Teaching Scheme and Syllabi of B.E. (Chemical Engineering)

Note:

- NSS/NCC/Sports proficiency/Community services/Professional society activities/placement activities/clubs/technical magazine/conferences/research papers/Technical activities related to the field of Engineering (1st to 3rd year, 1 credits to be earned in 7th semester; will be evaluated by a committee)

L: Lectures/Week, T: Tutorials/Week, P: Practical Hours/Week

Assessment will consist of the following components

1. Mid-Term
   a. One best of two minor tests (50% of Mid -term marks)
   b. Assignments (20% of Mid-term marks)
   c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks)
   d. Attendance (10% of Mid-term marks)
2. End -Term

As per UGC guidelines 40% of total courses can be run through MOOC s/Swayam platform.

BS- Basic Science, HSMC-Humanities, social science including management, ESC - Engineering Science Course, MC-Mandatory Course

COURSES- Minor Engineering in Software Applications

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)

First Year

1st SEMESTER

S. No.	Course code	Courses	Contact hrs per week			Mid Term	End Term	Total Marks	Credits
			L	T	P				
1.	BS101	Mathematics –I	3	1	-	50	50	100	4
2.	BS102	Physics	3	1	-	50	50	100	4
3.	BS103	Chemistry-I	3	-	-	50	50	100	3
4.	ESC 101	Computer Programming for problem solving	2	-	-	50	50	100	2
5.	ESC 102	Engineering Graphics	2	-	-	50	50	100	2
6.	ESC 151	Engineering Graphics	-	-	3	50	-	50	1.5
7.	ESC 152	Engineering Workshop	-	-	2	50	-	50	1
8.	BS 151	Physics Lab.	-	-	3	50	-	50	1.5
9.	BS 152	Chemistry I Lab.	-	-	3	50	-	50	1.5
10.	ESC 153	Computer Lab.	-	-	2	50	-	50	1
11.	MC 101	Introduction to Env. science	3	-	-	50	50	50	NC*
		Total	**16**	**2**	**13**	**500**	**250**	**750**	**21.5**

2nd SEMESTER

S. No.	Course code	Courses	Contact hrs per week			Mid Term	End Term	Total Marks	Credits
			L	T	P				
1.	BS104	Mathematics –II	3	1	-	50	50	100	**4**
2.	BS105	Chemistry II	3	-	-	50	50	100	3
3.	ESC 103	Electrical & Electronics Engineering	3	1	-	50	50	100	4
4.	PCC 101	Introduction to Engg and Technology	2	1	-	50	50	100	3
5.	HSMC 101	Communication Skills	2	-	-	50	50	100	2
6.	ESC 154	Electrical & Electronics Engineering Lab.	-	-	3	50	-	50	1.5
7.	BS 153	Chemistry II Lab.	-	-	3	50	-	50	1.5
8.	HSMC 151	Communication Skills Lab.	-	-	2	50	-	50	1
9.	MC 102	Ethics and self awareness	2	-	-	50	50	100	NC*
		Total	**15**	**3**	**8**	**400**	**250**	**650**	**20**

*** For a non-credit course passing with 40% marks will be compulsory, otherwise student will get reappear and passing this course will be mandatory.**

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)

2nd Year

3rd SEMESTER

S. No.	Course code	Courses	Contact hrs per week			Mid Term	End Term	Total Marks	Credits
			L	T	P				
1.	PCC 102	Material and Energy Balance	3	1	-	50	50	100	4
2.	PCC 103	Fluid Flow	3	1	-	50	50	100	4
3.	PCC 104	Mechanical Operations	3	1	-	50	50	100	4
4.	ESC 104	Strength of Materials	3	1	-	50	50	100	4
5.	ESC 105	Engg. Materials	3	1	-	50	50	100	4
6.	PCC 151	Mechanical Operation Lab.	-	-	3	50	-	50	1.5
7.	ESC 155	Process Equipment Design	-	-	3	50	-	50	1.5
8.	PCC 152	Fluid Flow Lab.	-	-	3	50	-	50	1.5
		Total	**15**	**5**	**9**	**400**	**250**	**650**	**24.5**

4th SEMESTER

S. No.	Course code	Courses	Contact hrs per week			Mid Term	End Term	Total Marks	Credits
			L	T	P				
1.	PCC 105	Heat Transfer	3	1	-	50	50	100	**4**
2.	PCC 106	Chemical Engineering Thermodynamics	3	1	-	50	50	100	**4**
3.	PCC 107	Chemical Technology-I(Inorganic)	3		-	50	50	100	**3**
4.	PEC 101	Deptt. Elective I	3	1	-	50	50	100	**4**
5.	ESC 106	Fuel Cell Technology	3		-	50	50	100	**3**
6.	PCC 153	Heat Transfer Lab.	-	-	3	50	-	50	1.5
7.	PEC 151	Deptt. Elective Lab. I			- 3	50	-	50	1.5
8.	PCC 154	Chemical Technology – I (Inorganic Lab.)	-	-	3	50	-	50	1.5
9.	CHE 101	Comprehensive viva	-	-	-	50	-	50	1
		Total	**15**	**3**	**9**	**450**	**250**	**700**	**23.5**

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)

3rd Year

5th SEMESTER

S. No.	Course code	Courses	Contact hrs per week			Mid Term	End Term	Total Marks	Credits
			L	T	P				
1.	PCC 108	Chemical Reaction Engineering-I	3	1	-	50	50	100	4
2.	PCC 109	Mass Transfer I	3	1	-	50	50	100	4
3.	PCC 110	Chemical Technology-II (Organic)	3	-	-	50	50	100	3
5.	BS 106	Statistics and Research Methodology	3	-	-	50	50	100	3
6.	PCC 155	Chemical Reaction Engineering Lab.	-	-	3	50	-	50	1.5
7.	PCC 156	Chemical Technology-II (Organic Lab.)	-	-	3	50	-	50	1.5
8.	PEC 153	Process Plant Design I	-	-	3	50	-	50	1.5
		Total	**12**	**2**	**09**	**350**	**200**	**550**	**18.5**

6th SEMESTER

S. No.	Course code	Courses	Contact hrs per week			Mid Term	End Term	Total Marks	Credits
			L	T	P				
1.	PCC 111	Chemical Reaction Engineering II	3	1	-	50	50	100	4
2.	PCC 112	Mass Transfer II	3	1	-	50	50	100	4
3.	PCC 113	Process Dynamics & Control	3	1	-	50	50	100	4
4.	PCC 114	Energy Technology	3	1	-	50	50	100	4
5.	PEC 102	Department Elective-II	3	-	-	50	50	100	3
5.	PCC 157	Mass Transfer Lab.	-	-	3	50	-	50	1.5
6.	PCC 158	Process Dynamics & Control Lab.	-	-	3	50	-	50	1.5
7.	PEC 152	Department Elective II Lab.	-	-	3	50	-	50	1.5
8.	CHE 102	Industrial Training*				-	-	-	
		Total	**15**	**4**	**9**	**400**	**250**	**650**	**23.5**

* There will be 6-8 weeks' compulsory industrial training after 6th semester theory examination during summer vacation. Every student will submit the Industrial Training report within one month from the start of teaching of the 7th semester. After that it will be evaluated by the team of Training & Placement Officers. The Credits for the Industrial Training will be awarded in the seventh semester

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)

4th Year

7th SEMESTER

S. No.	Course code	Courses	Contact hrs per week			Mid Term	End Term	Total Marks	Credits
			L	T	P				
1.	PEC 103	Department Elective III	3	1	-	50	50	100	4
2.	OEC I01	Open Elective I	3	-	-	50	50	100	3
3.	OEC 102	Open Elective II (Process Modelling and Simulation)	3	-	-	50	50	100	3
4.	HSMC 102	Process Engineering Economics	3	1	-	50	50	100	4
5.	PEC 154	Process Plant Design II	-	-	3	50	-	50	1.5
6.	OEC 151	Open Elective II Lab.	-	-	3	50	-	50	1.5
7.	CHE 103	Project Work**	-	-	2	-	-	-	
8.	CHE 104	Literature Survey, Report Writing and Seminar	-	-	3	50	-	50	1.5
9.	CHE 102	Industrial Training	-	-	-	100	-	100	2
10.	CHE 105	NSS/NCC/Sports proficiency/Community services/Professional activities		-	-		-	-	1
		Total	**12**	**2**	**11**	**450**	**200**	**650**	**21.5**

8th SEMESTER

S. No.	Course code	Courses	Contact hrs per week			Mid Term	End Term	Total Marks	Credits
			L	T	P				
1.	PCC 115	Environmental Engineering	3	1	-	50	50	100	**4**
2.	OEC 103	Open Elective III	3	1	-	50	50	100	**4**
3.	OEC 104	Open Elective IV	3	-	-	50	50	100	**3**
4.	PEC 104	Department Elective IV	3	-	-	50	50	100	**3**
5.	CHE 103	Project Work	-	-	2	50	50	100	**2**
6.	PCC 159	Environmental Engineering Lab.	-	-	3	50	-	50	1.5
7.	CHE 106	Comprehensive Viva		-	-	-	50	50	1
		Total	**12**	**2**	**5**	**300**	**250**	**600**	**18.5**

TOTAL CREDITS OF ALL SEMESTORS= 171.5

**** Marks and Credits for Project work will be awarded in 8th Semester**

S. No.	List of Departmental Electives	S. No.	List of Open Electives

1	Numerical Methods in Chemical Engineering	1.	Process Instrumentation
2	Petroleum Processing Engineering	2.	Industrial Safety and Hazards
3	Transport Phenomena	3.	Nanotechnology
4	Plant Utilities	4.	Polymer Science and Engineering
5	Petrochemical Technology	5.	Process Modelling & Simulation
6	Biochemical Engineering	6.	Supply Chain and Logistic Management
7	Food Processing	7.	Project Management and Entrepreneurship
8	Corrosion Engineering	8.	**Environment Impact Assessment**
9	Heterogeneous Catalysis and Reactor Design	9.	Energy Management and Audit
10	**Industrial Environmental Management**	10.	Applications of computational fluid dynamics
11	Introduction to Multiphase Flow	11.	Chemical Process Optimization
12	Natural Gas Engineering	12.	Fluidization Engineering
13	Catalysis	13.	**MOOCS COURSES(all chemical engg subjects)**
14	Introduction to Colloids and Interfacial Science and Engineering	14.	**Crystal physics**
15	Biorefinery and Bioproducts Engineering	15.	Advance Physics
16.	**MOOCS COURSES(all chemical engg and allied subjects)**	16.	Energy Materials
		17.	Material Characterization
		18.	Functional Material
		19.	
		20.	Nano Materials

See MOOCs courses at: www.swayam.gov.in and www.nptel.ac.in

COURSES- Minor Engineering in Software Applications

S.NO	COURSE NAME	Semester	CREDITS (20)
1	Joy Of Computing Using Python	3rd Semester	3
2	Database Management System	4th Semester	2
3	Data Analytics With Python	5th Semester	4
4	Introduction To Machine Learning	6th Semester	3
5	Ethical hacking	7th Semester	4
6	Modern Application Development	8th Semester	4

1. Joy of computing using python-NPTEL-IIT Ropar
Course Duration -12 weeks
No. of hours – 30
Credits - 3

Course Content
Week 1: Motivation for Computing
Week 2: Welcome to Programming!!
Week 3: Variables and Expressions : Design your own calculator
Week 4: Loops and Conditionals : Hopscotch once again
Week 5: Lists, Tuples and Conditionals : Lets go on a trip
Week 6: Abstraction Everywhere : Apps in your phone
Week 7: Counting Candies : Crowd to the rescue
Week 8: Birthday Paradox : Find your twin
Week 9: Google Translate : Speak in any Language
Week 10: Currency Converter : Count your foreign trip expenses
Week 11: Monte Hall : 3 doors and a twist
Week 12: Sorting : Arrange the books

2. Database Management System NPTEL-IIT Kharagpur
Course Duration - 8 weeks
No. of hours – 25
Credits - 2
Course Content
Week 1: Course Overview, Introduction to RDBMS
Week 2: Structured Query Language (SQL)
Week 3: Relational Algebra, Entity-Relationship Model
Week 4: Relational Database Design
Week 5: Application Development, Case Studies, Storage and File Structure
Week 6: Indexing and Hashing, Query Processing
Week 7: Query Optimization, Transactions (Serializability and Recoverability)
Week 8: Concurrency Control, Recovery Systems, Course Summarization

3. Data Analytics with Python-NPTEL-IIT ROORKEE

Course Duration -12 weeks
No. of hours – 45
Credits - 4

Course Content
Week 1: Introduction to data analytics and Python fundamentals
Week 2: Introduction to probability
Week 3: Sampling and sampling distributions
Week 4: Hypothesis testing
Week 5: Two sample testing and introduction to ANOVA
Week 6: Two way ANOVA and linear regression
Week 7: Linear regression and multiple regression
Week 8: Concepts of MLE and Logistic regression

Week 9: ROC and Regression Analysis Model Building
Week 10: c test and introduction to cluster analysis
Week 11: Clustering analysis
Week 12:Classification and Regression Trees (CART)

4. Introduction to Machine Learning -NPTEL-IIT KHARAGPUR
Course Duration -8 weeks
No. of hours – 30
Credits - 3

Course content
Week 01 : Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation
Week 02 : Linear regression, Decision trees, over fitting.
Week 03 : Instance based learning, Feature reduction
Week 04 : Probability and Bayes learning.
Week 05 : Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM.
Week 06 : Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network.
Week 07 : Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning.
Week 08 : Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture model.

5. Ethical hacking -NPTEL-IIT Kharagpur
Course Duration -12 weeks
No. of hours – 45
Credits - 4

Course Content
Week 1 : Introduction to ethical hacking. Fundamentals of computer networking. TCP/IP protocol stack.
Week 2 : IP addressing and routing. Routing protocols.
Week 3 : Introduction to network security. Information gathering: reconnaissance, scanning, etc.
Week 4 : Vulnerability assessment: OpenVAS, Nessus, etc. System hacking: password cracking, penetration testing, etc.
Week 5 : Social engineering attacks. Malware threats, penetration testing by creating backdoors.
Week 6 : Introduction to cryptography, private-key encryption, public-key encryption.
Week 7 : Key exchange protocols, cryptographic hash functions, applications.
Week 8 : Steganography, biometric authentication, lightweight cryptographic algorithms.
Week 9 : Sniffing: Wireshark, ARP poisoning, DNS poisoning. Hacking wireless networks, Denial of service attacks.
Week 10 : Elements of hardware security: side-channel attacks, physical unclonable functions.
Week 11 : Hacking web applications: vulnerability assessment, SQL injection, cross-site scripting.
Week 12 : Case studies: various attacks scenarios and their remedies.

6. Modern Application Development NPTEL-IIT Madras
Course Duration -12 weeks
No. of hours – 45
Credits - 4
Course Content
Week 1 and 2 : From desktop application to internet application
Week 3 and 4 : Stateful applications
Week 5 and 6 : The front end
Week 7 and 8 : Databases and Simple files
Week 9 : Setting up a website
Week 10 : Using third party web services
Week 11 and 12: Extended project

SYLLABUS OF B.E. CHEMICAL ENGINEERING
FIRST YEAR

1st SEMESTER

Title	**MATHEMATICS-I**		**Credits**	04
Code	BS101	**Semester:-**1st	**L T P**	3 1 0
Max. Marks	**End term- 50**	**Mid Term- 50**	**Elective**	N
Pre requisites				
Objectives	To make the students 1. Understand the behaviour of infinite series and their use. 2. Learn the concepts related to functions of several variables and their applications. 3. Understand the concept of Vectors and its applications. 4. Learn the methods of evaluating multiple integrals and their applications to various problems. 5. Learn the methods to formulate and solve linear differential equations and apply them to solve engineering problems.			
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.			
SECTION- A				
Infinite Series: Infinite series and convergence, alternating series, power series and convergence. Taylor's and Maclaurin's Series.				
Multivariable Functions: Limit, Continuity and Partial Derivatives; Euler's Theorem for Homogeneous functions; Differentiability, Linearization and Differentials; Chain rule; Extreme values and Saddle Points; Lagrange multipliers; Taylor's Formula.				
Vector Deferential Calculus and Integral Theorems: Gradient, Divergence, Curl, Statement of Green's, Gauss and Stoke's Theorem and their simple applications.				
SECTION- B				
Solid Geometry: Cylinders and Cones, Cylindrical and Spherical Polar Coordinates				
Integral Calculus: Area between plane curves; Volumes of solids of revolution; Lengths of plane curves; Areas of surfaces of revolution. Double integrals in rectangular and Polar form, Triple integrals in Rectangular, Cylindrical and Spherical coordinates, Substitutions in Multiple Integrals.				
Ordinary Differential Equations: First order exact differential equations, Integrating factor, Orthogonal trajectories, Second and Higher order Linear Differential Equations with constant coefficients, Differential Operators, Methods of Variation of Parameters and Undetermined Coefficients, Euler Cauchy Equation, Wronskian.				
Text books:	1. G. B. Thomas, R. L. Finney: Calculus and Analytic Geometry, Ninth Edition, Pearson Education. 2. E. Kreyszig: Advanced Engineering Mathematics, Eighth Edition, John Wiley.			
Reference Books:	1. B. V. Ramana: Higher Engineering Mathematics, Tata McGraw Hill. 2. B. S. Grewal: Higher Engineering Mathematics, 41st Edition, Khanna Publishers, Delhi. 3. Differential Equations, Frank Ayers, TMH			
Course Outcomes	CO1: To test the behavior of infinite series. Operate vectors and convert line integral to surface integral to volume integral. CO2: Analyze functions of several variables and their applications. CO3: Evaluate multiple integrals and apply them to practical problems. CO4: To study cylinders and cones and understand applying cylindrical and polar coordinates. Co5: Formulate and solve linear differential equations.			

Title	PHYSICS			Credits	04
Code	BS 102	Semester:-1st		L T P	3 1 0
Max.Marks	End term- 50	Mid Term- 50		Elective	N
Pre requisites					
Objectives	Basic concepts of optics and its applications, electromagnetism and magnetism properties, and Structural characterizations.				
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.				

Objectives:

Basic concepts of optics and its applications, electromagnetism, magnetic properties, structural characterizations and concepts of nanotechnology.

Section A

1. **Optics and Fibre Optics** (12L + 4T)
   - Diffraction: Introduction to interference and example; concept of diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits; diffraction grating, characteristics of diffraction grating and its applications.
   - Polarisation: Introduction, polarisation by reflection, polarisation by double refraction, scattering of light, circular and elliptical polarisation, optical activity.
   - Fibre Optics: Introduction, optical fibre as a dielectric wave guide: total internal reflection, numerical aperture and various fibre parameters, losses associated with optical fibres, step and graded index fibres, application of optical fibres.
   - Lasers: Introduction to interaction of radiation with matter, principles and working of laser: population inversion, pumping, various modes, threshold population inversion, types of laser: solid state, semiconductor, gas; application of lasers.

2. **Structural Characterization:** (16 hours+5T)

   Space lattices and their symmetries, crystal structures (cubic and hexagonal cells), assignment of coordinates, directions and planes in crystals, linear, planer and space densities in crystals, close packed morphology (Hexagonal and cubic close packing), single and polycrystalline structures, interstitial spaces (trigonal, tetrahedral and octahedral voids, crystal Structure analysis, X-ray diffraction and Bragg's law, crystal defects, Point, line, surface and volume imperfections

Section B

3. **Electromagnetism and Magnetic Properties of Materials** (17L + 6T)

   Dielectric Materials: Review of basic formulas, dielectric constant and polarizability, sources of polarizability, classical treatment of dipolar, ionic and electronic polarizability, piezoelectricity, ferroelectrcity. (4)

   Magnetic Materials: Review of basic formulas, magnetic susceptibility, classification of materials, Langevin diamagnetism, paramagnetism (only classical treatment), magnetism in metals, ferromagnetism in insulators, anti-ferromagnetism and ferrimagnetism, ferromagnetism in metals, ferromagnetic domains, hysteresis (8)

   Superconductivity: Zero resistance, occurrence of superconductivity, Meissner effect, critical field, thermodynamics of superconducting transitions, electrodynamics of superconductors, qualitative idea of BCS theory. (3)

   Nanotechnology: Introduction, Synthesis of Nanoparticles: Mechanical Method, Sputtering, Chemical Vapour Deposition, Sol-gel Technique, Applications of Nanotechnology

   Nanomaterials and its applications, chemical and physical synthesis techniques of nano-powder and thin films. (2)

Text Books	1. Introduction to Solid State Physics: Charles Kittle 8th Ed. 2.
Reference Books	a. Material science and Engineering – An Introduction by William D Callister, Jr, Sixth Edition, John Wiley and Sons. b. Material science and Engineering – A First Course by V.Raghvan Fourth Edition, EasternEconomy Edition c. Introduction to Solids (Tata McGraw Hill, Third Edition) - Leonid V Azaroff
Course Assessment Methods	Assessment will consist of the following components 1.Mid-Term a. One best of two minor tests (50% of Mid -term marks) b. Assignments (20% of Mid-term marks) c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks) d. Attendance. (10% of Mid-term marks) 2.End –Term

Course outcomes

CO1: Understand Bragg's law and introduced to the principles of lasers, types of lasers and applications.
CO2: Various terms related to properties of materials such as permeability, polarization etc.
CO3: Basic knowledge of structural properties, crystal structure and X ray diffraction analysis.
CO4: Basic knowledge of magnetic, superconducting, dielectric properties of materials.
CO5: Knowledge of nanomaterials, nanotechnology and its application.

