Characteristics, Methods of sampling and characterization, Effects of improper disposal of solid wastes, Public health effects. Principle of solid waste management, Social and economic aspects, Public awareness, Role of NGOs; Legislation.

UNIT - 2 **L-10**

ON-SITE STORAGE & PROCESSING : On-site storage methods, Materials used for containers–on-site segregation of solid wastes, Public health and economic aspects of storage, Options under Indian conditions, Critical Evaluation of Options.

UNIT - 3 **L-9**

COLLECTION AND TRANSFER : Methods of Collection, Types of vehicles, Manpower requirement, Collection routes, Transfer stations, Selection of location, Operation and maintenance, Options under Indian conditions.

UNIT - 4 **L-8**

OFF-SITE PROCESSING : Processing techniques and Equipment, Resource recovery from solid wastes, Composting, Incineration, Pyrolysis.

UNIT - 5 **L-8**

DISPOSAL : Dumping of solid waste, Sanitary land fills–site selection, Design and operation of sanitary landfills, Leachate collection and treatment.

TEXT BOOKS :

1. George Tchobanoglous, “Integrated Solid Waste Management Engineering Principles and Management Issues”, McGraw-Hill, 1993.
2. Vesilind PA, Worrell W and Reinhart D, “Solid Waste Engineering”, Brooks Cole Thomson Learning Inc, 2002.

REFERENCE BOOKS :

1. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2000.
2. Qian X, Koerner RM and Gray DH, “Geotechnical Aspects of Landfill Design and Construction”, Prentice Hall of India, 2002.

16CH350 ENVIRONMENTAL REGULATIONS AND IMPACT ANALYSIS

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	6	5	5	5

Course Description and Objectives:

This course provides a overall review of environmental protection, acts and procedures. The objective of this course is to make a student aware of environmental protection acts and policies.

Course Outcomes:

The student will be able to :

- identify the environmental attributes to be considered for the EIA study.
- plan the methodology to monitor and review the environmental regulations.

SKILLS :

- ✓ *Analyze proposed development project plans for possible environmental effects and prepare appropriate initial studies.*
- ✓ *Solve environmental related issues according to the Indian environmental policy requirements.*

ACTIVITIES:

- *Case study on impact analysis of a process industry..*

UNIT - 1 **L-9**

INDIAN CONSTITUTION & ENVIRONMENT : Introduction Indian constitution and environment, Environmental policy of India and the legislative framework.

UNIT - 2 **L-9**

ENVIRONMENTAL POLICIES : Institution mechanism and environmental policy, Environmental clearance and guidelines for Industries.

UNIT - 3 **L-9**

ENVIRONMENTAL AUDIT : Environmental standards, Hazardous wastes, Environmental audit and Acts.

UNIT - 4 **L-9**

ENVIRONMENTAL POLLUTION : Water pollution, Air pollution, Zero discharge, Public liability insurance.

UNIT - 5 **L-9**

ENVIRONMENTAL ACTS : National environment appellate authority , National environment tribunal, Indian forest service, Environment protection.

TEXT BOOK:

1. R. K. Trivedi, “Handbook of Environmental Laws, Acts, Guidelines, Compliances & Standards”, 3rd edition, BS publications, 2010.

REFERENCE BOOK:

1. Barthwal, R. R., “Environmental Impact Assessment”, New Age International Publishers, 2002.

16CH440 INDUSTRIAL SAFETY AND HAZARD ANALYSIS

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	-	5	5	5

Course Description and Objectives:

The course provides information about hazards chemicals and their handling, accidents occur in plants and their control. The objective of this course is to impart comprehensive knowledge of safety and hazards aspects in industries and management.

Course Outcomes:

The student will be able to :

- identify the causes of accident and explain various engineering control methods.
- understand the storage, handling and transportation of hazardous materials.

SKILLS :

- ✓ *Proficiency in functions and activities of the safety engineering department.*
- ✓ *Carry out safety audits and write audit reports.*

ACTIVITIES:

- *Mini-project on safety and hazard evaluation.*

UNIT - 1 **L-9**

INTRODUCTION : Introduction, Safety programe, Engineering ethics, Accident and loss statistics, Acceptable risk, Public perception.

UNIT - 2 **L-9**

TOXICOLOGY : Toxicants, Biological organisms, Elimination of toxicants, Government regulations, Identification, Evaluation, Control.

UNIT - 3 **L-9**

FIRES AND EXPLOSIONS : Fire triangle, Distinction between fir e and explosions, Flammability characteristics, Ignition energy, Auto ignition, Auto oxidation, Adiabatic compression, Explosions.

UNIT - 4 **L-9**

INTRODUCTION TO RELIEF'S : Relief concepts, Definitions, Location of relief's, Relief types, Relief systems, Conventional spring operated reliefs, Rupture disc relief's in liquid, Vapour or gas.

UNIT – 5 **L-9**

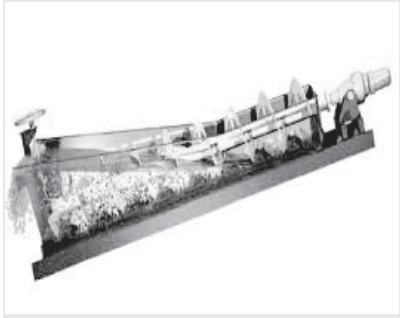
HAZARD'S IDENTIFICATION : Hazard identification, Process hazard checklists, Hazard surveys, Hazop safety reviews.

TEXT BOOKS:

1. D.A. Crowl and J.F. Louvar, "Chemical Process Safety", 3rd edition, Prentice Hall of India, 2011.
2. H. H. Fawcett and W. S. Wood, "Safety & Accident Prevention in Chemical Operations", 2nd edition, John Wiley and Sons, New York, 1982.

REFERENCE BOOKS:

1. R. K. Sinnoot, "Coulson and Richardson's - Chemical Engineering", Vol 6, Butterworth - Heinmann Limited, 1996.
2. R. Sanders, "Chemical Process Safety", 1st edition, Elsevier, 2007.



16CH241 MINERAL PROCESSING TECHNOLOGY

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	-	-	5	5

Course Description and Objectives:

This course deals with the identification of ores, and their processing for valuable minerals. The objective of this course is to explain the principles of various methods of minerals concentration, processing and equipment.

Course Outcomes:

The student will be able to :

- understand the principles of minerals processing industry.
- describe typical unit processes and unit operations for production of various metals.

SKILLS :

- ✓ Identify the structures and textures of minerals.
- ✓ Perform ore compositional analysis by chemical and mineralogical techniques.
- ✓ Prepare metallurgical mass balance–recovery, grade and loss.

ACTIVITIES:

- *Identify mineral components of an ore under different light conditions in the petrographic microscope.*
- *Develop process flow sheet for a mineral processing plant and determine recovery, losses and grades.*
- *Carry out tests for identification of metals.*

UNIT - 1 **L-9**

MINERALS AND THEIR PROPERTIES : Names, Compositions and properties of the important minerals of common metals like iron, Copper, Lead, Zinc, Tin, Chromium, Aluminum, Manganese, Gold, Silver, Uranium, Thorium, Titanium, Zirconium.

UNIT - 2 **L-9**

ORES AND THEIR SUITABILITY : Cut off, Average and concentrate grades of each ore. Information about industrial minerals like calcite, Silimanite, Phosphate, Granite, Dolomite, Magnesite, Llmenite, Rutile, Zircon, Garnet, Monazite, Pyrite, Quartz, Feldspar.

UNIT - 3 **L-9**

BENEFICIATION OF IRON ORES : Beneficiation circuits for hematite and magnetite iron ores. Dry and wet processes, their scopes and limitations, Estimation of water requirements and pumping loads.

UNIT - 4 **L-9**

COMMINUTION OF CIRCUITS AND EQUIPMENT : Beneficiation circuits for lead, Zinc and copper ores. Optimization of the grinding process for liberation of the minerals and minimization of slime loss. Scope and limitations of regrinding circuits.

UNIT - 5 **L-9**

BENEFICIATION OF BEACH MINERALS AND OTHER ORES : Concentrate up gradation and separation processes for beach sand minerals. Effects of repeated cleaner operations on grades and recoveries. Overview of the beneficiation circuits ores of gold, Tin, Manganese, Lime stone, Graphite and other industrial minerals.

TEXT BOOKS:

1. A.F.Taggart, “Elements of Mineral Dressing”, John Wiley and Sons, 1964.
2. Barty A. Wills and Tim Napier Munn, “Mineral Processing Technology”, Elsevier, 2005.

REFERENCE BOOK:

1. A.M.Gaudin, “Mineral Dressing”, McCraw-Hill, 1939.

16CH341 MINING METHODS AND UNIT OPERATONS

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	-	-	5	5

Course Description and Objectives:

The course provides knowledge on mineral exploration and mining methods. The objective of this course is to train the student on various methods of exploration, sampling of ore and grade and tonnage calculations.

Course Outcomes:

The student will be able to :

- evaluate underground mining methods in the context of variable ore body conditions.
- perform underground mine design and mine planning processes.
- select and estimate cost of equipment for different underground mining methods.