Title	**CHEMISTRY I**			Credits	3
Code	BS 103			L T P	3 - -
Max.Marks	End term- 50	Mid term- 50	Practical	Elective	M
Pre requisites	-				

THEORY		Time	3 Hours
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		

Objectives

The students shall

- Get an introductory idea of quantum mechanics as applied to structure of atom
- Learn properties of ideal solutions and deviation from the ideal behavior
- Learn the details of bonding and reactions of coordination compounds
- Learn the principles and application of electrochemical processes
- Get an introductory idea of laws of photochemistry

Section A

Quantum Chemistry of atoms :Schrodinger wave equation, interpretation of Ψ and Ψ^2 as applied to hydrogen atom. **4h**

Bonding in Coordination Compounds: crystal field theory applied to tetrahedral, octahedral and distorted octahedral (square planar) crystal fields. Electronic spectra and magnetic properties of complexes.**8h**

Reactivity of coordination compounds: Thermodynamic and Kinetic stability of coordination compounds.Ligand Substitution reactions and mechanism in complexes with coordination numbers 4 and 6 . **8h**

Section B

Solutions and Colligative Properties :Dilute solutions, Raoult's and Henry's Laws and their applications. Thermodynamic derivation(using chemical potential) of (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution **8h**

Electrochemistry :Electrolytic Conductance, interionic interactions ,introduction to :(i) ionic mobility,(ii) transport number ,(iii)activity and activity coefficient ,(iv)ionic strength. Faraday's laws of electrolysis, electrode potential ,electrochemical series , measurement of EMF of a cell and its application in calculation of (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pHvalues, Nernst equation, electrolyte and electrode concentration cells .**12h**

Photochemistry : laws of photochemistry ,quantum yield ,photosensitization and quenching **5h**

Outcome of course

CO1 will be able to understand the cause of color and magnetic properties of coordination compounds and will be able to judge the kind of reactions shown and the stability of such compounds

CO2 will get an introductory idea to quantum mechanics

CO3 the students will be able to derive and apply laws related to ideal and non- idealsolutions,

CO4 will be able to solve numericals based on faradays laws and emf ,and will develop and understanding on the functioning of concentration cells

CO5 the students will be able to apply laws of photochemistry as applied to the use of a spectrophotometer

Reference Books

- Sharpe, A. G.:Inorganic Chemistry, 3rd Edition, Longman Publishers ELBS, 1992
- Lee, J. D:Concise: Inorganic Chemistry, 5th Edition, Chapman and Hall Publishers, 1996.
- Cotton, F. A. & Wilkinson, G.:Advanced Inorganic Chemistry, 3rd Edition,Wiley Eastern Ltd., 1982
- Atkins, P.W & Paula, J.D. Physical Chemistry, 10th Ed., Oxford University Press(2014).
- Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
- Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Rogers, D. W. Concise Physical Chemistry Wiley (2010).
- Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).
- Silbey, R. J.; Alberty, R. A. &Bawendi, M. G. Physical Chemistry 4th Ed., JohnWiley & Sons, Inc.

Title	**COMPUTER PROGRAMMING FOR PROBLEM SOLVING**			**Credits**	2
Code	ESC 101	**Semester: -**1st		**L T P**	2 -
Max. Marks	**End term-** 50	**Mid Term-** 50		**Elective**	N
Pre requisites					
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.				
Course Objectives	1. To develop logical skills so that students should be able to solve basic computing problems. 2. To learn the syntax and usage of C++ programming constructs.				
Course Outcomes	CO1: The student will demonstrate proficiency in C++ programming language. CO2: The student will be able to solve basic engineering computation problems using C++				
SECTION- A					**Hrs.**
Introduction to Programming: Basic introduction to computers, block diagram of computer. Evolution of languages: Machine languages, Assembly languages, High-level languages. Software requirements					04

for programming: System softwares like operating system, compiler, linker, and loader. Application programs like editor. Overview of Algorithm and Flowcharts.	
Programming In C++ : Data types in C++, Formatted input-output for printing integer, floating point numbers, characters and strings.	04
Operators And Expression: Expressions in C++ and their evaluation. Precedence and associativity rules. Operators: Arithmetic operators, relational operators, logical operators, miscellaneous operators.	04
Statements: Decision making structures: if, if-else, nested if and if-else, switch-Case. Loop control structures: for, while, do-while. Role of statements like break, continue, go to.	03
SECTION- B	
Arrays: Concept and use of arrays, declaration and usage of 1-dimensional arrays and 2-dimensional arrays.	04
Functions: Advantage of modularizing C++ program into functions, function definition and function invocation. Methods of passing parameters to a function: call-by-value, call-by-reference; Passing arrays to functions, Recursion, Library functions.	04
Introduction To User-Defined Data Types: Structures- definition, declaration, use. Unions: definition, declaration, use, introduction to classes and Properties of object oriented programming.	04
Introduction to Numerical Methods and Spreadsheet Calculations: Developing programs to solve engineering computation problems and working with spreadsheets.	03

Text books:	1. Arora, Sumita"Computer Science with C++" Dhanpat Rai & Co. 2. Balaguruswamy, "Object Oriented Programming in C++", Tata McGraw Hill.
Reference Books:	1. Kamthane, "Object Oriented Programming in ANSI and Turbo C++" Pearson Education India 2. Lafore ,Robert "Object Orients Programming in C++"
Course Assessment Methods	Assessment will consist of the following components 1.Mid-Term a. One best of two minor tests (50% of Mid -term marks) b. Assignments (20% of Mid-term marks) c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks) d. Attendance. (10% of Mid-term marks) 2.End –Term

Title	**ENGINEERING GRAPHICS**		**Credits**	2
Code	ESC 102	**Semester:-**1st	**L T P**	2 - -
Max. Marks	**End term- 50**	**Mid Term- 50**	**Elective**	N
Pre requisites				
	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.			
THEORY				
Note for the Examiner				
Objectives	Objectives of the Engineering Drawing course is 1. To introduce the students to visual science in the form of technical graphics. 2. To give general instructions related to theory of orthographic projection of points, lines, planes and solids as per the BIS codes prevalent to drawing practices. 3. To upgrade the basic understanding and visualization of geometric objects or			

	machine parts by introducing the students to section of solids, intersection and development of surfaces, isometric projection and orthographic projection of simple solids. 4. To introduce the students to Computer graphics to enhance understanding of the subject.

SECTION-A

Introduction: Significance and scope of Engineering drawing, Drawing instruments, drawing sheet layout and its folding method, types of lines, reduced scale, enlarged scale, sense of proportionate, freehand sketching, basic introduction to CAD software. (4 Hours)

Lettering and dimensioning: Single stroke Letters, Double stroke Letters, procedure of Lettering, principles of dimensioning, types of dimensioning, unidirectional dimensioning, aligned dimensioning, chain dimensioning, parallel dimensioning, combined dimensioning. (4 Hours)

Projections of Points, lines and planes: Types of projections, orthographic projection, methods of obtaining different views, four quadrants, rotation of horizontal plane, 1st angle projection, 3rd angle projections, Projection of points, lines and planes on principal and Auxiliary planes in different quadrants, Inclination, trace and true length of lines, Introduction to planes, their traces and true shapes. (7Hours)

SECTION-B

Projection of solids: Types of solids, polyhedral solids, solids of surfaces of revolution prisms, pyramids, cone, cylinder, frustum and truncated solids, Projection of solids, Sectioning of solids, section plane, full section view , half section view. (7 Hours)

Isometric Projection:Principle of isometric projection, isometric scale, isometric view and isometric projection, isometric projections of planes and solids in different positions. (4 Hours)

Development of Surfaces: Importance of development of surface of objects, parallel line method and radial line method, development of surfaces of simple and truncatedprism, cylinder, pyramid and cone. Introduction to assembly drawing using freehand sketching4 Hours)

***Books Recommended*:**

Recommended Books:	1. P.S. Gill: Engineering Drawing 2. R.K. Dhawan : A textbook of engineering Drawing, S. Chand & Co. Ltd. New Delhi 2nd edition. 3. P.S.Gill: Machine Drawing 4. Sham Tickoo : Understanding AutoCAD 2006, Wiley Publication 5. James D. Bethune : AutoCAD, Pearson Publishers
Course Assessment Methods	The students will be assessed based upon the practical assignments and viva voce.
Course Outcomes	Student will be able to CO1 understand the basics of engineering drawing. CO2 visualize the different types of geometrical objects and the assembly of machine parts.

Title	**ENGINEERING GRAPHICS (PRACTICAL)**		**Credits**	1.5
Code	ESC151	**Semester:-**1st	**L T P**	- - 3
Max. Marks	**Practical-** 50		**Elective**	N
Pre requisites				

PRACTICAL

Objectives	1. To give general instructions related to Theory of Orthographic Projection of points, lines, planes and solids as per the BIS codes prevalent to drawing practices. 2. To upgrade the basic understanding and visualization of geometric objects and

	machine parts by introducing the students to section of solids, intersection and development of surfaces, isometric projection and orthographic projection of simple solids/blocks. 3. To introduce the students to Computer graphics to enhance understanding of the subject.

LIST OF PRACTICALS

1. To write single and double stroke upper-case and lowercase letters. (4 Hours)
2. To dimension the objects using different types of dimensioning. (3 Hours)
3. To draw the projections of points. (4 Hours)
4. To draw the projections of lines. (4 Hours)
5. To draw the projections of planes. (4 Hours)
6. To draw the projections of solids. (4 Hours)
7. To draw the projections of frustums and truncated solids. (3 Hours)
8. To draw the sectioning of solids. (4 Hours)
9. To draw the isometric projection of objects. (4 Hours)
10. To develop the surfaces of objects like cylinders, pyramids, cone etc. (4 Hours)
11. To develop the surfaces of truncated objects. (3 Hours)
12. To draw the assembly drawing of machine parts using free hand sketching. (4 hours)

Recommended Books:	1. P.S. Gill: Engineering Drawing 2. R.K. Dhawan : A textbook of engineering Drawing, S. Chand & Co. Ltd. New Delhi 2nd edition. 3. P.S.Gill: Machine Drawing 4. Sham Tickoo : Understanding AutoCAD 2006, Wiley Publication 5. James D. Bethune : AutoCAD, Pearson Publishers
Course Assessment Methods	The students will be assessed based upon the practical assignments and viva voce.
Course Outcomes	CO1: Understand the use of different drawing tools, types of lines, dimensioning rotation of planes and types of projections. CO2: Projection of points, lines and planes. Visualization of solid objects through projection of solids and assembly drawing. CO3: Understand the importance of development of surfaces, isometric projection and computer graphics.

Title	**ENGINEERING WORKSHOP (PRACTICAL)**		**Credits**	1
Code	ESC 152	**Semester:- 1st**	**L T P**	- - 2
Max. marks	**Practical –** 50		**Elective**	N
Pre-requisites				

PRACTICAL

Objectives	1. To make the students understand the need and importance of different manufacturing techniques. 2. To introduce the different tools and equipments used in mechanical workshops and develop the skill to use the same.

Carpentry Shop: Description and use of carpenter's tools, Wood and timber, defects found in wood, seasoning of wood. Different types of timber in common use, making of lap joint, Bridle joint, dovetail joint and Mitre joint.

Electric Tools: Exercise of wiring in link clip and casting and causing wiring of lights with switches in parallels, series and with 2 ways switches, Connecting energy meter, main switch and distribution board, testing a wiring installation for insulation resistance, Relevant Indian Electricity Rules.

Machine Shop:Classification of fabrication processes, machine tools and materials, introduction to working of lathe, shapper, milling and drilling machines, power hacksaw, shearing machine and grinding wheel. Simple turning, threading, drilling board and knurling operations on a lathe.

***Welding*:**Introduction to electric arc welding, gas welding and their use in making different types of joints e.g. lap joint, butt joint and T joint.

Reccomended Books	1. Raghuwanshi, B.S. : A course in Workshop technology, Vol 1 & II, Dhanpat Rai & Sons , New Delhi. 2. Swarn Singh: Workshop Technology.
Course	CO1: Identify basic prototypes in the carpentry trade such as Lap joint, Lap Tee joint,

Outcomes	Dove tail join, Bridle joint, and Mitre joint. CO2: Recognize and differentiate between the use of arc welding and gas welding in making different types of welding joints such as Lap joint, Lap Tee joint, Edge joint, Butt joint and Corner joint. CO3: Describe the various fabrication processes in Machine shop, use of machine tools and materials, introduction to working of lathe, shapper, milling and drilling machines, power hacksaw, shearing machine and grinding wheel. CO4: Recognize the wiring techniques in link clip and casting and causing wiring of lights with switches in parallels, series and with 2 ways switches, Connecting energy meter, main switch and distribution board, testing a wiring installation for insulation resistance.

Title	**PHYSICS LAB.**		**Credits**	1.5
Code	BS 151	**Semester:- 1st**	**L T P**	- - 3
Max. marks	**Practical –** 50		**Elective**	N
Pre-requisites				

Objectives

Physics lab provides students the firsthand experience of verifying various theoretical concepts learnt in theory courses.

1. In a semester at least 10 experiments to illustrate the concepts learnt in Physics

1. To find the energy band gap of the given semiconductor by four probe method.	
2. To study the Hall Effect of a given semiconductor	
3. To determine the dielectric constant of the given materials.	
4. To study the B-H curve of the ferromagnetic materials.	
5. To determine the value of e/m for electron by long solenoid (helical) method.	
6. To study the variation of magnetic field with distance along the axis of a circular coil carrying current by plotting a graph 7. To determine the velocity of ultrasonics waves in a given liquid. 8. To determine the frequency of A.C. mains using a sonometer and an electro-magnet. 9. To find the capacitance of a capacitor using flashing and quenching of a neon lamp. 10. To plot graph between current and frequency in a series LCR circuit and to find the resonant frequency. 11. To find the wavelength of sodium light using Fresnel's biprism.(3) 12. (i) To determine the wavelength of He-Ne laser using transmission grating. (ii) To determine the slit width using the diffraction pattern. 13. To determine the wave length of sodium light by Newton's rings method. 14. To determine the wave length of sodium light using a diffraction grating. 15. To find the specific rotation of sugar solution using a Bi-quartz Polarimeter. 16. To design a hollow prism and used it find the refractive index of a given liquid	
17. To synthesize the nanoparticles by chemical methods and structural characterization through X-ray diffraction.	
18. To investigate the optical band gap of nanomaterial using UV-vis spectroscopy.	
19. Fabrication of thin films by spray pyrolysis technique.	
20. Fabrication of thin films using spin coater technique.	
Text Books	1. Practical Physics by CL Arora, S Chand & Co. 2. Engineering physics by S.K. Srivastva
Reference Books	A text book of practical physics by William & Watson
Course Assessment Methods	One *project out of 6 carries 40% marks, 20% for respective viva and 20% for external exams and 10% for attendance.
Laboratory /Course outcomes	CO1: Proficiency in technical aspects of performing the experiments. CO2: State various laws which they have studied through experiments. CO3: Experimental data observations and analysis. CO4 Proficiency in designing scientific projects and reporting

Title	CHEMISTRY - I LAB.		Credits	1.5
Code	BS 152	Semester:- 1st	L T P	- - 3
Max. marks	Practical – 50		Elective	N
Pre-requisites				

Objectives

The students shall

- Understand physical properties of various solvents
- Learn to perform conductometric and potentiometric titrations
- Understand the calorimetric methods for determination of concentration
- Understand the concept of volumetric analysis of different types

1. Surface tension of liquids using Stalagmometer and calculation of Parachor values.
2. Viscosity of liquids and composition of a binary solution
3. Conductometric titrations of HCl vs NaOH
4. Potentiometric titration of HCl/CH_3COOH vs NaOH
5. Colorimetry Verification of Lambert-Beer Law and determination of concentration of solution of KMnO4/K2Cr2O

Volumetric Analysis

6. Redox Titrations :-Titrations involving K2Cr2O7 (Estimation of Fe+2/Fe+3)
7. Iodine [Iodometry&Iodimetry] -(Standardisation with SodiumThiosulphate, Estimation of Cu+2, and Sb+3)

8. Complexometric Titrations- Determination of Zn+2 by EDTA titration.
9. Gravimetric Analysis- Estimation of Ba+2/SO4 -2 as BaSO4

. **Outcome of course**

- The students will get a hands on experience in making solution of different concentrations
- The students will learn to use volumetric analysis as an easy, quick and accurate tool for estimation of concentration of different kind of ions.
- Will be able to understand and find out various physical constants of solvents
- will be able to understand practically utility of conductometric and potentiometric titrations
- will be able to understand the practical application of colorimetry.

Reference Books

- Lavitt, B.P. : Findlay's Practical Physical Chemistry, Longman Group Ltd
- Svehla G: Vogel's Qualitative Inorganic Analysis, 7th Ed. By, Pearson Education

Title	COMPUTER LAB.		Credits	1
Code	ESC 153	Semester:-2nd	L T P	- - 2
Max. Marks	Practical- 50		Elective	N
Pre requisites				
Course Assessment Methods	The students will be assessed based upon the practical assignments and viva voce			
Objectives	1. To develop programs using C++ To make the students design programs by using logic and become confident in handling numerical problems.			
Course Outcomes	CO1: The students will be able to demonstrate proficiency in C++ CO2: The student will become confident in solving any computation problem using his programming skills.			

S.No.	Topic	No. of Hours
1	Programs based on input & output in C++	2
2	Programs using Decision Statements if-else, CASE	4

3	Programs using while statements, do- while and for Loops	8
4	Array based programs	4
5	Developing user defined Functions with and without recursion	4
6	How to create and access user defined data types	4
7	Implementation of engineering computation programs using MATLAB and EXCEL spreadsheet.	4

Title	**Introduction to Environmental Science**			**Credits**	NC
Code	MC 101	**Semester:- 1st**		**L T P**	3 0 0
Max. marks	**End term- 50**	**Mid term- 50**	**Practical --**	**Elective**	N
Pre-requisites					

THEORY		**Time**	3 hours
Objectives			
Note for examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		

SECTION A	**Hrs**
Introduction Man and environment, environmental pollution, Ecosystem-structure and function of ecosystem, types of ecosystem, Introduction to biodiversity, International concern over environmental problems	8
Air pollution Sources of air pollution, types of air pollutants, air quality, effects of air pollution, greenhouse effect, ozone layer depletion, smog and photochemical smog, acid rain-theory and effects.	8
Water pollution Different types of water pollutants, effects of water pollution, pollution of receiving bodies, analysis of water pollution.	5
SECTION B	**Hrs**
Soil pollution Components of soil, soil pollution, detrimental effects of pesticides and metal ions	4
Noise pollution Classification ofnoise pollution, effectsof noise pollution and control measures	2
Nuclear hazards, radiation pollution, solid waste- Introduction and case studies	3
Social issues and the environment, concept of sustainable development, rain water harvesting, watershed management, wasteland reclamation	6
Population and economic growth	2
Environmental ethics, laws relating to environment	4

Text Books	1. J.G. Henry and G.W. Heinke ,"Environmental Science and Engineering", 2nd edition, , PHI Publisher, 2011. 2. A. Bhaskar ,"Environmental Studies" , Pearson Publisher, 2011. 3. C.N. Sawyer, P.L. McCarty, G.F. Parkin, "Chemistry for EnvironmentalEngineering" Tata McGraw Hill, New Delhi, 2000.
Reference Books	1. Edition Richard T. Wright and Bernard J. Nebel "Environmental Science:Toward a Sustainable Future", Eighth edition, Prentice Hall. 2. Samir K Banerji, "Environmental Chemistry" 2nd Edition, PHI Publisher, 2005 3. A K De,"Environmental Chemistry", 6th edition, New Age International, New Delhi, 2006.
Course Assessment Methods	Assessment will consist of the following components 1.Mid-Term a. One best of two minor tests (50% of Mid -term marks) b. Assignments (20% of Mid-term marks) c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks)

	d. Attendance. (10% of Mid-term marks) 2.End –Term
Course Outcomes	The students are able to: 1. To identify environmental problems relating to the living organisms. 2. To analyse various risks associated with environmental problems and their remedial measures 3. To develop a sense of community responsibility by becoming aware of scientific issues in larger social context.