SKILLS:

- ✓ *Selection and evaluation of underground coal and metaliferous mining systems.*
- ✓ *Proficiency in underground mining methods.*
- ✓ *Mining development and operations.*

ACTIVITIES:

- *Identify areas that are likely to contain mineral deposits.*
- *Evaluate the feasibility of mining identified deposits.*
- *Extract and process the mineral resource.*

UNIT - 1 **L-9**

SURFACE MINING : Deposits amenable to surface mining, Box cut-objectives, Types and methods, Production benches, Objectives, Formation and bench parameters, Unit operations and associated equipments, Classification of surface mining systems.

UNIT - 2 **L-9**

UNDERGROUND COAL MINING-1: Deposits amenable to underground coal mining classification of underground coal mining methods, Board and pillar methods, General description and applications and merits and demerits, Selection of panel size, Operation involved and associated equipment.

UNIT - 3 **L-9**

UNDERGROUND COAL MINING-2 : Longwall methods, Types and their general description, Applicability, Merits and demerits, Selection of face length and panel length, Operations involved and associated equipments, Methods for mining steeply inclined seams and thick seams, Hydraulic mining.

UNIT - 4 **L-9**

UNDERGROUND METAL MINING-1 : Deposits amenable to underground metal mining, Shape size and position of drifts and cross cuts, Raises and Winzes, Classification of underground metal mining methods.

UNIT - 5 **L-9**

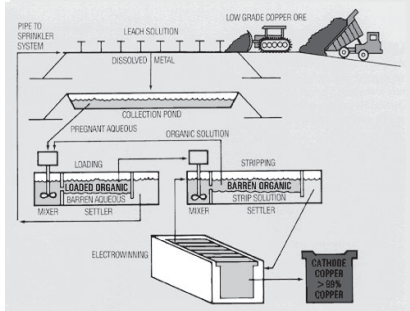
UNDERGROUND METAL MINING-2 : Stoping methods, General description, Applicability, Operations involved and associated equipments for room and pillar mining, Stope and pillar mining, Shrinkage, Stoping, Sub-level stoping, Cut and fill stoping, VCR methods, Sub-level caving and caving.

TEXT BOOKS :

1. B. Boky, “Mining”, MIR Publishers, 1967.
2. Statham I. C. F., **“**Coal Mining Practice”, Caxton Publishing Company Limited, London, 1958.

REFERENCE BOOK :

1. Syd. S. Peng and H. S. Chiang, “Longwall Mining”, John Wiley & Sons Inc., 1984



16CH351 PHYSICAL SEPARATION PROCESS

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	3	-	5	5

Course Description and Objective:

This course deals with physical separation techniques used in mineral processing. The objective of this course is to teach the student major process operations used for size reduction, liberation and separation of mineral particles.

Course Outcomes:

The student will be able to :

- understand gravity concentration methods.
- recognize various classification techniques.
- gain knowledge on solid-liquid separation techniques.
- grasp magnetic separation and electronic sorting methods.

SKILLS:

- ✓ *Handle fine and ultrafine concentrate and gangue suspensions.*
- ✓ *Safe disposal of the tailings suspensions.*
- ✓ *Process bimodal solids systems.*
- ✓ *Remove auxiliary substances from the gangue and value mineral fraction.*
- ✓ *Wash filter cake to increase leaching yields.*

ACTIVITIES:

- *Case study on water management/ recovery of mining chemicals.*
- *Identification of the interfaces involved in a given system.*

UNIT - 1 **L-9**

PRELIMINARY SEPARATION : Separation of particles using wilfley table. Performance analysis of a laboratory size mineral Jig, Laboratory concentration table treating synthetic mixture samples.

UNIT - 2 **L-9**

HYDROSTATIC SEPARATORS : Effect of irrigation water, Inclination, Angle on the performance of a mozely mineral separator treating various minerals.

UNIT - 3 **L-9**

GRAVITY SEPARATORS : Gravity concentration methods, Separation of mineral and gangue. Demonstration on multi-gravity separator.

UNIT - 4 **L-9**

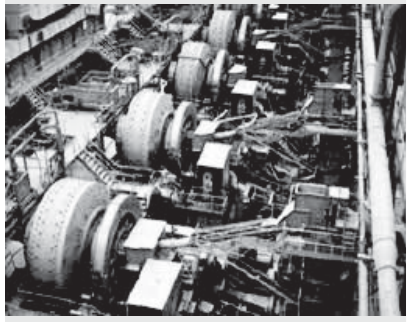
MAGNETIC SEPARATORS : Determination of magnetic content of a given sample using Davis tube magnetic separator. Effect of feed rate, current intensity on separation of magnetic and non-magnetic particles with Low and high intensity magnetic separators.

UNIT - 5 **L-9**

ELECTROSTATIC SEPARATORS : Recovery of minerals by using electrostatic separators.

TEXTBOOK :

1. B.A. Wills and Tim Napier-Munn, “Mineral Processing Technology”, 7th edition, Butterworth-Heinemann Ltd., 2006.



16CH441 EXTRACTIVE METALLURGY

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	-	-	5	5

Course Description and Objective:

This course deals with various processes used for metal extractions. The objective of this course is to expose the student to the methods of extraction of metals from their ores using hydro metallurgy, pyro metallurgy and other techniques.

Course outcomes:

The student will be able to :

- understand metallurgy in the context of mineral and metal processing.
- select the suitable extraction process of a metal from a given mineral.

SKILLS:

- ✓ *Operation of mineral processing equipments.*
- ✓ *Propose a method for extraction of a given metal from its ore.*
- ✓ *Suggest techniques for recovering metals.*

ACTIVITIES:

- *Flow-sheet design for extraction of ferrous and non-ferrous metals from ores.*
- *Mineral beneficiation tests using flotation and gravity concentration methods.*

UNIT - 1 **L-9**

UNIT PROCESSES IN PYROMETALLURGY : Calcination and roasting, Sintering, Smelting, Converting, Reduction, Smelting-reduction, Metallothermic and hydrogen reduction.

UNIT - 2 **L-9**

REFINING METHODS : Distillation and other physical and chemical refining methods and their thermodynamic and kinetic treatment with appropriate examples.

UNIT - 3 **L-9**

UNIT PROCESSES IN HYDROMETALLURGY : Leaching, Purification of leach liquor, Solvent extraction, Ion-exchange process, Potential-pH diagrams.

UNIT - 4 **L-9**

DIFFERENT METAL RECOVERY PROCESSES : Different metal recovery processes from aqueous phase, Bacteria leaching. Electrometallurgy-Faraday's laws of electrolysis, Concept of overvoltage, Limiting current density, Total cell voltage, Series and parallel electrical circuits in refining, Aqueous and fused salt electrolysis.

UNIT - 5 **L-9**

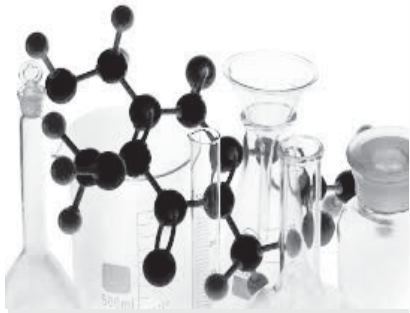
ELECTRO REFINING OF COMMON METALS : Electro refining of common metals like Cu, Zn, Ag, Au, Ni, Mn, Al, Mg etc., Numerical problems relevant to different pyro, Hydro and electrometallurgical processes.

TEXT BOOKS:

1. Ahindra Ghosh, H. S. Ray, "Principles of Extractive Metallurgy", New Age International Publishers, 1991.
2. L. Coudurier, D. W. Hopkins, I. Wilkomirsky, "Fundamentals of Metallurgical Processes", Elsevier, 1985.

REFERENCE BOOKS :

1. A. Butts, "Metallurgical Problems", McGraw-Hill Book Company Inc., 1943.
2. C. L. Mantel, "Electrochemical Engineering", McGraw-Hill, 1960.



16CH242 PHARMACEUTICAL CHEMISTRY

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
15	35	-	10	5	5

Course Description & Objective:

This course deals with grading of chemicals, preparation and production of pharmaceuticals and their formulations. The objective of this course is to impart the student fundamental concepts of analysis of raw materials and also principles of synthesis and physical and analytical techniques used to produce drugs.

Course outcomes:

The student will be able to :

- demonstrate the importance of chemistry in the development and application of therapeutic drugs.
- develop an understanding of the physico-chemical properties of drugs.
- obtain a working knowledge of chemical structures and nomenclature.
- understand how drugs were developed and future scope of development.

SKILLS :

- ✓ *Design and production of a drug.*
- ✓ *Recognize the necessary specifications of the drugs.*
- ✓ *Analyze the working condition of the drug synthesis.*

ACTIVITY:

- *Evaluation of drug synthesis using MAT LAB.*
- *Estimation of physical and chemical properties of drugs.*

UNIT - 1 **L-9**

STEREO CHEMISTRY : Elements of symmetry, Simple axis of symmetry, Notation, Relative configuration and absolute configuration, Compounds with a chiral carbon atom, Compounds with other quadrivalent chiral atoms, Optical isomerism in compounds containing no chiral atom, Biphenyl, Allenes, Compounds with exocylic double bonds and spirans, Chirality due to helical shape, Cis / trans, E – Z isomerism resulting from double bonds, Monocyclic compounds, Fused ring system, Racemic modifications and methods for resolution of racemic mixtures, Asymmetric synthesis and stereo–selective synthesis.

UNIT - 2 **L-9**

REACTIVE INTERMEDIATES : Definitions, Generation, Stability, Structure and reactivity of free radicals carbocations, Carbanions, Carbenes, Nitrenes/Nitrenium ions, Concepts of aromaticity and antiaromaticity, Nonbenzenoid aromatic compounds.

UNIT - 3 **L-9**

MECHANISMS OF ORGANIC REACTIONS : Free radical, Electrophilic, Nucleophilic reactions of aliphatic and aromatic compounds.

UNIT - 4 **L-9**

ELIMINATION REACTIONS : E1, E2, E1CB and E2CB mechanisms, Mechanisms and orientation in pyrolytic eliminations, Effect of substrate structure, Attacking base, Leaving group and reaction bond, Medium and reactivity addition to carbon–carbon multiple bond reactions, Mechanisms, Orientation and reactivity.

UNIT - 5 **L-9**

ELECTROCYCLIC, PERICYCLIC AND SIGMOTROPIC REACTIONS : Introduction, Terminology and mechanism with suitable examples.

TEXT BOOKS :

1. Francis A. Carey and Richard J. Sunberg, “Advanced Organic Chemistry: Part B: Reactions and synthesis”, 5th edition, springer, 2001.
2. Ernest L. Eliel, Samuel H. Wilen., “Stereochemistry of Organic Compounds”, John Wiley & Sons, New York, 2008.

REFERENCE BOOK:

1. Michael B. Smith and Jerry March, “Advanced Organic Chemistry: Reactions Mechanisms and Structure”, 6th edition, John Wiley & Sons, New York, 2007.

16CH342 PHARMACEUTICALS AND FINE CHEMICALS

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	35	-	15	3	2

Course Description and Objective:

This course deals with the grading of chemicals, preparation and production of pharmaceuticals and their formulations. The objective of this course is to impart the student fundamental concepts of analysis of raw materials and also principles of synthesis and physical and analytical techniques used to produce drug.

Course Outcomes:

The student will be able to :

- demonstrate the importance of chemistry in the development and application of therapeutic drugs.
- develop an understanding of the physico-chemical properties of drugs.
- obtain a working knowledge of chemical structures and nomenclature.
- understand how drugs were developed and future scope of development.

SKILLS :

- ✓ Categorize the fundamentals of organic and physical chemistry.
- ✓ Recognize the necessary specifications of the drugs.
- ✓ Analyze the working condition of the drug synthesis.

ACTIVITY:

- Estimation of physical and chemical properties of drugs.

UNIT - 1 **L-9**

INTRODUCTION TO PHARMACEUTICALS : A brief outline of grades of chemicals, Sources of impurities in chemicals, Principles (without going into details of individual chemicals) of limit test for arsenic, Lead, Iron, Chloride and sulfate in Pharmaceuticals. Outlines of preparation, Properties, Uses and testing of the following Pharmaceuticals, Sulfacetamide, Paracetamol, Riboflavin, Nicotinamide.

UNIT - 2 **L-9**

PREPARATION AND PROPERTIES : Outlines of preparation, Properties, Uses and testing of the following fine chemicals, Methyl orange, Fluorescence, Procaine hydrochloride, Paramino salicylic acid, Isonicatinic acid hydrazide. Manufacture with flow sheets, Properties uses and testing of the following Pharmaceuticals, Aspirin, Penicillin, Calcium gluconate.

UNIT- 3 **L-9**

MANUFACTURING AND TESTING : Manufacturing procedures with flow sheets, Properties, Uses and testing of the following, Ferric ammonium citrate, Pthallic anhydride and phenol flourobenzene process and benzene sulfate process, Other processes in outline only.

UNIT - 4 **L-9**

TABLET MAKING AND COATING : Tablet making and coating, Granulation equipments, Preparation of capsules, Extraction of crude drugs.

UNIT - 5 **L-9**

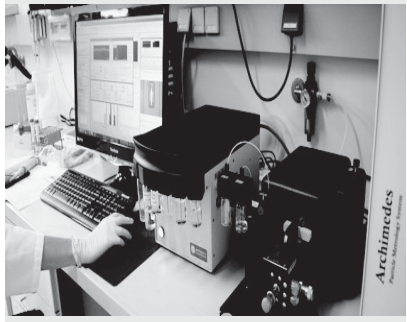
STERILIZATION : Sterilization: Introduction, Risk factor, Methods of sterilization, Heat (dry and moist), Heating with bactericide, Filtration, Gaseous sterilization and radiation sterilization, Suitable example to be discussed.

TEXT BOOKS :

1. Remington's, "Pharmaceutical Science", 13th edition, Mac Publishing Company, 2002.
2. Blently and Driver, "Text Book of Pharmaceutical Chemistry" 8th edition, Oxford University Press, London, 2001.

REFERENCE BOOKS :

1. H A Rawlins, B Tindell and Box Blently's,"Text Book of Pharmaceutical Chemistry", 8th edition, OU Press, London.
2. Faith, Kayes and Clark, "Industrial Chemicals", 3rd edition, John Wiley & Sons, 2006.



16CH352 PHARMACEUTICAL ANALYTICAL TECHNIQUES

Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P
45	15	-

WA/RA	SSH/HSH	CS	SA	S	BS
15	38	5	15	3	-

Course Description and Objectives:

This course deals with the various modern analytical techniques like UV-Visible, IR, NMR, MS, GC, HPLC, different chromatographic methods. The objective of the course is to impart knowledge in the field of pharmaceutical analysis.

Course Outcomes:

The student will be able to :

- get firsthand knowledge of various analytical techniques of chemistry.
- work on different spectroscopes.

SKILLS:

- ✓ Categorize the importance of wave length in spectroscopic analysis.
- ✓ *Recognize the obligatory specifications of the IR, NMR and GC.*
- ✓ *Test the working condition of the spectro photometer.*
- ✓ *Analyze the working condition of the NMR and HPLC.*

ACTIVITIES:

- *Evaluation of chemical compositions using GC technique.*
- *Assessment of concentration limits of metals using HPLC.*

UNIT - 1 **L-9**

A) UV-VISIBLE SPECTROSCOPY : Basic principles, Interaction of electromagnetic radiation with matter and its effects (electronic transitions), Concept of chromophore and auxochrome, Effect of conjugation, Solvent and pH, Instrumentation (components and their significance), Absorption spectra of organic compounds and complexes illustrating the phenomenon and its utilization in qualitative and quantitative studies of drugs including multicomponent analysis, Woodward-Fieser rules for caculating absorption maximum for unsaturated hydrocarbons, Difference and derivative spectra.

B) INFRA-RED SPECTROSCOPY : Interaction of infrared radiation with organic molecules and it's effects on bonds, Instrumentation, Dispersive IR spectrophotometers and Fourier transform spectrophotometers, Sample handling for IR spectroscopy, Interpretation of IR spectra, Brief note on ATR.(Attenuated Total Reflectance).

UNIT - 2 **L-9**

NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY : Fundamental principles of NMR, Instrumentation (components and their significance), Chemical shifts concept, Spin- spin coupling and spin-spin decoupling, Shielding and deshielding, Solvents, Signal multiplicity phenomena in high resolution PMR, Interpretation of PMR spectra, Brief introduction about Carbon-13 NMR and 2D NMR Spectroscopy.

UNIT - 3 **L-9**

MASS SPECTROMETRY : Basic principles and instrumentation (components and their significance), Ionization techniques, Mass spectrum and its characteristics, Molecular ion, Metastable ions, Fragment ions, Fragmentation processes, Fragmentation patterns and fragment characteristics in relation to parent structure and functional groups, Relative abundances of isotopes and their contribution to characteristic peaks.

UNIT - 4 **L-9**

CHROMATOGRAPHIC TECHNIQUES : Classification of chromatographic methods based on mechanism of separation and their basic principles.

GAS CHROMATOGRAPHY : Instrumentation, Column efficiency parameters, Derivatisation methods, Applications in pharmaceutical analysis.

LIQUID CHROMATOGRAPHY : Comparison of GC and HPLC, instrumentation in HPLC, Normal and reversed phase packing materials, Column selection, Mobile phase selection, Efficiency parameters, Applications in pharmaceutical analysis, Instrumentation and applications of HPTLC, Ion exchange chromatography, Gel permeation chromatography, Chiral chromatography, Flash chromatography and Supercritical Fluid Chromatography (SFC).

UNIT - 5 **L-9**

ELECTROPHORESIS : Principles, Instrumentation and applications of moving boundary electrophoresis, Zone Electrophoresis (ZE), Isotachphoresis, Iso Electric Focusing (IEF), Continuous electrophoresis (preparative) and capillary electrophoresis. SDS gel electrophoresis and blotting techniques.

TEXT BOOKS :

1. Skoog D A, Holler F J, and Crouch S R, "Principles of Instrumental Analysis", 6th edition, Baba Barkhanath Printers, Haryana, 2007.

2. Silverstein R M and Webstar F X, "Spectrometric Identification of Organic Compounds", 6th edition, John Wiley & Sons (Asia) Pvt. Ltd., Singapore, 2005.