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)

2nd SEMESTER

Title	MATHEMATICS-II		Credits	4
Code	BS104	Semester:- 2nd	L T P	3 1 -
Max marks	End term- 50	Mid term- 50	Elective	N
Pre-requisites	MATHEMATICS-I			
Objectives	The students shall • Learn to expand various functions in terms of Fourier series. • Learn the methods to formulate and solve partial differential equations. • Be taught to apply the method of separation of variables to solve partial differential equations of engineering interest. • Learn to find Laplace transforms and inverse transforms and apply these to solve differential equations. • Understand the concept of Complex functions and their applications to various problems.			
Note for examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.			

SECTION A

Fourier Series
Euler's Formulae, Dirchielet's Conditions for Expansion, Change of interval, Odd and Even Functions, Expansion of Odd and Even Periodic Functions, Introduction to Harmonic Analysis.

Partial Differential Equations (Pde's)
Formation and classification of partial differential equations, first order linear equations, standard forms of non linear equations, Charpit's method, homogeneous linear equations with constant coefficients.

Engineering Applications OfPde's
Method of separation of variables , Solution of partial differential equations of engineering interest by the method of separation of variables.

SECTION B

Laplace Transforms
Definition, Transforms of Elementary functions, Properties of Transforms, Inverse Transforms, Transforms of Derivatives, Unit Step Function, Dirac's Delta Function & Unit Impulse function. Periodic Functions, Application of Transform to the solution of ordinary Differential equations

Calculus Of Complex Functions
Functions of complex variables, analytic functions, Cauchy-Riemann equations, Cauchy's theorem, Cauchy's integral formula, introduction to Tayler's series and Laurent's series, Residues, Residue theorem and its simple applications.

Text Books	1. G. B. Thomas, R. L. Finney: Calculus and Analytic Geometry, Ninth Edition, Pearson Education. 2. E. Kreyszig: Advanced Engineering Mathematics, Eighth Edition, John Wiley.
Reference Books	1. B. V. Ramana: Higher Engineering Mathematics, Tata McGraw Hill. 2. B. S. Grewal: Higher Engineering Mathematics, 41st Edition, Khanna Publishers, Delhi. 3. Differential Equations, Frank Ayers, TMH
Course Outcomes	CO1: Expand functions in terms of Fourier series and introduction of harmonic analysis. CO2: Formulate and solve various partial differential equations. Solve partial differential equations of engineering interest by the method of separation of variables. CO3: Find Laplace transforms, inverse transforms and apply these to solve various differential equations. CO4: Evaluate complex integrals and apply these to various problems.

Title	CHEMISTRY II		Credits	3
Code	BS105	Semester:- 2nd	L T P	3 - -

Max marks	**End term- 50**	**Mid Term- 50**		**Elective**	N
Pre-requisites					
Note for the Examiner	The examiner will set seven questions of equal marks. The first question , which is compulsory, will cover the entire syllabus having ten conceptual questions of one mark each or five questions two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part. The duration of End Term exam will be 3hrs.				
Course Objectives	1.Learn and understand the concept of structural conformations and stereochemistry of organic compounds . 2. To introduce the basic knowledge regarding acidity, basicity and nucleophilicity of organic compounds . 3. To explain the formation of different reaction intermediates like free radical, carbonium and carbanion ions in order to be able to understand the mechanism of various substitution reactions. 4.To create an awareness about the effects of different attached groups on the reactivity and rate of reactions in organic synthesis. 5. To explain the formation of organometallic compounds and the bonding in these compounds along with their utility as catalytic agents. 6. To create an awareness regarding the toxic effects of heavy metals.				
Course Outcomes:	On completion of this course, students will be able to: CO1.Understand and explain the molecular conformations in organic compounds as well as be able to understand the acidity and basicity of organic compounds. C02.Understand the concept of stereochemistry CO3.Learn and identify organic reaction intermediates and explain the mechanism including free radical substitution, electrophilic addition , electrophilic aromatic substitutionand nucleophilic substitution **.** CO4 Will be able to identify important organic reactions and their applications for syntheses C05 Understand the bonding and formation of organometalic compounds and the importance of these reagents as catalysts in industry Co6 Will be able to understand the sources of pollution by heavy metals and the toxicity of heavy metals.				

SECTION A

Fundamentals of Organic Chemistry: Shapes and Molecular orbital structures of compounds containing C, N and O. Conformations of cyclic and acyclic systems, structures of dienes, pyridine, pyrrole, aromatic compounds. Factors affecting acidity,basicity and nucleophilicity of molecules (Kinetic as well as thermodynamic aspects)
5 hrs

Organic reactions and their intermediates- free radical, carbonium and carbanions , inductive and mesomeric effects, carbonium and carbanions ,directive effects, activating and deactivating groups, stability of cycloalkanes
7 hrs

Electrophilic and Nucleophilic substitution reactions; Aromatic electrophillic substitution reactions, Nitration ,Sulphonation, Halogenations, Friedel-Crafts reaction,Anisol substitution reactions,nucleophilic substitution reactions ,Aldol condensation 4 hrs

Stereochemistry : Enantiomers, Diastereomers, Meso-and Racemic compounds, Resolution of racemic mixture. Asymmetric synthesis, Walden Inversion, Configuration (D and L nomenclature), Absolute con figuration (R , S, E andZnomenclature) 06hrs

SECTION B

Important Organic Reactions andMechanism : House synthesis, halogenation of alkanes, free radical mechanism, orientation, reactivity and selectivity;catalytic hydrogenation, dehydration of alcohols, dehydrohalogenation, Saytzeff rule, electrophillic addition reactions, peroxide effect, mechanism of allylic substitution, acidity of 1-alkynes, conjugated dienes, 1,2-and 1,4- additions, free radical and ionic mechanisms of addition polymerisation reactions, 12 hrs

Organometallic compounds and their use in industrially important reactions:Organometallic Compounds: Nomenclature, types of ligands and bonding in organometallic compounds, Synthetic utility of Grignard reagent and the catalytic properties of the organometallic compounds in homogeneous catalysis for important industrial processes like hydrogenation, polymerisation and hydroformylation .

07hrs

Metal Toxicology : Toxic effects of heavy metals with special reference to Cd, Pb, Hg and As. 04hrs

Books Recommended:

1.Bahl, B. S. &Bahl, Arun : Text-book of Organic Chemistry, 16th Edition, S. Chand and Company Ltd., NewDelhi.
2. Solomons, T. W. G. : Fundamentals of Organic Chemistry, John Wiley and Sons, Inc., New York, 1994.
3. Morrison &Boyd : Organic Chemistry, Pearson education, 6th edition,2007.
4 .F.A.Carey: Organic Chemistry, Tata McGraw Hill, 7th edition,2008.
5. Mukherji& Singh: Reaction mechanism in organic chemistry, Macmillan IndiaLtd.,
6. Amdur, doull&Klaasen (Eds):Casarette and Doulls Toxicology, Pergamon Press, New York 1991.
7. William &Burson(Eds.):Industrial Toxicology:Safety and Health applications in the work place, Van Nostrand-Reinhold,New York,1985.
8.Inorganic Chemistry:Principles of Structure And Reactivity, 4e By James E. Huheey, Ellen A. Keiter, Richard L. Keiter

Title	**ELECTRICAL AND ELECTRONICS ENGINEERING**			**Credits**	4
Code	ESC 103	**Semester:- 2nd**		**L T P**	3 1 -
Max. marks	**End term- 50**	**Mid Term- 50**		**Elective**	N
Pre-requisites					
Note for examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.				
Objectives	1. To provide the various Basic concepts, laws and various circuit analyzing methods applied in solving Electrical Circuits. 2. To provide students about basic knowledge of A.C and D.C circuits, theorems, laws. 3. Introduce to the students about difference between single phase and three phase system. 4. To teach the students basic principle of operation of transformers and other electrical machines. 5. To make them aware of the difference between analog and digital system and study diodes, rectifiers, digital circuits.				
Course Outcomes	CO1: The student will understand how various loads are connected in circuits and difference between single and three phase system. CO2: The students will know the principles and working of different types of electrical machines used in industry CO3: The students will have the basic knowledge of digitalization and conversion of physical quantity to digital quantity.				

SECTION A

DC Circuits and Single Phase A.C. Fundamentals

General introduction to Electrical Engineering, Kirchhoff's Laws, Mesh and Node analysis, Superposition theorem, Thevenin Theorem, Norton Theorem, Maximum power transfer theorem. Generation of alternating voltages and currents, Equations for AC quantities, cycle, time period, frequency, amplitude, calculation of R.M.S values, Average values for

different waveforms, solution and phasor diagram of single-phase AC circuit with sinusoidal source of excitation, series and parallel combination of R-L-C circuits. (14)
Three Phase AC Fundamentals Disadvantages of single-phase system, star and delta connection in three phase circuits, relation between line and phasor quantities, power in three phase system, solution of three phase balanced circuits, power and power factor measurement by two wattmeter method. (8)
Electrical Machines **B**asic principle and construction of transformers, E.M.F equation, approximate equivalent circuit, phasor diagram, losses, efficiency and condition for maximum efficiency, open circuit and short circuit test on single phase transformers. Operating principle and construction of three phase induction motors, Operating principle and construction of DC Machines, types of DC Machine & E.M.F equations. (12)
SECTION B
Semiconductor Diodes and Transistors General introduction to Electronics. Concept of stiff Voltage and Current Source. PN Junction, Depletion layer, Barrier Potential, Forward and Reverse Bias, Breakdown voltage, V-I characteristics, Half wave and full wave rectifiers, Zener diode. Introduction to junction transistors, Transistor amplifying action, CB, CE, CC-configuration characteristics. (14)
Digital Electronics Binary and Hexadecimal number system, conversion of numbers from one system to other, Boolean Algebra and Laws: Commutative, Associative and Distributive Laws. Concept of flip-flops, K-maps, RS, JK flip flops, shift register. (12)

Text Books	1. Edward Hughes: Electrical and Electronic Technology, Pearson Education Publication, Asia, 2003. 2. Nagsarkar, T.K. and Sukhija M.S.: Basic Electrical Engg., Oxford University Press, 2004. 3. Bhargava: Basic electronics and Linear circuits, Tata McGraw Hill.
Reference Books	1. Nagrath, I.J. and Kothari, D.P.: Basic Electrical Engg., TMH, New Delhi. 2. Malvino: Digital Principles and Applications, Tata McGraw Hill
Course Assessment Methods	Assessment will consist of the following components 1.Mid-Term a. One best of two minor tests (50% of Mid -term marks) b. Assignments (20% of Mid-term marks) c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks) d. Attendance. (10% of Mid-term marks) 2.End –Term

Title	**Introduction to Engineering & Technology**			**Credits**	03
Code	PCC 101	**2nd**		**L T P**	2 1 -
Max. Marks	**End term-** 50	**Mid term-** 50	**Practical --**	**Elective**	N
Pre requisites					

THEORY	**Time**	3 Hours
Objectives	1. To provide a comprehensive overview of the engineering profession and practice. 2. To develop systematic problem solving skills and enhance confidence in the students through varied numerical problems. 3. To prepare the students to formulate and solve material balances on chemical process systems.	
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.	
SECTION- A		**Hrs**
Definition of Engineering: Brief history of engineering. Various engineeringfields of specialisation: Chemical engineering, environmental engineering, Bio engineering, petrochemical engineering, food engineering, mechanical engineering, electrical engineering, civil engineering, computer engineering. Functions of engineering. Career opportunities for engineers. Issues of professional responsibility and ethics for an engineer.		02

Systematic analysis of chemical processes: Unit operations and unit processes, material and energy balances, thermodynamics, chemical reaction engineering, process instrumentation, process control and economics.	02
Introduction to Engineering Calculations: Units and dimensions, conversion of units, systems of units, conventions in methods of analysis and measurement, numerical calculation and estimation, dimensional homogeneity and dimensionless quantities, process data representation and analysis, Conversions involving process variables like pressure, temperature, density/specific gravity, mass, volume, flow rate and chemical composition. Chemical equation and stoichiometry.	12
SECTION- B	
P-V-T relations for gas and gas mixtures, calculations using ideal gas law, Use of compressibility charts and equations of state (Van der Waals') to predict real gas properties from experimental data.	06
Liquid and liquid mixtures: Vapour pressures (cox chart, Duhrings lines, Clausius Clapeyron equation), saturation, vapour-liquid equilibrium calculations using Raoult's law and Henry's law, partial saturation and humidity, material balances involving condensation and vaporization.	10
Introduction to material balances without chemical reactions, material balance on multiple–unit processes, Recycle, Bypass and Purge calculations.	10

Text books:	1. Wright, P.H.; "Introduction to Engineering", 3rd Edition, John Wiley & Sons (2002). 2. Felder, R. M. and Rousseau, R.W.; "Elementary Principles of Chemical Processes", 2nd Edition, John Wiley & Sons (2009). **3.** Himmelbleau, D. M.; "Basic Principles and Calculations of Chemical Engg." 7th Edition, Prentice Hall (2007).
Reference Books:	1. Littlejohn, C. E. and Meenagham, C. M.; "Introduction to Chemical Engineering", 1st Edition, McGraw Hill 2. Anderson, L. B., "Introduction to Chemical Engineering", 1st Edition, McGraw Hill. 3. Shaheen, E. I.; "Basic Practices of Chemical Engineering", Houghton Miftlin Company, Boston(1975)
Course Assessment Methods	Assessment will consist of the following components 1.Mid-Term a. One best of two minor tests (50% of Mid -term marks) b. Assignments (20% of Mid-term marks) c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks) d. Attendance. (10% of Mid-term marks) 2.End –Term
Course Outcomes	**CO1: The student will recognise his/her role as an engineer in the society and the associated responsibility lying ahead. The budding engineers will have a better understanding of professional ethics and importance of team work in achieving the professional goals.** **CO2 The course will enable the students to analyze the local and global impact of engineering solutions and applications on individuals, organizations and hence its impact on society.** **CO3 It will enable the students to identify, formulate and solve chemical engineering problems using law of conservation of mass and engineering sciences.** **CO 4 Students will be capable of representing and analysing the experimental process data that would be helpful in solving engineering problems.**

Title	**COMMUNICATION SKILLS**			**Credits**	2
Code	HSMC 101	**Semester: - 2nd**		**L T P**	2 - -
Max. Marks	**End term- 50**	**Mid Term- 50**		**Elective**	N
Pre-requisites					
Course	Assessment will consist of the following components				

Assessment Methods	1.Mid-Term a. One best of two minor tests (50% of Mid -term marks) b. Assignments (20% of Mid-term marks) c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks) d. Attendance. (10% of Mid-term marks) 2.End –Term
Course Objectives	1. To inculcate effective communication skills in students for better performance in professional as well as personal life. 2. To improve personality of students with advanced techniques in verbal, non-verbal and para verbal communication.
Course Outcomes	CO1: Gain proficiency in English language as medium for communication in both professional and personal life CO2: Increase in employment prospective of students by developing technical aspects of communication. CO3: Personality development of students by thorough knowledge of effective and enhanced communication skills

The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

SECTION A

Topic	No. of Hours
Advanced Communication Skills Scope, Significance, Process of Communication in an Organization, Types and Levels, Communication Networks, Technical Communication, Tools of Effective Communication, Barriers of Communication.	**3**
Speaking Skills Interpersonal Communication, Presentation Skills, Voice Modulation, Persuasion, Negotiation and Linguistic Programming, Public Speaking, Group Discussions, Interviews and Case Studies, Conducting Meetings and Conferences	**5**
Personality Development Body Language and importance of Non Verbal communication, Social and Professional etiquettes.	**6**

SECTION B

Topic	No. of Hours
Communication and Media Social and Political Context of Communication, Recent Developments in Media	**5**
Advanced Techniques in Speaking Skills Importance of Listening/Responding to native and global accents, Telephonic Interviews and Video Conferencing	**5**
Advanced Techniques in Technical Writing Job Application, CV Writing, Business Letters, Memos, Minutes, Reports and Report Writing Strategies, E-mail Etiquette, Blog Writing, Instruction Manuals and Technical Proposals	**6**

Text Books	1. Ashraf, M. Rizvi, "Effective Technical Communication", McGraw Hill 2. Bovee, Courtland L. and John, V. Thill, "Business Communication Today", Pearson Education
Reference Books	1. Sharma, R.C. and Mohan, K., "Business Correspondence and Report Writing", Tata McGraw Hill 2. Raman, Minakshi and Sharma, S., "Technical Communication: Principles and Practice", Oxford University Press 3. Scott, Bill, "Communication for Professional Engineers", Thomas Teleford Ltd. 4. McMurrey, David A. and Joanne, Buckley, "Handbook for

	TechnicalWriting", Cengage Learning 5. Harve, L., Locke, W. and Morey, A., "Enhancing Employability and Recognizing Diversity", Universities UK and CSU 6. Lock, R., "Student Activities for taking charge of your Career Direction and Job Search", Cole Publishing Pease, A., "Body Language", Sheldon Press

Title	**ELECTRICAL AND ELECTRONICS ENGINEERING LAB.**		**Credits**	1.5
Code	ESC 154	**Semester:-**2nd	**L T P**	- - 3
Max. Marks	**Practical- 50**		**Elective**	N
Pre requisites				
Objectives	Students will be able • to design electric circuits. • To use voltmeter, ammeter and wattmeter • Perform open circuit test and short circuit test on a single phase transformer and draw equivalent circuit • To identify diode characteristics and transistor characteristics and perform experiments related to rectifiers (half-wave and full-wave) • To verify various logical gates and networking theorems through experiments.			
Course Outcomes	CO1: Students will have hands on knowledge about the design, purpose and working of R-L-C series and parallel circuits CO2: Students will become confident in taking accurate readings of voltmeter, ammeter and wattmeter CO3: Students will have in depth knowledge about transformers, transistors, diodes and rectifiers and will be able to understand their applications in industry. CO4: Students will have knowledge about networking theorems and their utility in industry.			

1. Overview of the equipments, instruments and procedure to be used, safety precautions and report writing.
2. To study resonance in R-L-C series and parallel circuit.
3. Measurement of power and power factor by three voltmeter method.
4. Measurement of power and power factor by three ammeter method.
5. To measure power and power factor using a single wattmeter in a single-phase circuit.
6. Measurement of power and power factor of three phase balanced load by two wattmeter method.
7. To perform open circuit test and short circuit test on a single-phase transformer and draw equivalent circuit.
8. To obtain magnetization characteristics of DC Machine
9. Study the forward and reverse biased diode characteristics.
10. Study the CB, CE, CC transistor characteristics.
11. To obtain the waveforms of half wave rectifier circuit on CRO.
12. To obtain the waveforms of full wave rectifier circuit on CRO.
13. Verification of basic and universal gates.
14. To verify the Thevenin Theorem, Nortan Theorem, Maximum power transfer theorem

Title	**CHEMISTRY II LAB.**		**Credits**	1.5
Code	BS 153	**Semester:-**2nd	**L T P**	- - 3
Max. Marks	**Practical- 50**		**Elective**	N
Pre requisites				
COURSE Objectives	1.: To familiarise with the laboratory equipments, various chemicals and set up a chemical reaction to ensure lab safety. 2. To Learn and apply basic technique used in the organic laboratory for preparation, purification of organic compounds. 3. To understand the synthesis of Benzamide & Aspirin and carry out the purification and			

	percentage yield of compounds . 4: To Identify important functional groups by the study of their properties and chemical reactions.
Course Outcomes	CO1.Practise analytical skills and recognize various aspects of lab safety. CO2. Learn and apply basic technique used in the organic laboratory for preparation, purification and identification of organic compounds. CO3.Outline the synthesis of Benzamide & Aspirin and carry out the purification and percentage yield of compounds . CO4.Identify important functional groups by a study of their properties and reactions.