REFERENCE BOOKS :

1. William Kemp, "Organic Spectroscopy", 3rd edition, Palgrave, New York, 2006.

2. Jag Mohan, "Organic Spectroscopy:Principles and Applications", 2nd edition, Narosa Publishing House Pvt Ltd., New Delhi, 2005.

16CH442 DRUG DESIGN AND FORMULATION

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	48	4	12	2	2

Course Description and Objectives:

This course deals with the qualitative and quantitative methods for assessing and predicting the biological response in ligands. The objective of the course is to create understanding of ligand and receptor chemistry with respect to interactions between them and subsequent biological responses.

Course Outcomes:

The student will be able to :

- simulate, analyze molecular structure and interactions between them.
- improve the knowledge base related to various virtual and biological methods of screening and the regulations pertaining to the same.

SKILLS :

- ✓ *Analyze the qualitative and quantitative approach of drugs.*
- ✓ *Discover the electronic effects of QSAR.*
- ✓ *Spot the minimization of energy and optimization of geometry.*

UNIT - 1 **L-9**

STRUCTURE ACTIVITY RELATIONSHIPS IN DRUG DESIGN : Qualitative versus quantitative approaches, Advantages and disadvantages, Random screening, Non random screening, Drug metabolism studies, Clinical observations, Rational approaches to lead discovery, Homologation, Chain branching, Ring chain transformations, Bioisosterism, Insights into molecular recognition phenomenon, Structure based, Ligand based, Fragment based drug design and other de novo methods.

UNIT - 2 **L-9**

PHARMACOPHORE : Concept, Pharmacophore mapping, Methods of conformational search used in pharmacophore mapping, Comparison between the popular pharmacophore methods like catalyst/ HipHop, Disco Tech and GASP with practical examples.

UNIT - 3 **L-9**

QUANTITATIVE STRUCTURE-ACTIVITY RELATIONSHIP : Electronic effects, Hammett equation, Lipophilicity effects, Hansch equation, Steric Effects, Taft Equation, Experimental and theoretical approaches for the determination of physico-chemical parameters, Parameter inter-dependence, Case studies, Regression analysis, extrapolation versus interpolation, Linearity versus non-linearity, The importance of biological data in the correct form, 2D–QSAR, 3D-QSAR-examples CoMFA and CoMSIA.

UNIT - 4 **L-9**

MOLECULAR MODELLING : Energy minimization, geometry optimization, Conformational analysis, Global conformational minima determination, Approaches and problems, Bioactive verses global minimum conformations, Automated methods of conformational search, Advantages and limitations of available software, Molecular graphics, Computer methodologies behind molecular modeling including artificial intelligence methods.

UNIT - 5 **L-9**

MOLECULAR DOCKING AND DYNAMICS : Rigid docking, Flexible docking, Manual docking, Advantages and disadvantages of flex-X, flex-S, Autodock and dock softwares with successful examples, Monte Carlo simulations and molecular dynamics in performing conformational search, Docking.

TEXT BOOK :

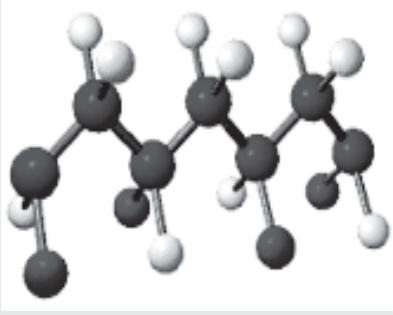
1. Hillisch A. and Hilgenfeld R., “Modern Methods of Drug Discovery”, Springer Verlag, 2003.

REFERENCE BOOKS :

1. Flower D.R., “Drug Design:Cutting Edge Approaches”, Royal Society of Chemistry, 2003.
2. Gubernator K. and Böhm H. J., “Structure-based Ligand Design”, VCH Publishing, 1998.
3. Böhm H. J and Schneider G., “Protein-Ligand Interactions : From Molecular Recognition to Drug Design”, John Wiley & Sons, 2003.

ACTIVITIES:

- *Comparison between the popular pharmacophore methods like catalyst/ HipHop, DiscoTech and GASP with practical examples.*



16CH243 POLYMER STRUCTURE AND PROPERTY RELATIONSHIP

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	-	-	5	5

Course Description and Objectives:

This course provides understanding of the structure/property relationships that drive the continued expansion of polymers into a wide array of applications. The objective of this course is to introduce to the student the fundamentals of polymer science and also to elucidate the effect of structure on the properties of various polymeric materials.

Course Outcomes:

The student will be able to :

- identify microstructural differences between thermoplastic, thermosetting, and elastomeric polymers and how these affect thermal and mechanical properties.
- discuss the crystallinity of polymers.
- understand the electrical and optical properties of polymeric materials.
- gain knowledge in chemical and mechanical properties of polymeric materials.

SKILLS :

- ✓ *Compare and contrast the yield and fracture behavior of polymers with metallic and ceramics materials.*
- ✓ *Interpret the results from common thermal characterization (TGA, DSC, DMA) techniques and relate them to polymer structure.*
- ✓ *Identification of dielectric behaviour of polymers.*

UNIT - 1 **L-9**

STRUCTURE AND PROPERTIES OF POLYMERS : Linear, Branched, Crosslinked and network polymers, Homochain and hetero atomic chain polymers, Copolymers and its types, Linear and cyclic arrangement, Prediction of polymer properties, Group contribution techniques, Topological techniques, Volumetric properties, Molar volume, Density.

UNIT - 2 **L-9**

MECHANICAL PROPERTIES : Stress-strain properties of polymers, Effect of polymer structure on modulus of elasticity, Tensile strength, Flexural strength, Impact strength, Yield strength, Fracture toughness, Crazing in glassy polymers, Ductile brittle transition. Effect of additives on mechanical properties of polymers, Creep, Stress relaxation and fatigue.

UNIT - 3 **L-9**

THERMODYNAMIC AND TRANSITION PROPERTIES : Transition temperature in polymers, Glass transition (Tg), melt transition (Tm), Relationship between Tg and Tm, Other transitions like â-transitions, Upper and lower glass transition, Crystallization and cold crystallization temperatures, Prediction of Tc, Tg and Tm of polymers by group contributions. Calorimetric properties, Heat capacity, specific heat, Latent heat of crystallization and fusion, Enthalpy and entropy, Calculation of heat capacities of polymers.

UNIT - 4 **L-9**

ELECTRICAL AND OPTICAL PROPERTIES : Effect of polymer structure on dielectric constant, Power factor, dissipation factor and loss factor, Effect of frequency of voltage and temperature on dielectric properties, Prediction of molar polarization and effective dipole moment. Effect of additives, Factors affecting the electrical conductivity of polymers. Optical properties, Effect of polymer structure on optical properties, Clarity, Transparency, Haze, Transmittance, Absorbance, Reflectance and gloss.

UNIT - 5 **L-9**

CHEMICAL PROPERTIES : Cohesive energy, Cohesive energy density, Solubility parameter, Determination of solubility parameter of polymers, Prediction of solubility parameter, Effect of polymer structure on solubility in solvents and oils, Influence of structure in prediction of flame retardancy, Water repellency, Chemical resistance of polymers.

ACTIVITIES:

- *Polymer property prediction.*
- *UTM data analysis.*
- *DSC, TGA data interpretation.*

TEXT BOOKS:

1. D.W. Van Krevelen and P.J. Hoftyzen, “Properties Of Polymer”, 3rd Edition, Elsevier Scientific Publishing Company, 1990.

2. J. E. Mark, “Physical Properties Of Polymers Hand Book”, 2nd edition, Springer, 2007.

REFERENCE BOOKS:

1. D. A. Seanor, “Electrical Properties of Polymers”, Academic Press, New York, 1982.

2. Jozef. Bicerano, “Prediction Of Polymer Properties”, 2nd edition, Marcel Dekker Inc., New York, 1995.

3. J.M.Margolis, “Engineering Thermoplastics Properties & Applications”, Marcel Dekker, New York, 1985.

4. R.J.Samuels, “Structured Polymer Properties”, John Wiley & Sons, New York, 1974.

5. I.M.Ward and D.W.Hadley, “An Introduction to the Mechanical Properties of Solid Polymers”, John Wiley & Sons, Chichester, England, 1993.

6. C.C.Ku and R.Liepins, “Electrical Properties of Polymers”, Hanser Publications, Munich,1987.

7. F. Bueche, “Physical Properties of Polymers”, John Wiley, New York, 1962.

8. J.Mort and G.Pfister, “Electronic Properties of Polymers”, Wiley Interscience, New York, 1982.

16CH343 MANUFACTURING OF INDUSTRIAL POLYMERS

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	3	-	5	5

Course Description and Objectives:

The course deals with the production of various polymers. The objective of this course is to make the student aware of concepts of polymer chemistry and morphology for understanding the structure and manufacturing of polymeric materials.

Course Outcomes:

The student will be able to :

- demonstrate knowledge in manufacturing methods used for industrial production of polymers.
- understand about various byproducts formed in the process of polymer manufacture.

SKILLS :

- ✓ *Identify the synthesis method for manufacture of polymer.*
- ✓ *Identify the equipments used for large scale production of polymers.*
- ✓ *Draw flowsheet for industrial production of polymers.*

ACTIVITIES:

- *Flowsheet preparation for manufacture of LDPE, PVC.*
- *Engineering cost analysis for manufacture of LDPE, PVC.*
- *Case Study on feasibility of manufacture of polyacrylic acid.*

UNIT - 1 **L-10**

POLYOLEFINS : Methods of manufacturing, Properties and applications of polyethylene, LDPE-LLDPE-HDPE, HMWHDPE-UHMWHDPE, Crosslinked polyethylene, Chlorinated polyethylene, Polypropylene, Homopolymers, Copolymers.

UNIT - 2 **L-10**

VINYL POLYMERS : Methods of manufacturing, Properties and applications of poly (vinyl chloride), Poly (vinylidene chloride), Poly(vinyl alcohol), Poly(vinyl acetate), Chlorinated poly(vinyl chloride), Plastisols, Poly vinylpyrrolidiene, Polystyrene, HIPS, EPS, SAN, EVA, EPDM, ABS.

UNIT - 3 **L-9**

POLYAMIDES : Methods of manufacturing, Properties and applications of Acrylates, Poly (methyl methacrylate), Polyacrylonitrile. Aliphatic polyamides, Aromatic polyamides, Polyethylene terephthalate, Polybutylene terephthalate, Polyacetals and copolymers, Polycarbonates, Thermoplastic Polyurethane (TPU).

UNIT - 4 **L-8**

FLUORO POLYMERS : Methods of manufacturing, Properties and applications of Fluoro polymers, Polytetrafluoroethylene, Polychlorofluoroethylene, Thermoplastic polyurethanes, Biodegradable polymers, Poly î–caprolactone and copolymers, Polylactic acid, Bacterial polyhydroxy alkonates.

UNIT - 5 **L-8**

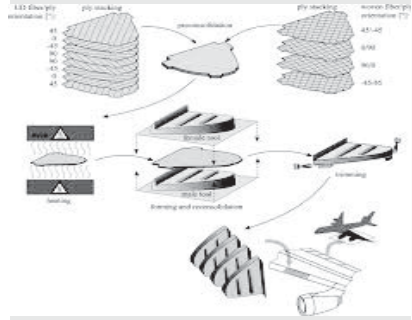
SPECIALITY POLYMERS : Preparation, Properties and applications of high performance thermoplastic materials-PPS, PO, Polysulphone, Polyether sulphone, PEEK, Polyimide, Biopolymer-Cotton, Wool, Collagen, Hyaluroran.

TEXT BOOKS :

1. A.Brydson, “Plastics Materials”, 6th editon, Butterworth-Heinemann-Oxford, 1995.
2. Feldman.D and Barbalata. A, “Synthetic Polymers”, Chapman Hall, 1996.

REFERENCE BOOKS :

1. Olagoke Olabisi, “Hand Book of Thermoplastics”, Marcel Decker, 1997.
2. K.J. Saunders, “Organic Polymer Chemistry”, Chapman & Hall, New York, 1988.
3. Irvin.I. Rubin, “Hand Book of Plastic Materials and Technology”, Wiley Interscience, New York, 1990.
4. Charles Gebelein, “Biotechnological Polymers:Medical, Pharmaceutical and Industrial Applications”, CRC Press,1993.



16CH353 POLYMER PROCESSING TECHNOLOGY

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	-	-	5	5

Course Description and Objectives:

The course deals with various processing techniques used in the production of polymeric products. The objective of this course is to make the student to know about the fundamentals of polymer processing methods and the influence of processing conditions on properties of the final product.

Course Outcomes:

The student will be able to :

- demonstrate knowledge in methods for processing of polymeric materials.
- gain understanding on various issues arising during polymer processing.
- understand the influence of processing conditions on product quality.

SKILLS :

- ✓ *Identify suitable processing technique for making a polymer based product.*
- ✓ *Troubleshooting of common defects in processed polymer products.*
- ✓ *Ability to set parameters for optimum processing conditions of basic equipments.*

ACTIVITIES:

- *Trouble shooting-defective polymer products.*
- *Mould design for injection moulding.*
- *New polymer product development flowsheet.*

UNIT - 1 **L-10**

INTRODUCTION TO POLYMER PROCESSING : Plastics processing techniques, Injection moulding, Terminology, Process description, Theory of injection moulding, Design and consideration, Moulding cycle, Classification and functions of moulds, Cavity lay out, Setting up of mould, Troubleshooting operations.

UNIT - 2 **L-10**

INJECTION UNITS : Types, Elements of plasticating process, Classification of screw, Screw design, Process control, Clamping unit, Classification of Machine Hydraulics, Ancillary equipment, Computer operations.

UNIT - 3 **L-9**

NON CONVENTIONAL INJECTIONS : Non conventional injection moulding, Gas injection moulding, Water injection mouldinginjection foam moulding, Types of microcellular injection foam moulding, Nucleation and pressure profiles during filling, Powder metal injection moulding, Process and steps involved, Microinjection moulding, Types and process details. Troubleshooting-Microstructure development in slow crystallizing and fast crystallizing polymers, Molecular orientation, Effect of crystallinity on material properties, Volumetric and anisotropic shrinkage, Weld lines and methods of removal of weld lines.

UNIT - 4 **L-8**

BLOW MOULDING : Fundamentals of the process, Complete blow moulding operation, Accumulator based machines, Extrusion blow moulding, Injection stretch blow moulding, Blow moulding machines, Start-up and shut-down procedures, Process control, Blow moulding plants, Parisan wall thickness control, Parisan swell, parisan inflation, Cutting devices, Process parameters and their effect on product quality control, Moulding defects, Causes and remedy.

UNIT - 5 **L-8**

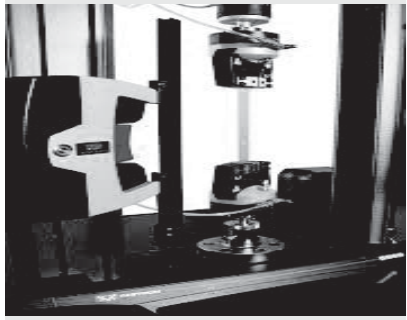
THERMOFORMING : Basic process, Thermoforming machines and plants, Thermoforming materials, analysis of sheet heating, Stretching and wall thickness distribution, Simple vacuum forming, Drape forming, Air-slip forming, Pressure forming, Drape forming, Blister forming, Solid-phase pressure forming, Plug-assist forming. Process factors in thermoforming, Overtation and heat reversion, Defects in thermoformed articles and remedies, Equipment details.

TEXT BOOKS:

1. D.V. Rosato Kluwer, “Injection Moulding Handbook”, 2nd edition, Academic Publishers, Boston, 1995.
2. Richard C. Progelhof and James. L. Throne, “Polymer Engineering Principles”, Hanser Publisher, Munich, 1993.
3. Frados J. Van and Nostrand Reinhold, “Plastic Engineering Handbook of the Society of the Plastics Industry”, 4th edition, New York, 1996.

REFERENCE BOOKS:

1. N.P. Charemisinoff and P.N. Chere, “Handbook of Applied Polymer Processing Technology”, Marcel Dekker, New York, 1996.
2. Herbert Recs, “Understanding of Injection Moulding Technology”, Hanser Publications, Munich, 1994.



16CH443 POLYMER TESTING METHODS

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	-	-	5	5

Course Description and Objectives:

The course deals with various testing methods employed for characterizing a polymer product. The objective of this course is to familiarize the student with the standard procedure for testing polymer products and testing equipments.

Course Outcomes:

The student will be able to :

- demonstrate knowledge in standard testing procedure to testing polymers.
- discuss about various equipments used in polymer characterization.
- understand the need to have standardized testing procedure and its implications.

SKILLS :

- ✓ *Documentation of specification tests of various polymer products.*
- ✓ *Determination of mechanical properties of various polymer products and correlated with national standards.*
- ✓ *Analysis of test result data and correlated with specification values based on standards of various polymer products.*

ACTIVITIES:

- *UTM data analysis and interpretations.*
- *DSC data analysis and interpretation.*
- *Rheological data analysis.*
- *UV-Vis spectroscope usage to analyze polymer sample.*

UNIT - 1 **L-9**

STANDARDS AND SPECIMEN PREPARATION : Standards - BIS, ASTM, ISO, Specifications and their importance with reference to polymer, Preparation of test specimen by various techniques for thermoplastics, Thermo sets, and elastomers conditioning and test atmospheres, Analytical tests-Determination of specific gravity, Density by density gradient method, Bulk density, Moisture absorption, Particle size analysis..

UNIT - 2 **L-10**

MECHANICAL AND RHEOLOGICAL PROPERTIES : Tensile, Compression, Flexural, Shear, Tear, Impact, Abrasion, Hardness, Permanent set, Resilience, Flex and cut growth resistance, Creep and stress relaxation, Fatigue, Viscosity, Rotational viscometer, MDR, Capillary rheometer and torque rheometer.

UNIT - 3 **L-8**

THERMAL PROPERTIES : Transition temperatures, Vicat softening temperature, Heat distortion temperature, Coefficient of expansion, Specific heat, Thermal conductivity, Shrinkage, Brittleness temperature, Thermal stability, and flammability, Melt flow index.