1. Synthesis oforganic compounds :Preparation of Benzamide& Aspirin-Purification, determination of melting point and percentageyield. 15 hrs
2. Identification of unknown organic compounds through
3. group detection, physical constants and preparation of derivatives – - 30 hrs
4. (i) Carboxylic acid ,
   (ii) Phenols,
   (iii) Aldehydes,
   (iv)Ketones, ,
   (v)Amides
   (vi)Amines.
   (vii) Hydrocarbons

Text Book:
Pradeep's advance practical chemistry Vol-II by S.C. Kheterpal, P.N.Kapil, S.N. Dhawan, Pradeep Publication
Reference books:
1.Mann,F.G. & Saunders,B.C. Practical Organic Chemistry, Pearson Education(2009)
2. Vogel's Practical organic chemistry by Furniss, B.S.; Hannaford, A.J.; Smith,P.W.G.;Tatchell, A.R. , 5th Ed., Pearson (2012)

Title	**COMMUNICATION SKILLS LAB.**		**Credits**	1
Code	**HSMC 151**	**Semester:- 2nd**	**L T P**	- - 2
Max. Marks	**Practical –** 50		**Elective**	N
Pre-requisites				
Course Objectives	1.To develop better pronunciation and communication skills. 2.To be able to face interviews and participate in conferences or any personal or professionals discussions with confidence. 3.To develop technical writing skills. 4.To be able to articulate ones voice and overcome stage fright.			
Course outcomes	CO1: English Speaking skills of students will be enhanced. CO2: Students will become self confident in handling both professional and personal meetings/discussions. CO3: Students will be able to demonstrate improved technical writing skills. CO4: Overall personality of students as well as their communication skills will be developed.			

S. No.	Topic	No. of Hours
1	**Organizational Communication** Verbal and Non-Verbal Communication at different levels of organization, Role Play, Interaction with Bosses and Co-employees	5
2	**Speaking Techniques**	15

	Preparation of Interviews, Participation in Group Discussions and Case Studies, Making and Presenting Power Point Lectures.	
3	**Advanced Speaking Techniques** Conducting Meetings and Conferences, Exposure to different Accents, Listening and responding in the global scenario, Telephonic Interviews/Conversations, Video Conferencing	5
4	**Technical Writing** Writing Letters, Memos, Minutes, Notes, CV, Job Applications, Reports and e-mails, Preparing Instruction Manuals and Technical Proposals	5

Title	**Ethics and self-awareness**		**Credits**	Non-credit
Code	MC102	**Semester:-**2nd	**L T P**	2 - -
Max. Marks	**End term- 50**	**Mid Term- 50**	**Elective**	N
Pre requisites				

THEORY	**Time**	3 Hours

Objectives	1. To provide basic knowledge about ethics, values, norms and standards and their importance in life. 2. To improve the personality of students by their self-assessment. 3. To imbibe positive thinking in students, thereby enhancing the quality of life of students and henceforth the nation as a whole.
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

SECTION- A	**Hrs**
Introduction to Ethics : Concept of Ethics – Nature, Scope, Sources, Types, Functions and Factors influencing Ethics, Approaches to Ethics – Psychological, Philosophical and Social, Broader Ethical Issues in Society.	06
Values, Norms, Standards and Morality: Concept and Role, Relation with Ethics, Psycho-Social Theories of Moral Development – Kohlberg and Carol Gilligan.	04
Ethics and Business: Concept of Business Ethics – Nature, Objectives and Factors influencing Business Ethics, 3 C's of Business Ethics, Ethics in Business Activities, Ethical Dilemmas in Business, Managing Ethics.	05
SECTION- B	
Self-Awareness: Concept of Self Awareness – Need, Elements, Self Assessment – SWOT Analysis, Self Concepts – Self-Knowledge, Assertiveness and Self-Confidence, Self-Esteem .	04
Self-Development: Concept of Self-Development, Social Intelligence, Emotional Intelligence, Managing Time and Stress, Positive Human Qualities (Self-Efficacy, Empathy, Gratitude, Compassion, Forgiveness and Motivation), Personality Development Models – Johari Window, Transactional Analysis, Myers Briggs Type Indicator, Self-Awareness and Self-Development Exercises.	09

Recommended books:	1. Murthy, C.S.V., "Business Ethics – Text and Cases", Himalaya Publishing House 2. Hartman, Laura P. and Chatterjee, Abha, "Business Ethics", Tata McGraw Hill 3. Rao, A.B., "Business Ethics and Professional Values", Excel Books 4. Velasquez, Manuel G., "Business Ethics – Concepts and Cases", Prentice Hall 5. Corey, G., Schneider, Corey M., and Callanan, P., "Issues and Ethics in the Helping Professions", Brooks/Cole 6. Hall, Calvin S., Lindzey, Dardner and Cambell, John B., "Theories of Personality", Hamilton Printing Company 7. Leary, M.R., "The Curse of Self: Self-awareness, Egotism and the Quality of Human Life", Oxford University Press.
Course Assessment Methods	Assessment will consist of the following components 1.Mid-Term a. One best of two minor tests (50% of Mid -term marks) b. Assignments (20% of Mid-term marks) c. Class Surprise Tests/ Quizzes/Presentations/Term paper (20% of Mid-term marks) d. Attendance. (10% of Mid-term marks) 2.End –Term
Course Outcomes	CO1 The students will become a better human being by being able to distinguish between right and wrong in both personal and professional front. CO2 The students will be able to realize the importance of ethics , moral values, duties and self awareness . CO3 The students will be able to identify their strengths, weaknesses, opportunities & threats and work enthusiastically to transform weaknesses into strengths and threats into opportunities

3rdSEMESTER

Title	**MATERIAL AND ENERGY BALANCE**		**Credits**	04
Code	PCC 102	**Semester:** 3RD	**L T P**	3 1 -
Max.Marks	**End term- 50**	**Mid term- 50**	**Elective**	N
Pre requisites				
Objectives	To study and apply the basics of calculations related to material and energy balance in chemical processes.			
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.			

SECTION-A

Review: Units and dimensions, Stoichiometric and composition relationships, Engineering calculations on process variables like flow rate, temperature and pressure, Ideal gas law calculations, Real gas relationships, Gaseous mixtures, vapor pressure and liquids, Saturation, Partial saturation and humidity.

Material Balances on Non-reactive processes: Fundamental Material balance calculations, Balances on multiple-unit processes, Material balance on Recycle, By-pass and Purge streams.

SECTION-B

Material Balances on Reactive processes: Molecular Species Balance, Atomic Species Balance and extent of reaction method, calculations involving recycle and purge streams, Combustion Calculations.

Energy balance on Non-reactive processes: Elements of Energy Balance Calculations, Calculations involving change in pressure, temperature and phase change operations.

Energy balance on Reactive processes: Heat of reaction, heat of formation and heat of combustion calculations, Energy balance calculations on reactive processes, Fuels and combustion. Humidity charts and their use.

Text books:	1. Himmelblau, D. M.: Basic Principles and Calculations in Chemical Engineering, 6th Edition, Prentice Hall, 1977 2. Felder, R. M. & Rousseau R.W.: Elementary Principles of Chemical Processes, 3rd Edition, John Wiley and Sons, 1986.
Reference Books:	1. Bhatt, V. I. & Vora, S. M.:Stoichiometry, 3rd Edition, Tata McGraw Hill, 1984. 2. Reklaithis, G. V.: Introduction of Material and Energy balances, John Wiley, 1983.
Course Outcomes	CO1: To review of Stoichiometric and composition relationship gas law, conversions etc. CO2: To study the dimensional consistency of the equations and review of basic concepts of fluid flow, vapour pressure and gaseous mixture. CO3: To study and application of material and energy balance of non-reacting and reacting systems for recycle, by pass and purge streams. CO4: To study combustion calculation s and use steam tables and psychometric charts.

Title	**FLUID FLOW**			**Credits**	4
Code	PCC103	**Semester:-**3rd		**L T P**	3 1 -
Max.Marks	**End term- 50**	**Mid term- 50**	**Practical -50**	**Elective**	N
Pre requisites					
THEORY			**Time**		3 Hours
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.				
Course Objective	The course objective is to inculcate fundamental aspects of fluid flow and apply basic principles of fluid static and fluid dynamics to various chemical engineering problems.				
Course Outcomes	CO1 Define types of fluids, describe boundary layer, define turbulence and apply Basic Equations of Fluid Flow.				

	CO2 Describe fluid statics, pressure and Forces on Submerged bodies, Flow of Incompressible Fluids, pipes and fittings, economic pipe diameter. CO3 Employ Dimensional analysis, describe Compressible flow and examine flow through nozzles. CO4 Classify Flow Measurement equipments, Classification and Performance of Pumps, Turbines, Compressors, and Blowers, Selection and Specification, Net positive Suction Head.

SECTION- A

Fluid Statics: Hydrostatic equilibrium, Manometers, Pressure Measurements, Normal forces in fluids, Forces on Submerged bodies, Buoyancy and Stability

Fluid Flow Phenomena: Potential flow, Newtonian and non-Newtonian Fluids, Viscosity, Reynolds number, Nature of Turbulence, Eddy Viscosity, Flow in Boundary Layers: laminar and turbulent flow, transition length, boundary layer separation

Basic Equation of Fluid Flow: Bernoulli's Equation, kinetic energy and momentum correction factors ,pump work in Bernoulli equation, Navier Stokes equation

Flow of Incompressible Fluids: stress distribution in a cylindrical tube, friction factor, Laminar flow in pipes: velocity Distribution in Pipes, maximum velocity, average velocity, frictional Losses in Pipes and Fittings, Hagen-Poiseulli equations, friction factor chart, friction factor in flow through channels of noncircular cross section, sudden contraction and expansion in pipe flows, estimation of economic pipe diameter.

SECTION- B

Dimensional analysis: Rayleigh's and Buckinghum's π theorem, applications of dimensional analysis to Fluid Flow.

Flow of compressible fluids: acoustic velocity, Mach number, sonic, subsonic, supersonic flows, Mach angle, stagnation properties, flow through nozzle, effect of area variation on properties in an isentropic flow, choking in a converging duct, isentropic flow through converging-diverging duct: pressure distribution, working chart for an isentropic flow.

Flow Measurements: Pilot tube, Orifice, Venturi and Rotameter, Notches and weirs, wet gas meter.

Fluid Machinery: Pumps, classification and performance of pumps, selection and specification of pumps, priming, cavitation, net positive suction head, turbines, blowers and Compressors.

***Books Recommended*:**

1. Mc Cabe, W.L., Smith, J.C. and Harriott, P. : Unit Operation of Chemical Engineering, McGraw Hill, Singapore, 5th edition, 1993.
2. Coulson, J.M. and Richardson, J.F. : Chemical Engineering, Vol. I, Pergamon press, 6th edition, 1999.
3. Foust, A.S., Wenzel, L.A., Clump, C.W., Maus, L. and Anderson, L. B. : Principles of Unit Operations, John Wiley.
4. Badger, W.L. and Banchero, J.T. : Introduction to Chemical Engineering, Tata McGraw Hill Pub. Co. Ltd., 1997.
5. Chattopadhya, P. : Unit Operations of Chemical Engineering, Vol. I, Khanna Publishers, Delhi, 1997.

Title	**MECHANICAL OPERATIONS**			**Credits**	4
Code	PCC 104	**Semester:-**3rd		**L T P**	3 1 -
Max. Marks	**End term- 50**	**Mid Term- 50**		**Elective**	N
Pre requisites					

Sr. No	**Course Outcome**
CO1.	Understand and determine various properties of solids, specific surface area, average particle sizes of particles in mixtures, sphericity and laws of crushing. Classification of SR equipments, power consumption of various machines, description and working of Size reduction equipments and their applications
CO2.	Understand various screening techniques and equipments, capacity and effectiveness of screens, standard screens
CO3.	Understand and apply knowledge of Filtration Processes , constant pressure and constant volume filtration and various filtration equipments, their types and applications
CO4.	Understanding and applying concepts of Flow around a single particle, drag force and drag coefficient, settling velocity of particles in a fluid, hindered and free settling of particles, thickening and gravity separation, types of settling devices.

CO5.	analyzing flow through a bed of particles, applications of fluidization & fluidized bed, conditions for fluidization, minimum fluidization velocity, types and applications of fluidization.
CO6.	Understand and applying concepts of Handling, Storage and Transportation of Solids , Agitation of liquids, axial flow impellers, radial flow impellers, design of agitators, velocity and power consumption of agitated vessels, blending & mixing.

THEORY		**Time**	3 Hours
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		

SECTION- A

Size Reduction: Crushers and Grinders: jaw crusher, crushing rolls, Gyratory Crusher Tumbling/revolving mills, hammer Mill and Fluid energy mill. Closed and open circuits grinding. Power requirements. Laws of crushing.

Mechanical Separation: Screening: Stationery screens, Grizzlies, Trommel and Vibrating screens. International Standard Screens & Indian Standard Screens. Screening Analysis-differential and cumulative.

- Motion of particle through a fluid: Stoke's Newton's law. Free and hindered setting.
- Setting tank and double cone classifiers
- Batch and continuous thickeners

Settling chamber, cyclone, filter bag and electrostatic precipitators.

SECTION- B

Filtration: Plate and frame filter press, continuous rotary vacuum filter, filter aids, theory of filtration for non-compressible cakes.
Centrifugation: Tubular bowl centrifuge, disk centrifuge and batch basket centrifuge.
Fluidization: Conditions for fluidization: Aggregate and particulate fluidization. Ergun's and Carman-Kozeny equations.
Mixing and Agitation: Basic ideas and characteristics of mixing equipment power consumptions scale-up.

Conveying: Mechanical and pneumatic conveying systems, storage & handling of materials.

***Books Recommended*:**

1. Mc Cabe, Warren L., Smith, Juluain C. and Harroit, Peter : Unit Operations of Chemical Engineering, 5th Edition, Mc Graw Hill Int. ed (Chemical Engineering Series) Mc Graw Hill Book Company, New York, 1993.
2. Foust, Alan S., Wenseli, Leonard A., Clump, Curtis W., mans, Louis and Anersen, L. Bryce : Principles of Unit Operations, Wiley International Edition, John Wiley & Sons Inc., New York.
3. Coulson, J.M. and Richardson, J.F. : Unit Operations (Volume 2 of Chemical Engineering) New York: Mc Graw – Hill Book Co;, Inc.
4. Gupta, Santosh K. : Momentum Transfer Operations, Tata McGraw-Hill, New Delhi.
5. Badger, Walter L. and Banchero, Julius T. : Introduction to Chemical Engineering, Mc Graw-Hill, Kogakusha Ltd., New Delhi.
6. Brown, C.G. : Unit Operations, John Wiley & Sons, Inc., New York.
7. Chattopadhyay, P. : Unit Operations of Chemical Engineering, Vol. I, Khanna Publishers, New Delhi.

Title	**STRENGTH OF MATERIALS**			**Credits**	4
Code	ESC 104	**Semester:-**3rd		**L T P**	3 1 -
Max. Marks	**End term- 50**	**Mid term- 50**	**Practical- -**	**Elective**	N
Pre requisites					

THEORY		**Time**	3 Hours
Note for the	The examiner will set seven questions of equal marks. The first question ,which is		

Examiner	compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.
Course Objectives	1. To make the students understand the basic concepts and principles of strength of materials. 2. To give ability to calculate stresses and deformations of objects under loading. 3. To make students able to apply the knowledge of strength of materials on engineering applications and design problems.
Course Outcomes	CO1: Identify various types of Stressers and Strains, define Hooke's law, modulus of dlasticity and modulus of rigidity, calculate stresses under impact loads and sudden applied loads under varying conditions. CO2: Apply the theory to solve numerical problems based on Shearing force, bending moment, types of load on beams, types of supports, Concentrated loads and uniformly distributed loads. CO3: Define different types of Struts and Columns, Explain Euler theory and its limitations, describe Rankine-Gordon formula and its applications to numerical problems. CO4: Describe Stresses and Strains in Thin Shells and in springs, Strain Energy and Theories of Elastic Failure and numerical problems.

SECTION-A

***Stresses and Strains*:** *Concept of simple stress and simple strain, t*ypesof load, Tensile stress , compressive stress, shear stress, complementary shear stress, thermal stresses, tensile test , stress strain curve , Hooke's law, modulus of elasticity, modulus of rigidity, Poisson's ratio, Principle of St. Venant strain, factor of safety, principle planes and principle stresses, Mohr's circle of stress, volumetric strain, elastic constants and relations between them. (6 hours)

***Shearing Force and Bending Moments in Beams*:** Shearing force, bending moment, types of beams,types of load on beams, types of supports, sign- conventions for shearing force and bending moment, point of inflection , shearing force and bending moment diagrams for beam under concentrated load and uniformly distributed load, numerical problems. (5 hours)

***Bending Stresses and Shearing Stresses in Beams*:** Pure bending, bending stress, composite beams, reinforced concrete beams, Shear stress distribution in rectangular section and circular section, numerical problems. (5 hours)

***Deflection of Beam*:** Introduction, Macauly's integration method, simply supported beam with load atmid span and beam with eccentric load, moment area method, deflection due to shear, numerical problems. (5 hours)

SECTION-B

***Torsion of Shafts*:** Torsion of thin circular shaft, composite shaft, combined bending and torsion. equivalent torque, equivalent bending moment, numerical problems. (4 hours)

***Struts and Columns*:** Definition of strut and column, Euler's Column theory and assumptions made,Strut with both ends pinned, strut with one end fixed and one end free, strut with both ends free, Slenderness ratio, limitations of Euler theory, Rankine's Empirical formula, numerical problems. (6 hours)

***Stresses and Strains in Thin Shells*:** Thin cylinder under internal pressure, thin spherical shell underinternal pressure, volumetric strain, modifications for built-up shells, numerical problems. (4 hours)

***Stresses and Strains in Springs*:** Types of Springs, stresses in Close coiled helical springs, open coiledhelical springs, leaf springs, springs in parallel and in series, numerical problems. (5 hours)

***Strain Energy and Theories of Elastic Failure*:** Strain energy, resilience, Strain energy in tensionand compression due to suddenly applied load and impact loads, strain energy due to shear, strain energy due to bending, strain energy due to torsion, theories of elastic failure and their graphical representation, numerical problems. (5 hours)

***Books Recommended*:**

1. Ryder, G. H. : Strength of Materials, 3rd Edition S.I. Units Macmillan, 1969.
2. Bedi, D. S. : Strength of Materials, 6th Edition Khana Book Publishing Co. (P)Ltd.
3. Timoshenko, S. : Strength of Materials Part-I, 3rd Edition, Cbs Publishers, 1986.

4.	Singal & Sharma	: Strength of Materials , Modern Publisher.

Title	**ENGINEERING MATERIALS**			**Credits**	4
Code	ESC 105	**Semester:-**3rd		**L T P**	3 1 -
Max. Marks	**End term- 50**	**Mid Term- 50**		**Elective**	N
Pre requisites					
THEORY			**Time**	3 Hours	
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.				
Course Objectives	➢ To understand crystal structures and imperfections in atomic arrangement ➢ interpret binary phase diagram and phase transformations ➢ use of time-temperature-transformation diagrams ➢ To understand properties of materials and application in engineering and corrosion				
Course Outcomes	CO1: Demonstrate an understanding of crystal structure, Space lattice, Miller Indices CO2: Describe and analyse imperfections in atomic arrangement, explain diffusion phenomenon in solids and perform simple diffusion problems CO3: Describe and analyse binary phase diagrams, TTT diagrams, demonstrate an understanding of phase transformations CO4: Classify types of materials, describe properties of materials and application in engineering and corrosion.				

SECTION-A

Crystal Structure : Space lattice, crystal systems, close packed morphology (Hexagonal and cubic close packing), interstitial spaces, Miller indices, linear and planar densities in crystals, single and polycrystalline structures, structure of ceramics (NaCl, Zinc blende, CsCl, silica and silicates, diamond crystal), effect of radius ratio on co-ordination 14 hours

Imperfections in atomic arrangement: various defects in atomic arrangement, diffusion phenomenon in solids, Fick's first and second law of diffusion, solid solution, slip systems, various methods of strengthening materials (grain size reduction, solid-solution strengthening, strain hardening), Schmid's law.
14 hours

SECTION-B

Phase diagrams and phase transformation: binary phase diagrams – Fe-Fe_3C, Cu-Ni, Pb-Sn. microstructure development, TTT diagrams, heat treatment processes-hot and cold working, hardening and softening processes.
12 hours

Materials: Standards and specifications, unified alloy numbering system, ferrous metals and alloys, nonferrous metals and alloys; overview of ceramic, polymeric and composite materials;
4 hours

Mechanical tests: standard test procedures for mechanical property determination-strength, toughness, fracture toughness, hardness, impact, fatigue, creep etc. 8 hours

Corrosion: Types and mechanism of corrosion, factors influencing corrosion, combating corrosion, selection of materials of construction for handling different chemicals.
8 hours

Paper Title: MECHANICAL OPERATIONS Lab.
Paper Code PCC 151 Max. Marks 50 Credits: 1.5

Course objective	The course is focused to have hands-on experience by conducting lab experiments on mechanical operations including screening, grinding, filtration, sedimentation, flow through fixed and fluidized beds etc.
Course outcomes	CO1: Understand the grinding operation and evaluate critical speed of a ball mill. CO2: Analyze particle size distribution and evaluate screen effectiveness. CO3: Understand pressure drop behavior for the flow of Newtonian fluid flowing though fixed and fluidized beds. CO4: Understand the process of filtration and apply the basic equations of filtration. CO5: Understand settling rate and behavior of particles falling in quiescent

	liquid.

List of experiments

1. To verify Ergun's equation for the flow of Newtonian fluid through packed bed.
2. To study the behaviour of pressure drop and bed height in fluidized beds.
3. To determine drag coefficient for the fall of particle in quiescent liquid.
4. To study batch settling of slurries.
5. To study the process of grinding and determining critical speed of a ball mill.
6. To determine screen effectiveness of a sieve shaker.
7. To study the batch filtration using Plate and frame filter press.
8. To study constant pressure filtration.
9. To determine particle size analysis using Andreasen's apparatus.

Title	**PROCESS EQUIPMENT DESIGN**			**Credits**	1.5
Code	ESC 155	**Semester:-**3rd		**L T P**	- - 3
Max. Marks			**Practical- 50**	**Elective**	N
Pre requisites				**Contact Hours**	45
PRACTICAL					
Objectives	To be familiar with the process and mechanical aspects of design of process equipments, various design factors, design procedures, design codes and standards.				
Course outcomes	CO1: Understand general design consideration, codes and specifications for pressure vessels. CO2: Design of thin-walled vessels under internal as well as external pressure. CO3: Design of foundation, supports and various joints.				
LIST OF PRACTICALS					

1. Study of factors influencing the design of vessels; classification of pressure vessels, applications, method of fabrications, fundamental principles and equations.
2. Study of pressure vessel codes specifications and standards; Review of code and its development, ASME codes, API-ASME code, Section VIII of ASME codes
3. General design considerations for pressure vessels; Design pressure, design temperature, materials, design stress (nominal design strength), corrosion allowance, design loads, minimum practical wall thickness.
4. Design of thin-walled vessels under internal pressure; Cylinders and spherical shells, heads and closures, design of flat ends, design of domes ends, conical sections and end closures.
5. Design of vessels subject to external pressure; Cylindrical shells, design of stiffening rings, vessels heads.
6. Design of vessels subject to combined loading: Weight loads, wind loads (tall vessels), torque.
7. Design of welded joints and Bolted flanged joints.
8. Design of Foundation and supports.

***Books Recommended*:**

1. Battacharyya, B.C. : Introduction to Chemical Equipment Design Mechanical aspects, Chemical Engineering Education Development Centre.
2. Brownell and Young : Process Equipment Design , Willey Publication
3. Joshi, M.V. : Process Equipment Design, Macmillan India.

Paper Title: FLUID Flow Lab.

Paper Code PCC 152 **Max. Marks 50** **Credits: 1.5**

Course Objective	The course is focused to have hands-on experience by conducting lab experiments related to fluid flow using various equipment including flow measurement devices; pipe, valve and fittings; pumps etc.
Course Outcomes	CO1: Verify Bernoulli's theorem.

	CO2: Evaluate discharge coefficient for various flow measurement devices and understand their industrial applications. CO3: Identify various types of flow, valves and fittings and evaluate the frictional losses associated with them. CO4: Calibrate a given flow meter. CO5: Understand the characteristics of pumps. CO6: Verify $f=16/Re$ for laminar flow through a straight tube.

List of experiments

1. To determine the coefficient of discharge for Venturi meter.
2. To calibrate a given Rotameter and determining its discharge coefficient.
3. To locate vena contracta in Orifice meter.
4. To study flow through a V-notch.
5. To study frictional losses through pipelines, valves & fittings.
6. To measure point velocity using Pitot tube.
7. To study flow through a straight tube and prove $f=16/Re$.
8. To verify Bernoulli's theorem.
9. To study characteristics of a centrifugal pump.
10. To study characteristics of a reciprocating pump.
11. To study compressible flow through an Orifice meter.
12. To study different types of flow using Reynolds number experiment.

4thSEMESTER

Title	**HEAT TRANSFER**			**Credits**	4
Code	PCC105	**Semester:-**4th		**L T P**	3 1 -
Max. Marks	**End term- 50**	**Mid term- 50**		**Elective**	N
Pre requisites					

objectives	CO1: To understand conduction, convection and radiation modes of heat transfer and to estimate heat transfer rates, CO2: To understand boiling and condensation phenomena CO3: To carryout thermal analysis of heat exchanger using LMTD and effectiveness method, CO4: To estimate steam economy, capacity of single and multiple-effect evaporators. CO5: To apply engineering judgment including an appreciation of cost and safety.
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

SECTION- A

Conduction: Steady state conduction in one dimensional system, general conduction equation, effect of variable thermal conductivity, steady state conduction involving internal heat generation, lagging on pipes, the critical thickness of insulation on pipes, extended surfaces of uniform thickness and fin effectiveness, fin efficiency.
Convection: Free and forced convection, concept of heat transfer co-efficient, dimensionless numbers in free and forced convection, Dimensional analysis, Determination of Heat transfer coefficient using heat and momentum transfer analogies, experimental determination of heat transfer coefficient and common working correlations.
Radiation Heat Transfer: Black Body radiation, and grey body radiation, physical mechanism, radiation properties and shape factor, heat exchange between non-black bodies, radiation shields pyrometry and effect of radiation on temperature measurement.

SECTION- B

Condensation and Boiling: Condensation heat transfer phenomenon, film condensation on vertical plates and cylinders as well as on horizontal cylinders. Effects of non-condensable gases and vapor velocity on condensation, pool boiling, forced convection boiling, working correlations for pool boiling.
Evaporation: Types of Evaporators, single and multiple effects, single and multiple-effect calculations, evaporator capacity, economy, effect of liquid head and boiling point elevation, methods of feeding.
Heat Exchangers: Various types of heat exchangers, overall heat transfer coefficients, heat exchanger mean temperature differences, heat exchanger effectiveness and the number of transfer units.

Text books:	1. Holman, J.P.: Basic Principles and Calculations in Chemical Engineering. 2. Mc Cabe, W.L., Smith, J.C.: Unit Operations of Chemical Engineering McGraw Hill. 3. Kern, D.Q.: Process Heat Transfer, McGraw Hill Book Co. 4. Geankoplis, C.J.: Transport Processes and Unit Operations, Prentice Hall of India Pvt. Ltd., 3rd Edition, 1999.
Reference Books:	1. Mc Adams, W.H:Heat Transmission, McGraw Hill Book Co. 2. Chapmann, A.J.: Heat Transfer, Mc Millan Publishing Co. 3. Kreith, F.: Principles of Heat Transfer, Harper & Row Pub., London.
Course Outcomes	Capability 1. To understand conduction, convection and radiation modes of heat transfer and to estimate heat transfer rates, 2. To understand boiling and condensation phenomena 3. To carryout thermal analysis of heat exchanger using LMTD and effectiveness method, 4. To estimate steam economy, capacity of single and multiple-effect evaporators. 5. To apply engineering judgment including an appreciation of cost and safety.

Title	**CHEMICAL ENGINEERING THERMODYNAMICS**			**Credits**	4
Code	PCC106	**Semester:-**4th		**L T P**	3 1 -
Max. Marks	**End term- 50**	**Mid term- 50**		**Elective**	N
Pre requisites					
THEORY			**Time**		3 Hours
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.				
Course objectives	Chemical Engineering Thermodynamics is a core course which aims to link the concepts and laws of thermodynamics to the applications that require conceptual and quantitative knowledge of thermodynamic properties. It imparts understanding of phase equilibrium for designing of separation equipments. The course aims to use the techniques, skills, and modern engineering tools necessary for engineering practice				
Leaning Outcomes	CO1: Understand the First and Second Laws of Thermodynamics apply it to open and closed systems, steady and unsteady state processes, isothermal and adiabatic processes and solve related engineering problems. CO2: Estimate the thermodynamic properties of pure substances, especially fluids. Knowledge of various PVT equations of state including Principle of corresponding states and heat capacities to evaluate thermodynamic properties of fluids. CO3: Explain the underlying principles of phase equilibrium and evaluate the thermodynamic properties in two-component and multi-component systems CO4: To develop and ability to envisage intermolecular potential and excess property behaviour of multi-component systems CO5: Impart ability to apply the concepts of phase equilibrium to vapour liquid equilibrium (VLE), separation processes and chemical reaction equilibrium				

SECTION- A

Brief review of the terms: state functions, types of systems, internal energy, heat and work and reversible and irreversible processes. 1 hour

Use of Steam tables, First Law of Thermodynamics and its Engineering Applications i.e. constant volume processes, constant pressure processes, isothermal and adiabatic processes, pumps, turbines, compressors, nozzles, heat exchangers, pitot tube, venturimeter and orifice meter. 8 hours

Throttling Processes, Joule-Thomson Coefficient, liquefication of gases 2 hours

Thermochemistry includes a brief review of heat capacities and their measurement, standard heat of reaction, standard heat of formation, standard heat of combustion, flame temperature, H-x diagrams, heat of solution, partial, molar enthalpies, enthalpy for phase change etc. 2 hours

Equation of state for real gases and their mixtures. Principle of corresponding states and generalized compressibility factor. 3 hours

Review of Second law of thermodynamics, entropy concept, Entropy and lost work calculations. Microscopic interpretation of entropy. Third Law of thermodynamics and its applications. 3 hours

Free energy functions and their significance in phase and chemical equilibria, Clapeyron's equation and some important correlations for estimating vapor pressures. Estimation of thermodynamic properties by using graphs and tables. 4 hours

SECTION- B

Phase Equilibria: Partial molar properties, partial molar Gibbs free energy, Chemical potential and its dependence on temperature and pressure Ideal solutions (Lewis-Randel Rule). 6 hours

Fugacity and its calculations. Dependence of fugacity of temperatures and pressure 4 hours

Solution behaviour of real liquids and solids. Activity and activity coefficients. Variation of activity co-efficient with temperature and composition. Activity coefficients of electrolytes standard states. Properties of mixing. Residual and Excess Properties 4 hours

Gibbs-Duhem equation and its application to vapour-liquid equilibria. 2 hours
Chemical Equilibria:
Equilibrium constant in terms of measurable properties variations of equilibrium constant with temperature and pressure. 4 hours
Adiabatic reactions, Gibbs phase rule, equilibria in homogeneous reactions. 2 hours

***Books Recommended*:**

1. Smith, J.M., Van Ness, H.C. and Abbott, M.M. : Introduction to Chemical Engineering Thermodynamics, 7th Edition, McGraw Hill Professional, 2005
2. Elliott, J.R and Lira, C.T. : Introductory Chemical Engineering Thermodynamic, Prentice Hall PTR., 1999.
3. Rao, Y.V.C. : Chemical Engg. Thermodynamics, Orient Blackswan, 1997.
4. Dodge, B.F. : Chemical Engg. Thermodynamics, McGraw Hill, 1944, Original from the University of Michigan, 2007.
5. Narayanan, K.V. : A Textbook of Chemical Engineering Thermodynamics, PHI Learning Pvt. Ltd., 2004.

Title	**CHEMICAL TECHNOLOGY-I (INORGANIC)**			**Credits**	3
Code	PCC 107		**Semester:-**4th	**L T P**	3 - -
Max. Marks	**End term 50**	**Mid term 50**	**Practical-**	**Elective**	N
Pre requisites	**-**				

THEORY

Course Outcomes

CO1: Identify the application of basic chemistry concepts to process industries like Chlor-Alkali Industry, Manufacture of soda ash and caustic soda and Sulphuric Acid.

CO2: Recognize current issues and trends in process industries with a Study of manufacture of Cement and Glass and identify the importance of safety, health, and the environment in process industries.

CO3: Understanding the basic history and manufacture of industrial gases, and Manufacture of different types of paints and Course outcomes outline the guiding principles of quality in the process industries.

CO4: Understanding the manufacture of various fertilizers and processes involved and recognize the safety aspects.

THEORY

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

SECTION-A

Chloralkali industry: Electrochemistry of brine electrolysis, current efficiency, energy efficiency, diaphragm, mercurcy and dow Cells, caustic soda, chlorine.

Soda Ash: Manufacture of soda ash by Solvay and Modified Solvay process,, handling and safety.

Sulphuric Acid: Introduction, Manufacture of sulphuric acid by Chamber and Contact process, Material of construction, Storage and handling.

*Cement :*Types of cement, Constituents of cement, Manufacture of Portland cement.

Glass-Introduction, Types of glass, Raw materials, Manufacture of glass.

SECTION-B

Industrial gases: Manufacture and uses of carbon dioxide, oxygen and nitrogen, acetylene.

Paints: Introduction, Classification of paints, Manufacture of paints, Requirement of a good Paint.
Fertilizers: Nitrogeneous fertilizers- Manufacture of Ammonia, Nitric acid, Urea, CAN, Ammonium Sulphate. Phosphatic fertilizers- superphosphate and triple superphosphate. Potassic fertilizers- Potassium Chloride and Potassium Sulphate, Safety aspects.

***Books Recommended*:**

1. Shreev, R.N. & Brink, J.A. : Chemical Process Industries, 5th Edition, McGraw Hill, 1987.
2. Austine, G.T. : Shreeves Chemicals Process Industries, 5th Edition, Mc Graw Hill, 1984.
3. Dryden, C.E., Rao M.G. & Silting, M. : Outlines of Chemical Technology, 3rd Edition, Affiliated East West Press Pvt. Ltd., N. Delhi, 2008.
4. Pandey, G.N. : Chemical Technology, Volume-I, Lion Press, Kanpur.

Title	**FUEL CELL TECHNOLOGY**			**Credits**	3
Code	ESC 106		**Semester:-**4th	**L T P**	3 - -
Max. Marks	**End term 50**	**Mid term 50**	**Practical-**	**Elective**	N
Pre requisites	**-**				

THEORY

To teach students

1. Fundamental knowledge required in the development of fuel cell technology.
2. Thermodynamics, chemical reaction engineering, transport processes and electrochemical engineering perspectives of fuel cell technology will be covered in the course.
3. Modelling and fuel cell characterization techniques will be covered in the course,
4. Knowledge of Hydrogen energy perspectives and hydrogen generation from renewal sources, storage and safety issues are covered

Course Outcomes

CO1: Knowledge and concept of fuel cell technology and various types.
CO2: Knowledge of thermodynamics, chemical reaction engineering, transport processes and electrochemical engineering perspectives.
CO3: Knowledge of fuel cell modeling and characterization techniques.
CO4: Knowledge of hydrogen energy, its generation and storage with safety issues

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

SECTION- A

Introduction and overview of fuel cells technology: low and high temperature fuel cells: Overview of fuel cells: Low and high temperature fuel cells **(02 hrs)**

Fuel cell thermodynamics: heat, work potentials, prediction of reversible voltage, fuel cell efficiency **(05 hrs)**

Fuel cell reaction kinetics: Introduction to electrode kinetics: electrode kinetics, overvoltages, Tafel equation, charge transfer reaction, exchange currents **(07 hrs)**

Exchange current and electro-catalysis, Simplified activation kinetics, Catalyst-electrode design: Electrocatalyses - design, activation kinetics **(06 hrs)**

SECTION-B

Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte. **(06 hrs)**

Fuel cell characterization: in-situ and ex-situ characterization techniques, i-V curve, frequency response analyses **(05 hrs)**

Fuel cell modeling and system integration: - 1D model - analytical solution and CFD models. (05 hrs)

Hydrogen Energy: Hydrogen production from renewable sources and storage **(04 hrs)**

Safety issues, cost expectation and life cycle analysis of fuel cells. **(02 hrs)**

Suggested books

1. O'Hayre, R.P.,S. Cha, W. Colella, F.B.Prinz, Fuel Cell Fundamentals, Wiley, NY (2006).
2. Basu,S.(Ed) Fuel Cell Science and Technology, Springer, N.Y.(2007).
3. Liu, H., Principles of fuel cells, Taylor & Francis, N.Y. (2006)

Reference books: Bard,A. J. , L. R., Faulkner, Electrochemical Methods, Wiley, N.Y.(2004)

Paper Title : HEAT TRANSFER Lab.

Course Outcomes

CO1: Determination of heat transfer coefficient for different types of heat transfer equipment and Unsteady state heat transfer in jacketed vessels.

CO2: Correlation of instantaneous heat transfer coefficients with time study deposition of scale on a heating surface & heat losses for insulated pipes. Study of double pipe heat exchanger and 1, 2 - shell and tube heat exchanger.

CO3: Study and operation of long tube, forced circulation and multiple effect evaporators, Duhring plot for solutions involving nonvolatile solutes

Paper Code PCC154 Max. Marks 50 Credits : 1.5

1. Determination of heat transfer coefficient for different types of heat transfer equipment. Wilson plots.
2. Unsteady state heat transfer in jacketed vessels. (Open pan evaporator)
3. Correlation of instantaneous heat transfer coefficients with time study deposition of scale on a heating surface.
4. Determination of heat losses for insulated pipes
5. Study of double pipe heat exchanger and to determine overall heat transfer coefficient
6. Study the performance characteristics of a 1,2 - shell and tube heat exchanger
7. Study and **operation** of long tube, forced circulation and multiple effect evaporators.
8. Duhring plot for solutions involving nonvolatile solutes

CHEMICAL TECHNOLOGY-I (INORGANIC) LAB.

PCC 154 Marks: 50 Credit: 1.5

Course Outcomes

CO1: Experimental determination of NPK Values and micronutrients in different fertilizers.

CO2: Estimation of Mg, Ca, Fe in cement and Loss of ignition, silica and insolubles.

CO3: To determine the %age of chlorine in given sample of bleaching powder.

1. Fertilizers: (i) Determination of N-P-K Values
   (ii) Determination of micronutrients
2. Cement: Loss of ignition, silica, insolubles, estimation of Mg, Ca, Fe.
3. Water

Title	COMPREHENSIVE VIVA	Credits	01

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)

Code	CHE 101		**Semester:-**4th	**L T P**	- - -
Max. Marks	**End term 50**	**Mid term- -**	**Practical-**	**Elective**	N
Pre requisites				**Contact Hours**	
The viva-voce examinations will be comprehensive and covering all subjects taught during first to fourth semesters.					

5thSEMESTER

Title	**CHEMICAL REACTION ENGINEERING–I**			**Credits**	4
Code	PCC 108		**Semester:-**5th	**L T P**	3 1 -
Max.Marks	**End term 50**	**Mid term 50**	**Practical : -**	**Elective**	N
Pre requisites	**-**				
THEORY					
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.				
Course Objective	The course aims to understand the basic concepts of chemical kinetics for different types of reactions. Design of the reactors for homogeneous reactions such as batch, plug-flow and mixed-flow reactors. To understand the effect of temperature and pressure on reaction kinetics. The students learn about the real reactor on understanding the reasons of non-ideality in ideal reactors.				
Course Outcomes	CO1: To understand the mechanism of chemical kinetics for different types of reactions. CO2: To design batch and flow reactors for single homogeneous reactions. CO3: To understand the factors affecting the conversion, yield and selectivity in multiple reactions. CO4: To understand the concepts of non-ideal reaction.				