UNIT - 4 **L-10**

ELECTRICAL, OPTICAL AND OTHER PROPERTIES : Volume and surface resistivity, Dielectric constant and power factor, Dielectric strength, Arc resistance, Tracking resistance, Static charge refractive index, Light transmission, Transparency, Haze, Gloss clarity, and birefringence, Environmental Stress Crack Resistance (ESCR), Water absorption, Weathering and chemical resistance, Aging, Ozone resistance, Permeability, Sorption, Diffusion and permeation, Adhesion.

UNIT - 5 **L-8**

TESTING OF PRODUCTS : Plastic films, Pipes, Laminates, Foams, Containers, and Rubber hose, Microcellular sheet, Wire and cables, Foams, Gloves, Tyres and tubes, Non-destructive testing, ultrasonic testing, Study of acoustic properties, X-ray fluorescence and imaging.

TEXT BOOKS:

1. Vishu Shah, “Handbook of Plastics Testing Technology”, John Wiley, New York, 1998.
2. G. C. Ives and J. A. Mead, and N. M. Riley “Handbook of Plastics Test Methods”, ILIFEE, London, 1971.

REFERENCE BOOKS:

1. Roger P. Brown, “Physical Testing of Rubber”, Wiley Interscience, New York, 1966.
2. Nicholas P.Cheremisinoff, “Product Design and Testing of Polymeric Materials”, Marcel Dekker, New York, 1990.

16CH244 PETROLEUM PRODUCTION OPERTIONS

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	-	-	5	5

Course Description and Objectives:

This course deals with knowledge in the field of petroleum production, production system analysis & optimization. The objective of the course is to impart the student with the knowledge of various well equipment, well production services and workover.

Course Outcomes:

The student will be able to :

- get firsthand knowledge of various techniques of petroleum production.
- work on different well production problems and mitigation.

SKILLS:

- ✓ *Analyze the working condition of the sucker rod pumping; progressive pump; plunger lift; hydraulic pump–piston and jet type.*
- ✓ *Well testing and troubleshooting.*
- ✓ *Recognize the obligatory specifications of the different types of artificial lift.*

ACTIVITIES:

- *Assessment of artificial lift Inflow performance principles and descriptions of artificial lift methods.*

UNIT - 1 **L-9**

WELL EQUIPMENT : Well head equipment, Christmas tree valves, Hangers, Flow control devices, packers, tubular and flow lines, Well completion design-Performing oil and gas wells, Conventional and unconventional techniques viz. through tubing and tube conveyed underbalanced perforating techniques, Type size orientation of perforation holes, Well activation, Use of compressed air and liquid nitrogen, Down hole equipment selection, Servicing, Installation and testing, Smart well–intelligent completions.

UNIT - 2 **L-9**

PRODUCTION SYSTEM ANALYSIS AND OPTIMIZATION : Self flow well- PI and IPR of self-flowing and artificial lift wells, Production testing–back pressure test, Flow after flow test and isochronal test, Surface layout, Test design and analysis of test data, Production characteristics of horizontal and multilateral wells-coning, IPR and skinfactor, Multiphase flow in tubing and flow lines, Sizing and selection performance of tubing, Chokes and surface pipes, Production optimization–Nodal system analysis.

UNIT - 3 **L-9**

WELL PRODUCTION PROBLEMS AND MITIGATION : Scale formation, Paraffin deposition, Formation damage, Water production, Gas production, Sand deposition, Designing gravel pack for sand control, Sand control techniques, Formation sand size analysis, Optimum gravel –Sand ratio, Gravel pack thickness, Gravel selection, Gravel packing fluid and gravel pack techniques.

UNIT - 4 **L-9**

WELL SERVICING AND WORKOVER : Workover system, Workover rig and selection, Rig less workover including endless/coiled tubing unit, Minor and major workover jobs-diagnosis and remedial measures, Water shut off and gas shut off, Chemical treatment conformance control, Workover and completion fluids–types and selection, Formation damage, Workover planning and economics asphaltine wax.

UNIT - 5 **L-9**

DIFFERENT TYPES OF ARTIFICIAL LIFT : Introduction, Definition and purpose of artificial lift, Inflow performance, Principles and descriptions of artificial lift methods, Gas lift–continuous and intermittent, Chamber lift, Electrical submersible pumping, Sucker rod pumping, Progressive pump, Plunger lift, Hydraulic pump–piston and jet type.

TEXT BOOKS:

1. Archer J.S and Wall C.C. “Petroleum Engineering Principles and Practice”, Kluwer, 1990.
2. Niadri Kumar Mitra and Adesh Kumar, “Principles of Artificial Lift”, Allied Publishers, 2000.

REFERENCE BOOKS:

1. Thomas O. Allen and Alan P. Roberts, “Production Operations-Volume 1,” 5th edition, Prenticer Hall of India, 2002.
2. Nind, “Principles of Well Production”, 2nd edition, McGraw-Hill, 2005.

16CH344 PETROLEUM REFINERY ENGINEERING

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	-	-	5	5

Course Description and Objectives:

This course deals with the conversion of crude oil and intermediate streams into finished products. The objective of this course is to impart the student about the knowledge of distillation, cracking and reforming processes used in a typical refinery.

Course Outcomes:

The student will be able to :

- explain the chemistry of petroleum and its characterization.
- understand principles of various distillations in a refinery.
- perform energy integration in a refinery.
- explain the need for basic noncatalytic and catalytic conversion processes.

SKILLS :

- ✓ *Recognize the obligatory specifications of the different types of distillation.*
- ✓ *Analyze the working condition of the vacuum and fractional distillation.*
- ✓ *Select suitable reforming process.*

ACTIVITIES:

- *Evaluation of chemical compositions using Instrumentation technique.*
- *Enhancement of petroleum refinery products.*

UNIT – 1 **L-9**

CHARACTERIZATION AND CLASSIFICATION OF CRUDE OILS : Composition of petroleum, Laboratory tests, Refinery feedstocks and products, General definItions, Introduction to petroleum refinery, Classification of crude oil, Characterization of crude oil, Composition of crude, Physical properties of crude oil, Analysis and distillation, Introduction to refinery "feedstock/s" and refinery products.

UNIT – 2 **L-9**

DISTILLATION OF CRUDE OIL : Evaluation of crude oil properties and design of crude oil distillation column, Dehydration and desalting of crude, Crude Assay ASTM TBP distillations evaluation of crude oil properties, API gravity various average boiling points and mid percent corves, Evaluation of properties of crude oil and its fractions, Design concept of crude oil distillation column design, Furnace design.

UNIT – 3 **L-9**

THERMAL AND CATALYTIC CRACKING : Coking and thermal process, Delayed coking, Catalytic cracking, Cracking reactions, Zeolite catalysts, Cracking feed stocks and reactors, Effect of process variables, FCC cracking, Catalyst coking and regeneration, Design concepts, New Designs for Fluidized-Bed Catalytic Cracking Units, Catalytic reforming, Objective and application of catalytic reforming process, Reforming catalysts, Reformer feed reforming reactor design-Continuous and semi regenerative process.

UNIT – 4 **L-9**

HYDROTREATING AND HYDROCRACKING : Objectives and hydrocracking reactions, Hydrocracking feed stocks, Modes of Hydrocracking, Effects of process variables, Hydro treating process and catalysts, Resid hydro processing, Effects of process variables, Reactor design concepts, Isomerization, Alkylation and polymerization isomerization process, Reactions, Effects of process variables, Alkylation process, Feedstocks, Reactions, Products, Catalysts and effect of process variables, Polymerization-Objectives, Process, Reactions, Catalysts and effect of process variables.

UNIT – 5 **L-9**

LUBE OIL MANUFACTURING : Lube oil processing, Propane deasphalting, Solvent extraction, Dewaxing, Additives production from refinery feedstocks, Environmental issues and new trends in petroleum refinery operations, Ecological consideration in petroleum refinery, Waste water treatment, Control of air pollution, New trends in refinery, Alternative energy sources, Biodiesel, Hydrogen energy from biomass.

TEXT BOOKS:

1. J.B.Maxwell, "Data Book of Hydrocarbons", Krieger publishing company, 1975.
2. W.C.Edmister, "Applied Hydrocarbon Thermodynamics Vol-I and Vol-II", Gulf Publishing Company, 1988.
3. Joseph Hilyard, "International Petroleum Encyclopedia (Volume-III)", Pennwell Corporation, 2008.

REFERENCE BOOKS:

1. W.L..Nelson, "Petroleum Refining Engineering", Mc Graw-Hill.
2. R.N.Watkins, "Petroleum Refinery Distillation", Gulf Publishing Company.
3. Robert A Mayers, "Hand book of Petroleum Refining Process".
4. James G Speight, "The Chemistry and Technology of Petroleum".
5. J.H. Gary and G.E. Handwerk, "Petrolem Refinery Technologies and Economics".

16CH354 PETROCHEMICALS

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	-	-	5	5

Course Description and Objectives:

This course deals with thermal, catalytic process, fractionation of crude oil and various chemicals used in petroleum industries.The objective of this course is to get the familiarity with the various chemical processes deployed in petroleum industries.