SECTION-A

Introduction and a brief review of the kinetics of homogeneous reactions : Kinetics of homogeneous reactions, single and multiple reactions, order & molecularity, rate constant, elementary and non - elementary reactions, temperature dependent term of rate equation, Arrhenius equation , Activation energy , Collision Theory of reaction rates.

Interpretation of rate data from constant volume and constant pressure systems : Constant volume batch reactor, integral method of analysis of data, series and parallel reactions, irreversible &reversible reactions, Variable volume batch reactor, Differential & integral method of analysis, Temperature and reactions rate.

Introduction to Reactor Design : Ideal batch reactor, mixed flow reactor, plug flow reactor, holding and space time.

Design for single reactions : Size comparison of single reactors , Multiple reactor systems, mixed flow reactors of different sizes in series Recycle reactor.

SECTION-B

Design for Multiple Reactions : Introduction to multiple reactions.Reactions in parallel and series in CSTR and plug flow reactor, yield & selectivity.

Thermal characteristics of reactors: Temperature and pressure effects, general graphical design procedure Optimum temperature progression , adiabatic operations .

Non-ideality in reactors and its effects on chemical conversion: Non-ideal flow patterns, E, F & C Curve, Mean residence time,One parameter models to represent the behaviour of chemical reactors, N Tanks in series model, dispersion number.

Recommended Books

1. Levenspiel, O. : Chemical Reaction Engineering, 3rd Edition, John Wiley

Sons, 2004.

2. Smith, J.M. : Chemical Engineering, Kinetics, 3rd Edition, and McGraw Hill, 1981.
4. Dinbigh, K. and Turner, K.G. : Chemical Reactor Theory – An Introduction, CambridgeUniv. Press.
5. Scott Fogler, H. : Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall, 2007.

Title	**MASS TRANSFER – I**			**Credits**	4
Code	PCC109		**Semester:-**5th	**L T P**	3 1 -
Max.Marks	**End term 50**	**Mid term 50**	**Practical 0**	**Elective**	N
Pre requisites	**-**				
Course Outcomes	CO1: Classify mass transfer operations and laws of mass transfer. CO2: Evaluation of molecular diffusion in gases, liquids and solids. CO3: Discuss diffusion coefficient/Mass transfer coefficient, interphase mass transfer and estimation of number of stages. CO4: Evaluation of humidification operations, design of cooling tower and working of gas-liquid contacting equipments. CO5: Analysis of drying and discuss the working of different types of dryers.				

THEORY

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

SECTION- A

Mass transfer operations, classification of mass transfer operations, choice of separation methods, methods of conducting mass transfer operations, design principles.

Introduction to mass transfer and diffusion, molecular diffusion in gases and liquids, diffusion coefficients for gases and liquids, diffusion in solids, types of solid diffusion.

Mass transfer coefficients, types of mass transfer coefficients, mass transfer coefficients in laminar flow, theories of mass transfer.

Interphase mass transfer, concept of overall mass transfer coefficient.

SECTION- B

Working principle, construction and industrial applications of various gas liquid contacting equipments like sparged vessels, mechanically agitated vessels, tray towers, packed towers, spray chambers, venturi scrubbers.

Humidification operations, psychometric chart, adiabatic saturation temperatures, wet bulb temperature, adiabatic operations, types of cooling towers.

Principle of drying, batch drying, drying curve, constructional details and working of different dryers

Recommended Books

1. Treybal, Robert E. : Mass Transfer Operations, 3rd Edition. McGraw-Hill, 1981.
2. Sherwood, T.K., Pifford, Robert L. and Wilke, Charles R. : Mass Transfer, McGraw-Hill.
3. Sharma, K.R. : Principles of Mass Transfer, Prentice Hall of India Pvt. Ltd., 2007.
4. McCabe, Warren L., Smith Juliam C. and Harriott, Peter : Unit Operations of Chemical Engg., 7th Edition, McGraw-Hill, 2005.
5. Coulson & Richardson : Chemical Engineering, Vol.I (6th Edition, 2009) and Vol. II. (5th Edition, 2006).

Title	**CHEMICAL TECHNOLOGY-II (ORGANIC)**	**Credits**	3

Code	PCC 110		Semester:-5th	L T P	3 - -
Max.Marks	End term 50	Mid term 50	Practical:	Elective	N
Pre requisites	-				

THEORY

Course Outcomes

CO1: Identify the processes and the concepts involved in the Extraction and refining of oils & fats, hydrogenation of oils and Manufacture of soap and detergents.

CO2: Understand the various water treatment processes for desalination as well as Water softening; using Lime soda, Ion exchange methods

CO3: Recognized the different Manufacturing processes of pulp, paper and sugar.

CO4: Understand the manufacture of activated carbon and carbon technology, synthesis of nano particle by plasma process.

THEORY

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

SECTION-A

Oils & Fats: Introduction, Extraction of oils from vegetable oils, refining of oils and fats, hydrogenation of oils.

Soaps and Detergents: Introduction, Raw materials, Manufacture of soap, Classification of detergents, finishing of detergents.

Water: Sources and Constraints, Impurities: dissolved, suspended, colloidal; Hardness of water; Water softening; Lime soda, Ion exchange.

Desalination: Classification of processes; Evaporative processes, Multieffect evaporation, multistage flash, vapour compression; Membrane processes, Reverse osmosis, electrodialysis.

SECTION-B

Pulp & paper: Introduction, Raw Materials, types of pulp, Manufacture of paper.

Sugar: Introduction; Sugar extraction, defacation, sulphitation, carbonation, concentration, crystallization, drying, refining; Uses of molasses and bagasse.

Polymers :Introduction,Degree of polymerisation,Classification of polymers,Polyethylene,Polyesters

Petroleum Refining: Intoduction,composition of crude oil,typical refinery operations like thermal cracking, catalytic cracking

Books Recommended

1. Shreev, R.N. & Brink, J.A. : Chemical Process Industries, 5th Edition, McGraw Hill, 1
2. Austine, G.T. : Shreeves Chemicals Process Industries, 5th Edition, Mc G Hill, 1984.
3. Dryden, C.E., Rao M.G. & Silting, M. : Outlines of Chemical Technology, 3rd Edition, Affiliated West Press Pvt. Ltd., N. Delhi, 2008.
4. Pandey, G.N. : Chemical Technology, Volume-II, Lion Press, Kanpur.

Title	Statistics and Research Methodology			Credits	3
Code	PCC 110	Semester:-5th		L T P	3 - -
Max.Marks	End term 50	Mid term 50	Practical:	Elective	N
Pre requisites	KnowledgeofMathematicsIand IIofB.Tech orequivalent				
THEORY					
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs				

CourseObjectives:

The objectives of this course are to familiarize the students with statistics andapplicationsof statisticaltechniques. Itaimstopresent the students with standard concepts and tools at an intermediate to superior level thatwillprovidethemwelltowardsundertakingavarietyofproblemsinthediscipline.

CourseOutcomes:

- Understand, analyze tools and applystatisticsincludingmeasuresofcentraltendency,correlation,regression andtheirproperties.
- Understand and apply probability and random variables and various discrete and continuousprobabilitydistributionsand theirproperties.
- Applications ofstatisticalmethodsofstudyingdatasamples,hypothesistesting, control chartsandtheirproperties.
- Analysis using ANNOVA, SQC, trend analysis

Section-A

StatisticalTechniquesI:

Introduction: Measuresofcentraltendency,Moments,Momentgenerating function(MGF),Skewness, Kurtosis, Curve Fitting , Method of least squares, Fitting of straight lines, Fitting ofseconddegreeparabola,Exponentialcurves,CorrelationandRankcorrelation,RegressionAnalysis: Regression lines of y on x and x on y, regression coefficients, properties of regressionscoefficientsand non linearregression.

StatisticalTechniquesII:

ProbabilityandDistribution: Introduction,Additionandmultiplicationlawofprobability,Conditional probability, Baye's theorem, Random variables (Discrete and Continuous Randomvariable) Probability mass function and Probability density function, Expectation and variance,DiscreteandContinuousProbabilitydistribution:Binomial,PoissionandNormaldistributions.

Section-B

StatisticalTechniquesIII:

Sampling,TestingofHypothesisandStatisticalQualityControl: Introduction,SamplingTheory(SmallandLarge),Hypothesis,Nullhypothesis,Alternativehypothesis,T estingaHypothesis,Levelofsignificance,Confidencelimits,Testofsignificanceofdifferenceofmeans,T-test, F-test and Chi-square test, One way Analysis of Variance (ANOVA).Statistical QualityControl(SQC),ControlCharts,ControlChartsforvariables(*X*andRCharts),ControlChartsforVar iables(p, np andCcharts). **Trend analysis.** —

TextBooks

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9thEdition, John Wiley &Sons, 2006.
2. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory,UniversalBook Stall,2003(Reprint).
3. S.Ross:AFirstCourseinProbability,6thEd.,PearsonEducationIndia,2002.
4. W.Feller,AnIntroductiontoProbabilityTheoryanditsApplications,Vol.1,3rdEd., Wiley,1968.

ReferenceBooks

1.B.S.Grewal,HigherEngineeringMathematics,KhannaPublishers,35thEdition,2000.
2.T.Veerarajan : Engineering Mathematics (for semester III), Tata McGraw-Hill, NewDelhi.
3. R.K.JainandS.R.K.Iyenger:AdvanceEngineeringMathematics;NarosaPublishingHouse,NewDelhi.
4. J.N.Kapur:MathematicalStatistics;S.Chand&SonsCompanyLimited,NewDelhi.
5. D.N.Elhance,V.Elhance&B.M.Aggarwal:FundamentalsofStatistics;KitabMahalDistributers,New Delhi.

Title	**CHEMICAL REACTION ENGG.-I LAB**			**Credits**	
Code	**PCC 155**	**Semester:-5th**		**L T P**	-
Max. Marks	**End term**	**Mid term**	**Practical:**	**Elective**	
Pre requisites	**-**				
THEORY					
Note for the Examiner					
Course Objectives	1. This practical lab course aims at performing various experiments for a batch reactor, CSTR, PFR ,semi – batch reactor to estimate the reaction kinetics. 2. This practical course also aims to find out the dispersion number for packed bed reactor . 3. To understand the kinetics of semi – batch & adiabatic batch reactor. 4. To understand the kinetics of isothermal semi – batch reactor.				
Course Outcomes	CO1: Describe the kinetics of a batch and semi batch and adiabatic batch reactor CO2: To understand and demonstrate kinetics of CSTR and PFR CO3: Perform RTD studies in a CSTR				

Practical

1. Kinetic studies in a batch reactor.
2. Kinetic studies in a plug flow reactor.
3. Kinetic studies in a CSTR.
4. Kinetic studies in a semi batch reactor.
5. RTD studies in CSTR.
6. Dispersion number for packed bed reactor.
7. Adiabatic batch reactor.
8. Isothermal semi – batch reactor.
9. Kinetics of the hydrolysis of methyl acetate in the presence of hydrochloric acid
10. Adsorption of acetic acid on activated charcoal.

Chemical Technology-II (Organic) Lab.

PCC 156 **Marks: 50** **Credit: 1.5**

Course Outcomes

COI Ability to understand the significance of Acid Vaiue,Iodine Value and Saponification Value.

CO2 Ability to understand the concept of Reducing and Non Reducing sugars using (i) Pavys Method (ii) Fehlings Method and the difference between the two methods

CO3 To identify the nature of soap by determining the free and combined alkali,total fatty matter and moisture content

1. *Oils & Fats*: Determination of Acid value, Iodine value, Saponification value.
2. *Carbohydrates*: Reducing and non reducing sugars by (i) Fehlings method (ii) Pavy's method
3. *Soaps*: Determination of free and combined alkali, total fatty matter, moisture and insoluble.

Title	**PROCESS PLANT DESIGN –I**		**Credits**	1.5
Code	PEC 153	**Semester:-5th**	**L T P**	- -3

Max.Marks	End term	Mid term	Practical:40	Elective	N
Pre requisites	-				

Course Outcomes:

CO1: Design and specifications of pipes, pumps, fans and blowers.
CO2: Design and specifications Dor thickeners, dust chambers, cyclone separators and centrifuges.
CO3: Design of agitated vessels, impellers and Conveyor system for solids.

Practical

1. Design of piping & piping networks.
2. Selection, specification & power requirements of process pumps, fans and blowers.
3. Design of settling equipments like Dor thickeners, dust chambers, cyclone separators and centrifuges.
4. Design of agitated vessels using various types of impellers.
5. Design of Conveyor system for solids.

Recommended Books

1. Luding, E.E. : Applied Process Design in Chemical in Petrochemical Plants. Gulf Publishing Company.
2. Perry, J.H. : Chemical Engineers Handbook, McGraw Hill.
3. Joshi, M.V. : Process Equipment Design, Macmillan Indian.
4. Peters, M.S. and Timmerhaus, K.D. Plant Design and Economics for Chemical Engineers McGraw Hill.

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)

6thSEMESTER

Title	**CHEMICAL REACTION ENGINEERING–II**			**Credits**	4
Code	PCC 111		**Semester:-6th**	**L T P**	3 1 -
Max.Marks	**End term 50**	**Mid term 50**	**Practical:**	**Elective**	N
Pre requisites	**-**				
THEORY					
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will co ver the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.				
Course Objectives	1. This course helps the students to learn the basic concepts,kinetics & mechanistic aspectsof catalysis. 2. The course also aims at Designing ofcatalytic and non-catalytic heterogeneous systems. 3. To understand the effect of external and internal transportation reaction rates and kinetic regimes for fluid-fluid reactions. 4. To understand the effect of effect of external and internal transportation reaction rates and kinetic regimes for fluid-solid reactions .				
Course Outcomes	CO1: Describe Heterogeneous catalyses, catalytic specificity. Preparation testing and characterisation of catalysts, catalyst poisoning and catalyst regeneration CO2: To understand and analyse the external and internal transport in catalytic reaction systems. CO3: Describe Fluid Solid catalytic reactions, reaction & diffusion within porous catalysts and effectiveness factors. CO4: Describe Fluid Solid non-catalytic reactors rate equations and their application to the design of reactors. CO5: Analysis of rate data design outline and selection of fixed bed, fluid bed and slurry reactions				

SECTION-A

Heterogeneous Catalyses:: A brief review of catalyses catalytic specificity. Preparation of catalysts, Determination of surface area, Rates of Adsorption, Surface reaction, Desorption, Rate limiting step, Power Law, Langmuir Hinshelwood rate, Eley-Rideal mechanism ,Void volume and solid density, Pore volume distribution, Theories of heterogeneous catalysis, Classification of catalysts, catalyst preparation, Promoter and inhibitors, catalyst poisoning and catalyst regeneration, Physical adsorption, chemisorption, adsorption isotherms. Nature of adsorbed state, Adsorption of gases on solids, Freundlich isotherm , Langmuir adsorption isotherm and BET isotherms .

Fluid Solid Catalytic Reaction: Kinetics,External transport processes, Reaction -and diffusion within porous spherical catalyst pellet. Gaseous diffusion in single cylindrical pore, Different modes of diffusion: Bulk diffusion, Knudsen diffusion and surface diffusion, Diffusion in Liquids, Diffusion in Porous Catalyst Effective diffusivity, thermal conductivity and effectiveness factors,**r**ate Equations for Fluid solid catalytic reactions, Numerical Problems ..

SECTION-B

Fluid - fluid reactions: Kinetic Regimes for Mass Transfer and Reaction, Film Conversion parameter, Clues to the kinetic Regime from solubility data, Clues to the Kinetic Regime from equipment, Applications to design.

Fluid Solid non-catalyticreactors: Rate equations and their application to the design of reactors.

Analysis of rate data design outline: Selection of fixed bed, fluidised bed, Trickle-Bed Catalytic Reactors and slurry reactors for fluid solid catalytic reactions.

Recommended Books

1.	Levenspiel, O.	:	Chemical Reaction Engineering, 3rd Edition, John Wiley and Sons, 2004.
2.	Smith, J.M.	:	Chemical Engineering, Kinetics, 3rd Edition, and McGraw Hill, 1981.
3.	Dinbigh, K. and Turner, K.G.	:	Chemical Reactor Theory – An Introduction, CambridgeUniv. Press.
.4.	Scott Fogler, H.	:	Elements of Chemical Reaction Engineering, 4th Edition, Prentice Hall, 2007. 5.

Title	**MASS TRANSFER-II**			**Credits**	4
Code	PCC 112		**Semester:-6th**	**L T P**	3 1 -
Max.Marks	**End term 50**	**Mid term 50**	**Practical :**	**Elective**	N
Pre requisites	**-**				

THEORY

Course Outcomes:

CO1: To understand the concepts of mass transfer equilibria for vapour-liquid and to generate operating line for various mass transfer systems like absorption, distillation, liquid-liquid extraction. Leaching, adsorption and principles of crystallization.

CO2: The students are able to comprehend the concepts of co current & counter current processes, cascades and concept of Ideal stage and stage efficiencies, continuous contact equipments, number of transfer units and height of a transfer unit (NTU & HTU) concepts, packed column for absorption, equipment for gas absorption

CO3: The students will get acquaintance about McCabe–Thiele methods & Ponchon Savarit method to calculate the number of stages for distillation column and able to design the column.

CO4: The students will be able to understand the working of different equipments used for various mass transfer operations such as leaching, crystallization, etc.

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

Course Objective/s: • To introduce the concepts of mass transfer operations-II and to apply those concepts to real engineering problems. • To study the concepts of mass transfer equilibria for vapour-liquid, liquid-liquid, solidliquid and solid-gas systems, liquid - liquid extraction, leaching, the principles of adsorption and crystallization.

Course outcomes • The students will get acquaintance about Lewis Sorel and McCabe–Thiele methods & 57 numerical, Ponchon Savarit method, Underwood and Fenske equations. • The students will be able to understand the working of different equipments used for various mass transfer operations such as leaching, crystallization, etc.

SECTION- A

Absorption: Equilibria for absorption systems – use of Raoult's law, Henry's law for solubility predictions, Selection of absorbent, limiting liquid gas ratios, absorption factor use in design of plate absorbers. Kremser equation for ideal plates and translation of ideal plates to real plates using various efficiencies. Concept of transfer units for the design of packed absorbers.

Distillation: Limitations and applications, prediction of VLE using thermodynamic & experimental techniques. Dew point & bubble point estimations for binary & multicomponent mixtures. Distillation methods – flash distillation, differential distillation for binary systems, steam distillation, optimum reflux ratio. Fractionation of binary mixtures using McCabe – Thiele method and enthalpy concentration method (Ponchon and Savarit method). Packed distillation columns. Azeotropic &extractive distillation preliminaries and molecular distillation.

SECTION- B

Liquid-Liquid Extraction: Ternary Equilibria and its representation on various plots. Selection criteria for solvent, Multistage extraction using partially miscible & immiscible solvents. Stagewise contact for countercurrent and crosscurrent extraction. Constructional details of equipment like mixer-settler, packed columns, pulsed extractor, sieve-tray extractor and centrifugal extractor.

Leaching: Preparation of solid, countercurrent and crosscurrent multistage contact Shank's system. Constructional details of equipment like Rotocel extractor, Hildebrandt extractor, Bollman extractor, Kennedy

Extractor & Beet-Sugar Diffusion battery extractor.
Adsorption: Types of adsorption, nature of adsorbents, equilibria for adsorption systems. Brief manufacture and commercial applications and characteristics for common adsorbents. Stagewise & continuous contacting of fluid and solid phase. Description of contact filtration adsorption system. Hypersorber Ion-exchange system.
Crystallization: Growth and properties of crystals saturation, nucleation, growth of crystals, effect of impurities on crystal formation, effect of temperature on solubility, fractional crystallization, yield of crystals, crystal purity, yield calculation using phase diagram, energy requirements using enthalpy-concentration diagram. Methods of creating super saturation-Meirs supersolubility curve. Mechanism and methods for nucleation. Derivation for ideal growth of crystals and discussion of actual growth. Swanson-Walker and various vacuum crystallizers.

Recommended Books

1. Treybal, Robert E. : Mass Transfer Operations, 3rd Edition, McGraw-Hill, 1981.
2. Sherwood,T.K., Pigford, R.L & Wilke,C.R. : Mass Transfer, McGraw-Hill, Chemical Engineering Series, 1975.
3. Skelland, A.H.P. : Diffusion Mass Transfer, John Wiley &Sons., New York, 1974.
4. McCabe, Warren L., Smith Julian C. and Harriot, H.P. : Unit-Operations of Chemical Engg., 7th Edition, McGraw-Hill, 2005.
5. King, C.J. : Separation Processes, Tata McGraw Hill Publishing Co. Ltd., New Delhi , 1982.
6. Geankoplis, C.J. : Transport Process and Separation Processes, 4th Edition, Prentice Hall Inc., New Delhi, 2003.

Title	**PROCESS DYNAMICS & CONTROL**			**Credits**	4
Code	PCC 113	**Semester:-6th**		**L T P**	3 1 -
Max.Marks	**End term 50**	**Mid term 50**	**Practical :**	**Elective**	N
Pre requisites	**Maths**				

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.
Course Objective	The objective of the course is focused to make the students understand the fundamental aspects of control systems employed in various chemical process industries along with the challenges and development of dynamic models of various processes through Laplace transformations.
Course Outcomes	CO1: Develop the output-input relationship in terms of transfer function for first and higher order systems and evaluate their response to various inputs. CO2: Analyse the stability characteristics of control systems and apply Root locus technique to evaluate control system's response. CO3: Understand the control system; various control configurationsalong with various controllers and their characteristics. CO4: Design the PID controllers using frequency response technique and understand the concepts of Bode plots. CO5: Understand closed loop transfer function, block diagram, transient response along with the basics of various advanced control techniques.

SECTION- A

Incentives for chemical process control, design aspects of a process control system. Hardware elements of a control system. Difference between feedback and feed forward control configuration. The control system: components of a control system, negative and positive feedback control, servo and regulator problem, control valve mechanism. Controllers: different modes of control actions and their basic characteristics
Laplace transforms and transfer functions. Difference between lumped and distributed parameter systems, Dynamic behaviour of first and higher order systems, interacting and non-interacting systems, dead time)

SECTION- B

Closed-loop transfer functions, Block Diagrams.Transient response of simple control systems.Stability: Routhtest for stability, Routh theorems. Root Locus: concepts, rules for plotting root locus diagram.

Frequency Response: Introduction to frequency response, Bode diagrams, control system design by frequency response: Bode stability criterion, gain margin and phase margins, Ziegler-Nichols controller settings.
Introduction to advanced control techniques such as cascade control, feed forward control, ratio control, inferential control.

Recommended Books

1. Coughanowr, D.R. : Process Systems Analysis and Control, 2nd Edition, McGraw Hill, Inc. 1991.
2. Stephanopolous G. : Chemical Process Control -An Introduction to Theory and Practice, Prentice Hall of India, New Delhi, 2012.
3. Ogata K.: System Dynamics, 4th Edition, Pearson Education, 2004.
4. Harriott, P.: Process Control, TMH Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1972.

Title	ENERGY TECHNOLOGY			**Credits**	4
Code	PCC 114	**Semester:-6TH**		**L T P**	3 1 -
Max.Marks	**End term 50**	**Mid term 50**	**Practical**	**Elective**	N
Pre requisites	**-**				

THEORY

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.
Course Objectives	➢ To make students understand various conventional and non-conventional energy resources. ➢ To make students solve the problems of combustion. ➢ To make students understand the working of various types of furnaces.
Course Outcomes	CO1: Have knowledge of solid fuels, their analysis, cleaning methods, carbonization process and synthetic fuels from coal CO2: Have knowledge of liquid fuels and manufacturing processes of gaseous fuels CO3: Be able to describe various furnaces, draught and furnace atmosphere and solve combustion problems CO4: Have in-depth knowledge of various renewable sources of energy, their scope and technologies in use

SECTION- A

Fuels: Types of conventional fuels, their merits and demerits. Non-conventional/renewable energy sources, their importance for sustainable development and environmental protection. 3 Hrs
Solid Fuels: Origin of coal, proximate and ultimate analysis of coal, coal preparation and washing methods, safe storage of coal. Low and High temperature carbonization, products of carbonization, By product coke ovens. Synthetics fuels from coal –Bergius process and Fischer Tropsch process. 15 Hrs
Liquid fuels: Origin of petroleum, refining and distillation of crude oil, uses of petroleum products. 5 Hrs
Gaseous fuels: Natural gas, manufacture of water gas and producer gas, gas cleaning methods. 7 Hrs

SECTION- B

Principles of combustion: Combustion calculations, waste heat utilization. 7 Hrs.
Furnaces: Classification of furnaces, draught, furnace atmosphere, Portland cement continuous rotary kiln, blast furnace, glass melting furnace 8 Hrs.
Alternate sources of energy:

- Introduction to solar radiation and evaluation of radiation incident on a solar collector.
- Applications of solar thermal energy such as solar water heater, solar cooker, solar concentrators and solar thermal power generation.

- Types of solar photovoltaic systems and applications.
- Photosynthesis and biomass conversion systems.
- Wind Energy: Nature of wind and wind turbine performance.

Other renewable energy sources such as geothermal, tidal, ocean and wave. 15 Hrs

Recommended Books

1. Gupta, O.P. : Elements of Fuels, Furnaces & Refractions, 5th Edition, Khanna Publishers, 20
2. Rao, S. and Parulekar, B.B. : Energy Technology – Non-conventional, Renewable & Conventional, 3rd Ed Khanna Publishers, 2007.
3. Dayal, M. : Renewable Energy – Environment and Development, Konark Publishers Pvt. 1989.
4. Sukhatme, S.P. : Solar Energy – Principles of Thermal Collection and Storage, 2nd Edition, McGraw – Hill Publishing Company Ltd., 2006.
5. Sharma, S.P. and Mohan, C. : Fuels and Combustion, Tata Mc-Graw Hill Publishing Company Ltd., 1984.

Mass Transfer Lab.
PCC 157 **Marks: 50** **Credit: 1.5**
Practical

Course Objectives	To reinforce the students' understanding of the mass transfer operations through suitably designed experiments
Course Outcomes	CO1: Application of different mass transfer equipments, Determination of mass transfer coefficients for naphthalene-air system. To determine drying rate curves for different wet solids in a batch drier. CO2: Verification of Rayleigh's equation for differential distillation, Determination of flooding velocities in packed columns. CO3: Determination of HETP for packed distillation columns, flooding velocities in packed columns. CO4: Practice operation of a pilot sized distillation column under total reflux, Fractional approach to equilibrium for liquid-liquid extraction from single drop.

List of practicals:

1. Determination of mass transfer coefficient for naphthalene-air system.
2. Study of drying characteristics of the given material under natural draft/forced draft conditions.
3. Determination of mass transfer coefficient in a wetted wall column.
4. Verification of Rayleigh's equation for differential distillation.
5. Study of absorption of carbon dioxide in a packed bed absorption tower.
6. Determination of HETP for packed distillation columns.
7. Study the operation of a rotary drier.
8. Study the solid-liquid extraction operation in a packed bed extraction unit.
9. Study of different mass transfer equipments.

Process Dynamics & Control Lab.

PCC 158 **Marks: 50** **Credit: 1.5**

Objective: To impart hands on experience on various process control systems.

Course Outcome:

CO1: To plot the response curve for a given input to a U-tube manometer and to determine the transfer function from the response

CO2: To study the dynamics of the given thermometer and compare the theoretical value of its time constant with the experimental value.

CO3: Determine Experimentally characteristics of of control valves and liquid level measurement systems.

CO4: Experimental studies on temperature and pressure control systems.

Practical

1. U-Tube manometer

(a) To plot the response curve for a given input to a U-tube manometer.
(b) To determine the transfer function from the response curve obtained in part (a).

2. Time constant of a mercury thermometer
   To study the dynamics of the given thermometer and compare the theoretical value of its time constant with the experimental value.
3. Analysis of valve
   Develop a block diagram representing the dynamic bahavoiur of the given globe valve.
4. (a) Liquid level measurement
   With the given Bubbler System for Liquid Level Measurement, evaluate liquid height in the tank and compare it with actual values.
   (b) Calibration of Pressure Gauge
   Calibrate a pressure gauge in the range 0 psi to 60 psi.
5. Temperature control system
   To maintain the temperature of the fluid at the set point value.
6. Time constant of liquid level tank
   To study the dynamics of liquid level in a tank and compare the analytical value of the time constant with the experimental value.
7. Liquid level control
   (a) To carry out the closed loop experiment on the given liquid level control system and record its response for step change in the inlet flow.
   (b) To plot the experimental response curve and comment on the response obtained.
8. Compurec
   Pressure control simulation with step input and sinusoidal input.

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)

7th SEMESTER

Title	**Process Engineering Economics**			**Credits**	4
Code	HSMC 102		**Semester:-7th**	**L T P**	3 1 -
Max.Marks	**End term 50**	**Mid term 50**	**Practical**	**Elective**	N
Pre requisites	**-**				
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.				
Course Objectives	The objective of the course is to expose students to basic concepts in engineering economics, plant design, safety features and its importance to chemical engineering. The course isolates those problems that are commonly faced by engineers and develops the tools to properly grasp, analyse, and solve them. The tools introduced include present worth analysis, annual cash flow, rate of return, incremental analysis, future worth analysis, and payback period. The course also covers such topics as depreciation, after tax analysis, replacement analysis, inflation, and deflation.				
Course Outcomes	CO1: Formulate and apply interest factors to real life engineering problems CO2: Perform economic analysis for process to calculate equipment cost CO3: Develop and apply mathematical models describing real life cash flows and time value of money CO4: Evaluate engineering alternatives and profitability for process CO5: Perform breakeven analysis and optimum and plant design of a process.				

THEORY

SECTION-A

Cost estimation: Factors affecting investment and production costs. Capital investments, fixed investments and working capital. Cost indices. Estimating equipment costs by scaling 6/10 factor rule. Methods for estimating capital investment. Estimation of total product cost. Different costs involved in the total product costs. Different cost involved in the total product for a typical chemical process plant. (10 hrs)

Interest and Investment Costs: Simple and compound interest. Nominal and effective rates of interest. Continuous interest ordinary annuity. Perpetuities and capitalized costs. (8 hrs)

Taxes and Insurance: Types of taxes and tax returns, types of insurance and legal responsibility. (6 hrs)

Depreciation: Types of depreciation. service life salvage value, present value and methods of determining depreciation, single unit and group depreciation. (7 hrs)

SECTION-B

Profitability, Alternative Investments and Replacements: Mathematical methods of profitability evaluation. Cash flow diagrams. Determination of acceptable investments. Alternatives when 'an investment must be made and analysis with small increment investment, replacement. Breakeven analysis. Balance sheet and income statement. (13 hrs)

Optimum Design: Procedure with one variable, optimum reflux ratio in distillation and other examples. (8 hrs)

Preliminary Steps in Plant Design: Plant design factors. project organization, plant location, preliminary data collection, process engineering (8 hrs)

***Books Recommended*:**

1. Peters, M.S. & Timmerhaus, K.D. : Plant Design and Economics of Chemical Engineers, Mc Graw Hill, New York, 4th Edition, 1991.
2. Ulrich, G.D. : A Guide to Chemical Engineering Process Design & Economics, John Wiley, 1984.
3. Guthrie, K.M. : Process Plant Estimating, Evaluation & Control, Craftsman Solano Beach, Calif, 1947.
4. Jelen, F.C. : Cost and Optimisation Engineering, McGraw Hill, New York, 1970.
5. Holland, F.A. & Wastson, F.A. : Introduction to Process Economics, 2nd Edition, Wiley, 1983.
6. Bassel, W.D. Preliminary Chemical Engineering Plant Design, Elsevier, New York, 1976.

Title	Process Plant Design-II			Credits	1.5
Code	PEC 154	Semester:-7th		L T P	- -3
Max.Marks	End term	Mid term	Practical:40	Elective	N
Pre requisites	-			Contact Hours	45

Course Outcomes:

CO1: Design and specifications of double pipe heat exchanger, shell and tube heat exchanger, plate type heat exchanger, condenser and reboiler.

CO2: Design of distillation column, calculation of number of plates, height and design of fractionator internals-sieve tray.

CO3: Design aspects of fixed bed reactors and fluidized bed reactors.

Practical

1. Process design and specifications of double pipe heat exchanger, shell and tube heat exchanger, plate type heat exchanger, condenser and reboiler.
2. Design of distillation column, calculation of number of plates, height and design of fractionator internals-sievetray.
3. Absorber/Stripper design of stage-wise and continuous contact equipment (packed column), height of column and diameter calculations. HTU and NTU.
4. Design aspects of fixed bed reactors and fluidized bed reactors.

***Books Recommended*:**

1. Coulson, Richardson & Sinnott, R.K. : Chemical Engineering, Volume 6 – An Introduction to C Engineering Design, 4th Edition, Pergamon Press, 2007.
2. Ludwig, E.E. : Applied Process Design in Chemical and Petrochemical Pla Edition, 1977.
3. Perry, J.H. : Chemical Engineers Handbook, 8th Edition, McGraw Hill, 200
4. Kern, D.Q. : Process Heat Transfer, McGraw Hill, 1965.
5. Shell and Tube Type Heat Exchangers, Indian Standards. : Instt., IS: 43-197.
6. Treybal, Robert E. : Mass Transfer Operations, 3rd Edition, McGraw-Hill, 1981.
7. Levenspiel, O. : Chemical Reaction Engineering, 3rd Edition, John Wiley and S 2004.
8. Walas, S.M. : Reaction Kinetics for Chemical Engg., McGraw Hill.
9. Scott Fogler, H. : Elements of Chemical Reaction Engineering, 4th Edition, Prent Hall, 2007.

Title	Literature Survey, Report Writing & Seminar			Credits	1.5
Code	CHE 104	Semester:-7th		L T P	- - 3
Max.Marks	End term	Mid term	Practical: 50	Elective	N
Pre requisites	-				
Course Objectives	➢ To gain an understanding of the existing research relevant to a particular topic or area of study and define the problem statement ➢ Critical analysis of the published work and develop arguments to support the published work with evidence ➢ To present that knowledge in the form of a presentation and written report.				
Course Outcomes	CO1: Survey of scientific, technical and commercial literature in engineering/technology and defining problem statement. CO2: Critical analysis and evaluation of literature CO3: Demonstrate effective public speaking and impromptu discussions CO4: Write technical report in a coherent and concise manner.				

Practical

The course focuses on understanding and identifying problem statement relevant to a particular area of study in

engineering/technology. Emphasis is placed on identification, summarization and explanation of the general & specific objectives of the research paper. Students will read and analyse research papers in the area of their choice pertaining to engineering/technology, critically evaluate published research papers, build hypothesis, summarize topic, research problem, major findings and conclusions. The course involves students practice speaking in front of a scientific audience and to explore research topics in detail. The task involves presentation and preparation of technical report on an assigned topic after survey of scientific, technical and commercial literature, (3-4, or more) related papers in a given area.

***Books Recommended*:**

1.	Mildren, K.W.	:	Use of Engineering Literature, Butterworths.
2.	Bottle, R.T.	:	The Use of Chemical Literature, Butterworths.
3.	Hoover, H.	:	Essentials For The Technical Writer, John Wiley.
4.	Robertson, W.S. & Siddle, W.D.	:	Technical Writing and Presentation, Pergamon.

Teaching Scheme and Syllabi of B.E. (Chemical Engineering)

8th SEMESTER

Title	**Environmental Engineering**			**Credits**	3 1 -
Code	PCC 115		**Semester:-**8th	**L T P**	4- -
Max.Marks	**End term 50**	**Mid term 50**	**Practical:**	**Elective**	N
Pre requisites	**-**				

THEORY

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.
Course Objectives	1. This course aims at developing the students about environmental impacts of air, water and solid pollution. 2. The course aims at giving the students an insight into the environmental issues related to chemical process industries in terms of their impact on land, water and air and the possible mitigation techniques to reduce this effect for sustainably. 3. This course also aims to develop the basic knowledge about the biomedical, hazardous, and waste management.
Course Outcomes	CO1: Describe principal air pollutants, their sources and effects. CO2: Discuss atmospheric dispersion of air pollutants and estimate concentration of air pollutants. CO3: Demonstrate the construction, working and theory of equipments used for the control of air pollution. CO4: Classify water pollutants, their sources and effects and calculation of water quality parameters. CO5: Application and design of physical/ chemical/ biological treatment methods for small communities/municipal sewage/industrial water/ waste water treatment. CO6: Classify solid wastes, their sources, effects and methods of disposal of solid wastes.

SECTION-A

Ambient air and water standards. Principal sources of pollution.

Inter-relationship between energy and environment pollution. Prevention of environmental pollution through conservation, raw material substitutions, process and equipment modifications. A case study on the concept of zero discharge.

Air Pollution:

- Principal air pollutants and their usual sources.
- Effect of air pollutants on human health, animals, vegetation and materials.
- Atmospheric dispersion of air pollutants, temperature inversions, Estimation of pollutants by Gaussian plume model.
- Process and equipments used for the control of particulate pollutants.

SECTION-B

Water Pollution:

- Types of water pollutants, their sources and effects.
- BOD and COD
- Waste water treatment techniques and equipments, flocculation, skimming, floatation, etc.
- Primary Treatment-through settling.
- Secondary Treatment-Aerobic and anaerobic digestion, activated sludge process, trickle filter and oxidation ponds.

Solid wastes: Control and disposal, sanitary landfill, incineration, pyrolysis gasification and recycling. 06 hours

***Books Recommended*:**

1. Perkins, H.C. : Air Pollution, McGraw Hill, N.Y.
2. Rao, C.S. : Environmental Pollution Control Engineering, 2nd Edition, New

			International Pvt. Ltd., 2006.
3.	Williamson, S.J.	:	Fundamental of Air Pollution, Addison Wesley Co. N.Y.
4.	Numerow, N.L.	:	Liquid Wastes of Industry, Addison Wesley Co., N.Y.
5.	Sincero, A.P. and Sincero, G.A.	:	Environmental Engineering, Prentice-Hall of India, 1999.
6.	Hammer, M.J. and Jr. Hammer, M.J.	:	Water and Wastewater Technology, 6th Edition, Prentice-Hall of India, 2008.
7.	Mahajan, S.P.	:	Pollution Control of Process Industries, Tata McGraw Hill.
8.	Metcalf and Eddy	:	Waste-Water Engineering, 4th Edition, Tata McGraw Hill, 2007.

PROJECT WORK

Course Outcomes:

CO1: Apply the knowledge of chemical engineering and basic sciences to design or fabricate a system/unit/plant.

CO2: Apply knowledge of chemical engineering to solve energy and material balance and design efficient process.

CO3: Analyze the process components and perform the coat analysis and efficiency of the process.

CHE 103 **Marks: 50** **Credit: 2**

Each student is required to submit a project report on the design of a chemical plant, selecting the best process with optimum equipment size and operating conditions. The object is to test the ability of the student to apply his entire knowledge of Chemical Engineering principles to conceptualize, analyze and solve the problems. To judge his knowledge and originality and capacity for application of laboratory data in designing chemical plants and to determine the level of his proficiency at the end of the course.

Environment Engineering Lab.

PCC 159 **Marks: 50** **Credit: 1.5**

Course Outcomes

CO1: Calculate BOD, COD, TSS & TDS of wastewater samples.

CO2: Determination of chromium separation, phenol content of water sample & To find the biodegradation constant (K) and the effect of timing on it

CO3: Practice and apply electro dialysis apparatus and reverse osmosis set up for waste water analysis.

CO4: To use stack monitoring kit to find: Efficiency of a cyclone & Dust sampling.

To find BOD of water sample.

1. To find COD of waste sample.
2. To find the total dissolved solids (TDS) and its volatile and non-volatile components.
3. To find the total suspended solids (TSS) and its volatile and non-volatile components.
4. To do the chromium separation by different techniques from electroplating wastes.
5. To find the phenol content of water sample and evolution of parameters.
6. To operate the electrodialysis apparatus.
7. To find the biodegradation constant (K) and the effect of timing on it.
8. To use the membrane separation techniques for salt brine and reverse osmosis process for sugar.
9. To use stack monitoring kit to find:
    a. Efficiency of a cyclone.
    b. Dust sampling.