Course Outcomes:

The student will be able to:

- understand the importance of cracking.
- identify the difference between thermal and catalytic cracking.
- recognize the reforming process.

SKILLS :

- ✓ *Draw the specific PFD & PID diagrams.*
- ✓ *Analyze the principles behind the production of aldehydes and alcohols.*

ACTIVITIES:

- *Evaluation of petrochemicals by advanced techniques.*
- *Enhancement of petroleum products using various methods.*

UNIT - 1 **L-9**

SOURCE OF PETROLEUM : Origin and formation of petroleum, Reserves and deposits of world, Indian Petroleum industry.

UNIT - 2 **L-9**

FRACTIONATION OF PETROLEUM : Dehydration and desalting of crudes, heating of crude pipe still heaters, Distillation of petroleum, blending of gasoline.

UNIT - 3 **L-9**

THERMAL AND CATALYTIC PROCESSES : Cracking, Catalytic cracking, Catalytic reforming, Naphtha cracking, Coking, Hydrogenation processes, Alkylation processes, Isomerisation processes.

UNIT - 4 **L-9**

PETROCHEMICAL TECHNOLOGY : Chemicals from ethane, Ethylene and acetylene, Synthetic ethanol, Acetaldehyde and acetic acid, Vinyl acetate, butraldehyde, 2-Ethyl hexanol and drop ethylene, Oxide, Ethylene glycols, Acrilonitrile, Polyesters, Ethandaminess, Ethyl chloride, Ethylene dichloride.

UNIT - 5 **L-9**

CHEMICALS FORM BUTANES : Butanes, Pentanes, Butadiene, Butane epoxides and butanolamines butanol, Butyl acetate, Methyl ethyl ketone, Isoprene, Amyl alcohol.

Text Book:

1. B.K.Bhaskara Rao “A Text on Petrochemicals”, 5th edition, Khanna Publishers, 2003.

Reference Books :

1. W.S Grueses and D.R.Stevens, “Chemical Technology of Petroleum”, 1st edition, McGraw-Hill, 1980.
2. Waddams A.L., “Chemicals from Petroleum”, 1st edition, Chemical Publishing,1969.
3. Popchiev, A.V.Naigyer and M.F Shakhaklttinskii, “Synthetic Materials from Petroleum”, 1st edition, Pergamon Press, London, 1962.

16PL401 NATURAL GAS ENGINEERING

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	-	-	5	5

Course Description and Objectives:

This course covers basic concepts and applications in natural gas engineering. The objective of this course is to train the student on the fundamental properties and technology for production and transportation of natural gas.

Course Outcomes:

The student will be able to :

- understand natural gas processing techniques.
- familiarize with gas compression, gas gathering and transport methods.
- know about installation, operation and trouble shooting of natural gas pipelines.

SKILLS :

- ✓ *Suggest natural gas compression techniques and equipments.*
- ✓ *Predict IPR curve and AOF of wells.*
- ✓ *Perform gas transport pressure calculations.*

ACTIVITIES:

- *Derive equations for incompressible fluid flow through pipes.*
- *Calculate residual properties of gas using equation of state.*

UNIT - 1 **L-9**

NATURAL GAS TECHNOLOGY AND EARTH SCIENCE : Branches of petroleum industry, Sources of information for natural gas engineering and its applications, Geology and earth sciences-historical geology, Sedimentation process, Petroleum reservoirs, Origin of petroleum, Earth temperatures and earth pressure, Petroleum-natural gas, Gas hydrates, LP gas, Condensate and crude oil.

UNIT - 2 **L-9**

PROPERTIES OF NATURAL GASES: Typical compositions, Equations of state-General cubic equations, Specific high accuracy equations, Use of equation of state to find residual energy properties, Gas measurement, Condensate stabilization, Acid gas treating, Gas dehydrations, Compressors, Process control deliverability test, Gathering and transmission and natural gas liquefaction.

UNIT - 3 **L-9**

GAS COMPRESSION : Positive displacement and centrifugal compressors, Fans, Calculation of poser requirements, Compressible flow in pipes, Fundamental equations of flow continuity, Momentum, Energy equations.

UNIT - 4 **L-9**

ISOTHERMAL FLOW IN PIPES : Weymouth equation, Static and flowing bottom-hole pressures in wells, Fundamentals of gas flow in porous media, Steady state flow equations, Definition of pseudo-pressure function, Gas flow in cylindrical reservoirs, General equation for radial flow of gases in symmetrical homogeneous reservoirs.

UNIT - 5 **L-9**

DIMENSTIONAL ANALYSIS : Non-dimensional forms of the equation, Derivation of coefficient relations dimensionless to real variables, Infinite reservoir solution, pseudo-steady-state solution.

GAS WELL DELIVERABILITY TESTS : Flow-after-flow test, Prediction of IPR curve and AOF for the well, Isochronal tests, Draw down tests, Need for data at two flow rates.

Text Book:

1. Katz D.L., “Natural Gas Engineering:Production and Storage”, 2nd edition, McGraw-Hill, 1990.

Reference Book :

1. Lyons W. C. and Plisga G.C.,”Standard Handbook of Petroleum and Natural Gas Engineering Vol-2”, 6th edition, Gulf Professional Publishing, 1996.

16CH245 CONVENTIONAL ENERGY SOURCES

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
15	35	5	-	5	5

Course Description & Objective:

This course provides a comprehensive overview of conventional energy sources. The objective of this course is to teach the student types of conventional fuels and their classification based on availability and physical state.

Course outcomes:

The student will be able to:

- understand the key concepts of conventional energy sources and evaluate their advantages and disadvantages.
- analyze the conventional energy sources and conduct a feasibility study to select the right model of conventional energy for their day-to-day life.

SKILLS :

- ✓ *Classification of fuels based on the physical state and calorific values.*
- ✓ *Critique the impact of government regulations on the use of non-renewable energies.*
- ✓ *Estimate the energy demands and energy reserves of fossil fuels.*
- ✓ *Investigate the potentials of conventional energy technologies to help solve economic problems within society.*

ACTIVITY:

- *Case study on the pros and cons of various conventional energy technologies and propose the best possible energy conversion system for a particular location.*

UNIT - 1 **L-9**

SOURCES OF ENERGY : Types of fuels, Energy and relative forms, Calorific value-gross and net value, Calculation of calorific value from fuel analysis, Experimental determination energy resources present and future energy demands with reference to India.

UNIT - 2 **L-9**

COAL : Origin, Occurrence, Reserves, Petrography, Classification, Ranking, Analysis, Testing, Storage, Coal carbonization and byproduct recovery, Liquefaction of coal, Gasification of coal, Burning of coal and firing mechanism, Burning of pulverized coal.

UNIT - 3 **L-9**

LIQUID FUELS : Petroleum, Origin, Occurrence, Reserves, Composition, Classification, Characteristics, Fractionation, Reforming, Cracking, Petroleum products, Specification of petroleum products, Burning of liquid fuels.

UNIT - 4 **L-9**

GASEOUS FUELS : Natural gas, Coke oven gas, Producer gas, water gas, LPG, Burning of gaseous fuels, Hydrogen (from water) as future fuel, Fuel cells, Flue gas analysis.

UNIT - 5 **L-9**

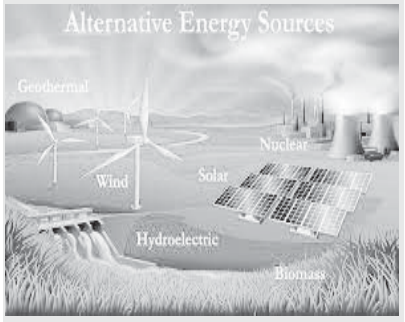
NUCLEAR ENERGY : Introduction, Energy and mass, Nuclear fission, Chain reaction, Critical mass, Power from nuclear fission reactors, Thermonuclear fusion, Difficulties, Fuel reserves, Safety and waste issues, Unconventional oil and gas resources, Oil shale, Tar sands.

TEXT BOOKS :

1. Gupta O. P., “Elements of Fuels, Furnaces and Refractories”, 6th edition, Khanna Publishers, Delhi, India, 2008.
2. Sami Sarkar, “Fuels and Combustion”, 3rd edition, University Press, 1998.

REFERENCE BOOKS:

1. Christian Ngo and Joseph B. Natowitz, “Our Future Resources: Alternatives and the environment”, John Wiley & Sons, 2009 .
2. Ristinen R. A., Kraushaar J. J. and Akraushaar J. P., “Energy and the Environment”, 2nd edition, John Wiley, 2006.



16CH345 NON CONVENTIONAL ENERGY SOURCES

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	35	-	-	5	5

Course Description and Objective:

This course provides a comprehensive overview of renewable energies including solar energy, wind power, hydropower, fuel cells, biomass, and alternative transportation options. The objective of this course is to teach overview of alternative energy sources, its availability, current status and basic principles for harnessing this resource.

Course Outcomes:

The student will be able to :

- describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.
- explain the technological basis for harnessing renewable energy sources.
- recognize the effects that current energy systems based on fossil fuels have over the environment and the society.
- describe the main components of different renewable energy systems.
- compare different renewable energy technologies and choose the most appropriate based on local conditions.

SKILLS :

- ✓ *Able to assess the viability of a wind power hydropower or biomass system for a given site.*
- ✓ *Able to explain the impact of government regulations on the use of renewable energies.*
- ✓ *Able to analyze these renewable energy systems and will calculate savings fractions backup energy needs financing options and economic analyses.*
- ✓ *Able to investigate the potentials of renewable energy technologies to help solve environmental and economic problems within society.*

ACTIVITY:

- *Compare the pros and cons of various renewable energy technologies and propose the best possible energy conversion system for a particular location.*
- *Investigate the potentials of renewable energy technologies to help solve environmental and economic problems within society.*

UNIT – 1 **L-9**

SOLAR ENERGY : Solar radiation its measurements and prediction, Solar thermal flat plate collectors, Concentrating collectors, Applications, Heating, Cooling, Desalination, Power generation, Drying, cooking etc., Principle of photovoltaic conversion of solar energy, Types of solar cells and fabrication, Photovoltaic applications-Battery charger, Domestic lighting, Street lighting and water pumping, Power generation schemes.

UNIT – 2 **L-9**

WIND ENERGY : Atmospheric circulations, Classification, Factors influencing wind, Wind shear, Turbulence, Wind speed monitoring, Betz limit, Aerodynamics of wind turbine rotorsite selection, Wind resource assessment, Wind energy conversion devices, Classification, Characteristics, Applications, Hybrid systems-Safety and environmental aspects.

UNIT – 3 **L-9**

BIO-ENERGY : Biomass resources and their classification, Chemical constituents and physicochemical characteristics of biomass, Biomass conversion processes, Thermo chemical conversion-Direct combustion, Gasification, Pyrolysis and liquefaction, Biochemical conversion-Biogas, Generation, Types of biogas Plants, Applications, Anaerobic digestion, Alcohol production from biomass, Chemical conversion process-Hydrolysis and hydrogenation.

UNIT – 4 **L-9**

HYDROGEN AND FUEL CELLS : Thermodynamics and electrochemical principles, Bbasic design, Types and applications, Production methods, Biophotolysis-Hydrogen generation from algae biological pathways, Storage gaseous, Cryogenic and metal hydride and transportation, Fuel cell- Principle of working, Various types, Construction and applications.

UNIT – 5 **L-9**

OTHER TYPES OF ENERGY : Ocean energy resources, Principles of ocean thermal energy conversion systems, Ocean thermal power plants, Principles of ocean wave energy conversion and tidal energy conversion, Hydropower, Site selection, Construction, Environmental issues, Geothermal energy, Types of geothermal energy sites, Site selection and geothermal power plants.

TEXT BOOKS :

1. G.D.Rai, “Non-Conventional Energy Sources”, 5th edition, Khanna Publishers, 2010.
2. G. N. Tiwari and R. K. Mishra, “Advanced renewable energy sources”, RSC Publishing, 2012.

REFERENCE BOOKS :

1. S.P Sukhatme, J.K Nayak, “Solar Energy : Principles Of Thermal Collection and Storage”, 3rd edition, Tata McGraw-Hill, 2008.
2. John Twidell, and Tony Weir, “Renewable Energy Sources”, 3rd edition, Routledge Publisher, 2015.

16CH355 ENERGY MANAGEMENT AND AUDITING

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
15	38	5	-	-	-

Course Description and Objectives :

This course provides an understanding on the energy efficiency measures which can be implemented by industrial and domestic users. The objective of this course is to demonstrate energy technologies that include lighting, air conditioning, compressed air, steam, hot water, chilled water and a number of process specific technologies.

Course Outcomes :

The student will be able to :

- understand energy efficiency and demand management project proposals.
- exhibit proficiency in energy auditing methods.
- provide energy efficiency solutions.
- evaluate thermal performance, energy management and audit.

SKILLS :

- ✓ *Analyze energy systems from a supply and demand perspective.*
- ✓ *Develop energy efficiency solutions and demand management strategies.*
- ✓ *Apply energy efficiency technologies for engineering applications.*

ACTIVITIES:

- *Classroom discussions on quantifying energy efficiency.*
- *Identifying and implementing energy efficiency measures.*
- *Case study on analyzing issues related to the implementation of energy efficiency measures.*
- *Preparing energy audit reports.*

UNIT - 1 **L-9**

ENERGY AUDIT : Types and methodology, Energy audit reporting format, Understanding energy costs, Benchmarking and energy performance, Matching energy usage to requirement, Maximising system efficiency, Fuel and energy substitution, Energy audit instruments, Duties and responsibilities of energy auditors.

UNIT – 2 **L-9**

ENERGY CONSERVATION : Energy conservation and its importance, Energy strategy for the future, The energy conservation act 2001 and its features.

ENERGY MANAGEMENT : Definition and objectives of energy management, Importance, Indian need of energy management, Duties and responsibilities of energy managers.

UNIT – 3 **L-9**

ENERGY ECONOMICS : Costing techniques, Financial appraisal and profitability, Cost optimization, Optimal target investment schedule, Project management energy utilization and conversion systems, Furnaces, Loses, Hydraulic power systems, Compressed air, Steam turbines, Combined power and heating systems, Energy conversion, District heating .

UNIT – 4 **L-9**

ENERGY MONITORING AND TARGETING : Definition, Elements of monitoring and targeting system, A rationale for monitoring, Targeting and reporting, Data and information analysis, Relating energy consumption and production, CUSUM, Case study.

UNIT – 5 **L-9**

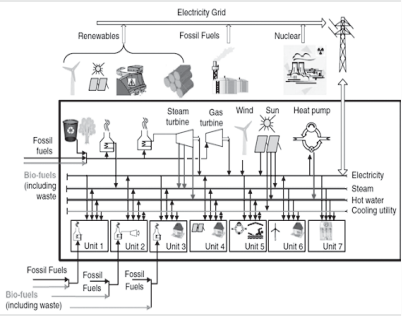
HEAT RECOVERY : Sources of waste heat and its potential applications, Heat recovery systems, Incinerators, Regenerators and recuperators, Waste heat boilers.

TEXT BOOKS :

1. W R Murphy, G McKay, “Energy Management”, Butterworth Heinemann, 2007
2. Barun Kumar De, “Energy Management, Audit and Conservation”, 2nd edition, Vrinda Publications, 2014.
3. WC Turner, “Energy Management Handbook”, 7th edition, Fairmont Press, 2007.

REFERENCE BOOKS :

1. Fengyuan Wang and Andy Chen, “Energy Management Handbook”, BSR Publishers, 2012.
2. YP Abbi and Shashank Jain, “Handbook on Energy Audit and Environment Management”, TERI Press, 2006.



16CH445 ENERGY INTEGRATION

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	48	-	-	5	5

Course Description and Objectives:

The course covers a strategy for design of integrated production systems with focus on efficient use of energy. The objective of this course is to impart knowledge on systematic methods established for analysis and design of thermally driven separation systems, heat exchanger networks and utility systems.

Course Outcomes:

The student will be able to :

- understand process integration and pinch analysis.
- analyze heat exchanger networks.
- realize heat and power integration.
- know raw and wastewater utilization techniques.

SKILLS :

- ✓ *Proficient in heat integration.*
- ✓ *Recognize the main components of energy conservation.*

ACTIVITIES:

- *Evaluate maximum theoretical performance of the processes in power plants.*
- *Team activity on small scale power plant measurements.*

UNIT- 1 **L-9**

KEY CONCEPTS OF PINCH ANALYSIS : Pinch analysis, History and industrial experience, Why does pinch analysis work, Concept of process synthesis, Role of thermodynamics in process design, Heat recovery and heat exchange, Pinch and its significance.

UNIT – 2 **L-9**

HEAT EXCHANGER NETWORK DESIGN : Heat exchange equipment, Stream splitting and cyclic matching, Network relaxation, Multiple pinches and near pinches, Retrofit design, Case studies.

UNIT- 3 **L-9**

DATA EXTRACTION : Heat and mass balance, Stream data extraction, Calculating heat loads and heat capacities, Choosing streams, Mixing, Heat losses case study.

ENERGY TARGETING: T min contributions for individual streams, Threshold problems, Multiple utilities-types of utility, Appropriate placement principle, Constant temperature utilities, Utility pinches, variable-temperature utilities, Targeting heat exchange, Units, Area and shells.

UNIT- 4 **L-9**

PROCESS CHANGE AND EVOLUTION : Basic objective, The plus-minus principle, Appropriate placement applied to unit operations, Reactor systems, Distillation columns and other separation systems.

UNIT- 5 **L-9**

BATCH AND TIME DEPENDENT PROCESSES : Introduction, Concepts, Types of streams in batch processes, Time intervals, Calculating energy targets, Rescheduling, Debottlenecking, Heat exchanger network design, Other time dependent applications.

TEXT BOOKS :

1. Ian C Kemp, “Pinch Analysis and Process Integration”, 2nd edition, Elsevier Publications, 2007.
2. Bodo Linnhoff, “A User Guide on Process Integration for the Efficient use of Energy”, Institution of chemical engineers,1994.

REFERENCE BOOK :

1. Lorenz T Biegler, Ignacio E Grossmann and Aurthur W Westerberg, “Systematic Methods of Chemical Process Design”, Prentice Hall of India, 1997.