Note: Any six of the above mentioned experiments are to be conducted.

Title	**COMPREHENSIVE VIVA**			**Credits**	01
Code	CHE 106	**Semester:-**8th		**L T P**	- - -
Max. Marks	**End term--50**	**Mid term- -**	**Practical-**	**Elective**	N
Pre requisites					
The viva-voce examinations will be comprehensive and covering mainly chemical engineering and technology subjects covered during all the semester including the Eight Semester.					

Paper Title: Open Elective (Theory)

Title	**Process Instrumentation**		
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		
Course Objectives	➢ To provide knowledge of pressure, temperature, level, humidity, viscosity, conductivity, humidity, pH, density and weight measurements. ➢ To provide knowledge of recording instruments, indicating and signalling instruments, control centre, transmission of instrument reading and instrumentation diagrams.		
Course Outcomes	CO1: Classify elements and types of instruments, static and dynamic characteristics of instruments. CO2: Illustrate the different methods for the measurement of temperature and their useful applications. CO3: Elucidate the construction and working of various industrial devices used to measure pressure and vacuum. CO4: Explicate the construction and working of various industrial devices used to measure level. CO5: Discuss methods for measurement of viscosity, conductivity, humidity, density, weight and pH. CO6: Describe recording/indicating/signalling instruments and Control Centre. CO7: Construct Instrumentation diagrams.		

THEORY

SECTION-A

General Concept: Need and classification of measurements and instruments, Basic and auxiliary functional elements of a measurement system. Static and Dynamic Characteristics of Instruments: Static Characteristics: Range and span, accuracy and static error, reproducibility and drift, sensitivity and dead zone. Dynamic Characteristics: Speed of response and lag, fidelity and dynamic error, dead time. 6 Hrs.

Temperature measurement: Bimetallic thermometers, filled-in system thermometers. Thermocouples, metal resistance thermometers and thermistors, optical and radiation pyrometers, radiation receiving elements. 12 Hrs.

Pressure measurement: Bourdon gauge, Bellows type gauge.

Vacuum measurement– Mcleod gauge, thermoionic type ionization gauge, pirani vacuum gauge. Measurement of pressure in corrosive fluids: Diaphragm seal, liquid seal and purge system. 12 Hrs.

SECTION-B

Liquid level measurement: Direct measurement of liquid level– Float & tape liquid level gauge, float and shaft liquid level unit, hydraulic remote transmission of liquid level. Level measurement in open vessels: Bubbler system, diaphragm box system, air trap system. Level measurement in pressure vessels– Differential pressure manometer, use of liquid seals with a manometer, displacement float liquid level gauge. 8 Hrs.

Measurement of viscosity, conductivity, humidity and pH. 8 Hrs.

Density measurement: Liquid level method, displacement meter and hydrometer. 4 Hrs.

Weight measurement: Spring scale, pneumatic force meter & hydrostatic force meter. 4Hrs.

Process Instrumentation: Recording instruments, indicating and signaling instruments, control centre, transmission of instrument reading, instrumentation diagrams. 6 Hrs.

***Books Recommended*:**

1. Patranabis, D. : Principles of Industrial Instrumentation, Tata McGrawHill Publishing Co. Lt
2. Eckman, Donald P. : Industrial Instrumentation, CBS Publisher and Distributors
3. Considine, D.N. : Process Instruments and Controls Handbook, McGraw Hill
4. Fribance, A.E. : Industrial Instrumentation Fundamentals, Tata McGraw-Hill Publishing Co.
5. Singh, S.K. : Industrial Instrumentation and Control, Tata McGraw-Hill

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INDUSTRIAL SAFETY & HAZARDS (Theory)

THEORY		**Time**	3 Hours
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		

THEORY	
Note for the Examiner	**The question paper should be divided into Section A and Section B Total of 7 questions.** The examiner will set seven questions of equal marks. The first question, which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of the paper will be divided into two sections having three questions each and the candidate is required to attempt at least t wo questions from each section.
Course Objectives	1. To know about industrial safety programs and toxicology, industrial laws, regulations and source models 2. To understand about fire and explosion, preventive methods, explosives and inflammable substances. 3. To determine about industrial hazards and its risk assessment. 4. To analyze the effects of workplace exposures, injuries and illnesses, and the methods to prevent incidents using effective control strategies.
Course Outcomes	CO1: Identify the various types of hazards in work-place environment, protective and preventive measures in hazard control, Toxic Chemicals, maximum allowable concentrations and other standards. Biological threshold limit values. CO2: Recognize Mechanical and Electrical hazards, Explosives and inflammable substances, radioactive hazards CO3: Select appropriate Personal protective equipments and effective control strategies for Fire prevention. Good housekeeping in industrial environment. CO4: Understand Standard safety procedures and disaster control, OSHAS, OHSMS and OSHA. Current amendments in Indian Legislation on safety and prevention of hazards and safety code: ISO 14000, ISO9000. CO5: Describe Environmental impact assessment. Case studies of typical hazardous industries. CO6: Select proper control strategies for hazardous wastes.

SECTION-A

Definition, Hazards identification, Hazards and operability studies (HAZOP), Failure mode and effect analysis (FMEA), classification and assessment of various types of hazards in work-place environment and Industrial Hygiene, protective and preventive measures in hazard control.
-10 hours

Toxic Chemicals: maximum allowable concentrations and other standards. Biological threshold limit values.
-05 hours

Mechanical and electrical hazards. Personal protective equipments. Explosives and inflammable substances. Radioactive hazards. Good housekeeping in industrial environment.
-06 hours

SECTION-B

Fire prevention, design to prevent fire and explosion (inverting static electricity, sprinkler system), boiling liquid expending vapour explosion (BLEVE). Fire triangle, Dow's Fire and explosion index, dilution and ventilation.
-09 hours

Standard safety procedures and disaster control; OSHAS, OHSMS and OSHA. Current amendments in Indian Legislation on safety and prevention of hazards and safety code: ISO 14000, ISO 9000. Environmental impact

assessment. -09 hours

Control strategies for hazardous wastes. Case Studies of typical hazardous industries. -06 hours

***Books Recommended*:**

1. Wills, G.L. : Safety in Process Plant Design.
2. Less, F.P. : Loss Prevention in Process Industries.
3. Chanleft, E.T. : Environmental Protection.
4. Berhowex, P.M. & Rudd, D.F : Strategy of Pollution Control.
5. Safety for Chemical Engineers : A.I.Ch.E. Publications, 1976-77.

NANO TECHNOLOGY(Theory)

THEORY	**Time**	3 Hours

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.
Course Objective	Students learn about nuances of Nanotechnology from basics to application such that they may be able to use this knowledge in their Professional Careers
Course Outcome	CO1: Understand the basis of nanotechnology in terms of bonding, types of nanomaterials. CO2 : Explain methods of synthesis and fabricating nanostructures (top down- bottom up). CO3: Relate the unique properties of nanomaterials to the reduced dimensionality of the material through characterisation. CO4 : Discuss applications of nanomaterials in various fields.

Section-A

Introduction: Plenty of room at the bottom-Feynman's concept, evolution of ultra-fine materials, the missing link between conventional laws in physics and chemistry and new theories. **2 h**

Building Blocks of Nanotechnology: covalent architecture, coordinated architecture and weakly bound aggregates, Interactions and topology **2 h**

Chemical Properties: The effect of nanoscale metals on chemical reactivity, effect of nanostructure on mass transport, metal nanocrystallites support on oxides, supported nanoscale catalysts. **3 h**

General principles for synthesis of monodispersed nanoparticles, metals and intermetallics, Ceramics, composites, nanoparticles, colloids/Micelles/vesicles/Polymers/glasses, Crystalline, and zeolite hosts. **7h**

Review of fundamental behaviour of 0-D(nanoclusters), 1-D(nanowires), 2-D(thin film multilayers), and 3-D(bulk nanostructures) materials. Introduction to size dependent phenomenon in nanostructure for various applications, specific production techniques like chemical vapor deposition, arc ignition etc. Formation of clusters and nanoparticles from supersaturated vapor and selected properties, sputtering and thermal evaporation and laser methods. Synthesis of nanoparticles by chemical routes. **10h**

Section-B

Approches to production: Top down and bottom up,Mechanical attrition, high energy ball milling, and mechanical attrition, nanocomposites by mechano-chemistry, mechanism of grain size reduction, property of microstructure relationships. **7 h**

Characterization techniques : Tools in nanotechnology: Scanning electron microscopy(SEM), Transmission electron microscopy and high resolution(TEM), energy dispersive spectroscopy (EDX), Atomic force microscopy(AFM), Magnetic force microscopy(MFM), Chemical Force Microscopy(CFM), Focused ion beam, nanolithography, powder x-ray diffractometry, UV visible. **8 h**

Nanomaterials:CNTs, Polymer Nanocomposites nanoceramics, nanometals, nanopolymers, structures-properties-applications, Quantum dots. Concepts Bio-Nanotechnology. **3 h**

Applications: Nanotherapeutics, Molecular diagnostics, tissue engineering, nanopumps, nanorobtoics cells, molecular motors, nanomembranes, Organic molecular based computers, bionanodevices (sensors & actuators). **3 h**

Books Recommended

1. Nanoscale Materials in Chemistry by Kenneth J. Khabhunde (ed.) Wiley Interscience.
2. Nanotechnology – An introduction to nanostructure of technique by Michel Kohler and Wolfgang Frittsche 2004- Wiley VCH
3. Springer Handbook of Nanotechnology by Bharat Bhushan
4. Encyclopedia of Nanotechnology- Hari Singh Nalwa.
5. Nanostructures and Nanomaterials by G. Cao, Imperial College Press, 2004
6. Introduction to Nanotechnology by Owen and Poole, Wiley
7. Nano-materials by A. K. Bandopadhyay, New Age International

POLYMER SCIENCE AND ENGINEERING(Theory)

THEORY		**Time**	3 Hours
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		

Course Outcomes:

CO1: Describe chemistry of polymers, classification of polymers, addition and condensation polymersation, coplymerization, polymerization techniques.

CO2: Characterization of polymers, concept of average molecular weight and types, polymer crystallinity, analysis of polymers using IR, XRD, DSC, DMTA, TGA etc techniques.

CO3: Define Polymer compounding, different compounding ingredients for rubber and plastics, crosslinking and vulcanization.

CO4: Applications of Polymer processing techniques, injection molding, blow molding, calendaring, rotational molding, thermoforming, rubber processing etc.

Section-A

Chemistry of polymers:

Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness,

Polymerization methods: addition and condensation; their kinetics, copolymerization, monomer reactivity ratios and its significance, kinetics, different copolymers, random, alternating, azeotropic copolymerization, block and graft copolymers, techniques for copolymerization-bulk, solution, suspension, emulsion.

Polymer Characterization:

Solubility and swelling, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, polymer crystallinity, analysis of polymers using IR, XRD, thermal (DSC, DMTA, TGA), microscopic (optical and electronic) techniques.

Section-B

Polymer Technology:

Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, crosslinking and vulcanization

Polymer processing:

Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer.

Books Recommended:

1. Williams, D.J. : Polymer Science and Engineering, Prentice Hall Inc.

2. Rodriguez, F. : Principles of Polymer Systems, Tata McGraw Hill Pub.
3. Odian,G. : Principles of Polymerization, McGraw Hill.
4. Collins, E.A., Bares, J. & Billmeryer, F.W., Experiments in Polymer Science, Wiley Inter Science.
5. Kumar, A. & Gupta, S.K. : Fundamental of Polymer Science and Engineering, Tata McGraw Hill Pub.
6. Middleman, S. : Fundamentals of Polymer Processing, McGraw Hill, New York.
7. Moore, G.R. and Kline, D.E., "Properties and Processing of Polymers for Engineers", Society of Plastics Engineers, Prentice–Hall, Englewood Cliffs, NJ, 1984
8. Tadmor, Z. and Gogos, C.G.: Principles of Polymer Processing, John Wiley & Sons, 1979.

SUPPLY CHAIN & LOGISTIC MANAGEMENT (Theory)

THEORY	**Time**	3 Hours
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.	

Section-A

Introduction to Supply Chain Management: Definition; Scope & Importance of Supply Chain Management; Key drivers Of the SCM; Features of Supply Chain Management; Supply Chain Network – 1st Tier , 2nd Tier; Network decisions in SCM; Suppliers and Customers; Customer Service Dimension (Seven "R" Principles, Service after sale, Customer delight)

Role of Logistics in Supply Chains: Definition of Logistics Management; Scope and role of Transportation, Traffic & transportation; Relationship between transportation and other business functions, Transport Economics: Distance – volume-density, Freight Cost, Handling, Liability, market factors; Third party logistics (3 PL) & fourth party logistics service provider (4 PL), Logistics equipment; Reverse Logistics, Government rule & regulations related to Logistics; Purchase Cycle, Make or Buy, Price analysis, Negotiations.

Section-B

Inventory Management: Inventory Control, Planning & Managing Inventories; Warehouse Management (Receipt, issue, storage and preservation, stock verification, In bound and out bound distribution operations); Order Management; Competitive advantage through logistics and supply chain management; Responsive Supply Chain; Supply chain process integration, performance measurement; Value Chain, Value System and Supply Chain.

Planning demand and supply: Planning & Sourcing in Supply Chain, Demand forecasting, Type and Time horizon of forecast and category of forecasting, aggregate planning; Financial issues in Supply Chain - Macro and micro view, Asset management, Du Pont Model, Supply Chain Costing; Decision environment in SCM; Global supply chain perspectives - New business models, role of IT in SCM.

Books Recommended:

1. Harald Dyckhoff et al, Ed.: Supply Chain Management and Reverse Logistics, Springer (India).
2. Jayashree Dubey and M.L. Saikumar Ed.: Supply Chain Management, IIPE Hyderabad and New Century Publication.
3. Sarika Kulkarni, Ashok Sharma: Supply Chain Management-Creating Linkages for Faster Business Turnaround, McGraw Hill.
4. RP Mohanty: Supply Chain Management-Theories and Practice, Biztantra.
5. Robert B. Handfield, Ernest L. Nicholas, Jr.: Introduction to Supply Chain Management,Pearson Education.
6. Ronald H. Ballou, Samir K. Srivastava: Business Logistics/Supply Chain Management, Pearson Education.
7. John Mentzer: Supply Chain Management, Response Books.
8. Janat Shah: Supply Chain Management, Pearson Publications.
9. N. Chandrasekaran: Supply Chain Management - Process, System and Practice, Oxford Press.

PROJECT MANAGEMENT AND ENTREPRENEURSHIP (Theory)

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.
Course Objectives	1. To understand basic concepts in the area of entrepreneurship 2. To know the role and importance of entrepreneurship for economic development 3. To develop personal creativity and entrepreneurial initiative 4. To adopt of the key steps in the elaboration of business idea 5. To know the stages of the entrepreneurial process and the resources needed for the successful development of entrepreneurial ventures. 6. To enable the students to evolve a suitable framework for the preparation, appraisal, monitoring and control of industrial projects. 7. To make them understand the concepts of Project Management for planning to execution of projects. 8. To make them understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.
Course Outcomes	CO1: To consider the legal and financial conditions for starting a business venture To evaluate the effectiveness of different entrepreneurial strategies CO2: To understand the nature of entrepreneurship and functions of the successful entrepreneur. To identify personal attributes that enable best use of entrepreneurial opportunities CO3: Explain the concept and attributes of projects, project management system, process and its principles, and various stages of a project. Perform technical feasibility, marketing feasibility and commercial viability using NPV, and further to understand tax and legal aspects of a project. CO4: Analyse project appraisal in public & private sector and estimate shadow prices and social discount rate. Examine project risk and performance assessment. Evaluate project management techniques using case studies.

SECTION-A

Project Management: concept of project management attributes of a project, project management systems, project life cycle, Difference among Projects, Routine Activities and Programs, responsibilities and qualities of a project manager, project management team-composition, functions and responsibilities, co-ordination procedures. **5 Hours**

Project Planning: Work Breakdown Structure, Types of Work Breakdown Structure, Planning Framework and Its Importance **2 Hours**

Project Formulations and Planning ,Private commercial criteria for project choice, feasibility, marketing feasibility, Financing for Projects and financial feasibility, Preparation of techno-economic feasibility report, Project Identification: Principles of project identification, Project Implementation. Brief outline of social cost benefit analysis: rationale, UNIDO and little Mirrlees approaches, UNIDO IDCAS manual **7 Hours**

Project appraisal: time value of money, project appraisal techniques: Non discounting criteria, discounting criteria, appraisal and selection in practice, payback period, accounting rate of return, net present value, internal rate of return, benefit cost ratio, social cost benefit analysis, effective rate of protection, risk analysis: measures of risk, sensitivity analysis, simulation analysis, decision tree analysis. **4 Hours**

Network analysis, PERT/CPM Bar chart, Preconstruction Planning, Project Scheduling control and Monitoring: Resource Scheduling, manpower scheduling, multi project scheduling, cost scheduling, crash costing and updating and levelling of resources, Implementation of Project schedules. **5 Hours**

SECTION-B

Entrepreneur- Concept on percent - Functions and clarifications of entrepreneurs - Characteristics of entrepreneur - Nature and importance of ,entrepreneur – Entrepreneur vs. professional manager - Women entrepreneurs **6 Hours**

Concept of Entrepreneurship - Entrepreneurship and environment-Policies governing entrepreneurs, entrepreneurial development programmes - Institutions for - entrepreneurship development, entrepreneurship. Entrepreneurship -Entrepreneurship development in other countries. Institutions for Entrepreneurial Development - Role of constancy organizations **5 Hours**

Role of financial institutions -Bank finance to entrepreneurs Entrepreneurship development: Role of development financial institutions **10 Hours**

Books Recommended:

- Chandra. Prasanna. Project Preparation, Appraisal and Implementation. Tata McGraw Hill.
- Gido, Jack, And Clements, James P. Project Management. Cengage Learning.
- Gray, Clifford F., Larson, Eric W., and Desai, Gautam V. Project Management: The Managerial Process. McGraw Hill Education.
- Barker, Stephen.and Cole, Rob. Brilliant Project Management, Pearson.
- Kharua, Sitangshu. Project Management and Appraisal. Oxford Press University
- Kharbhanda, O.P. Total Project Management, Gower Publishing Co. Ltd., England.
- Choudhury : Project Management, Tata McGraw Hill, New Delhi,1988.
- Rao Ramesh, K.S. : Fundamentals of Financial Management, Macmillan Publishing Co., New York, 1989.
- Bansal, J.C. and Ghosh, B.: Project Management of Process Plants, Panjab University, 1985
- Vasanta Desai: Dynamics of entrepreneurial development and management, 11th edition, Himalaya pub.
- UNIDO: Guidelines for Project Evaluation, United Nations, reprinted,1993..
- Manual for the preparation of Industrial Feasibility Studies, United Nations 1995.
- Manual for Evaluation of Industrial Projects, United Nations, reprinted on 1993..
- IMD little and J.A. Mirrlees: Project Apraisal and Planning in Developing Countries,
- Vasanta Desai: Entrepreneurial development, and Management, 13th edition, Himalaya pub., Harper Collins, edition- Paperback.
- Peter F. Drucker: Innovation and development

Process Modelling and Simulation

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

Pre-requisites: Knowledge of Chemical Process Calculations, Heat Transfer, Mass Transfer, Chemical Reaction Engineering

Course Objectives: The course aims at developing the ability of students in mathematical treatment of chemical engineering processes. The objective is to understand the basic concepts of process modeling and simulation. Starting from formulation of the model, the course presents several processes from chemical engineering, where simulation approaches and mathematical tools are discussed.

Syllabus:

Introduction:
Definition of mathematical model, lumped parameter models, distributed parameter models, uses of mathematical models, scope of coverage, principles of formulation.

Fundamental laws:
Continuity equations, energy equations, equation of motion, equations of state, equilibrium, chemical kinetics Mathematical

Models for Chemical Engineering Systems:
Series of isothermal constant holdup CSTRs, CSTRs with variable holdups, Two heated tanks, Non-isothermal CSTR, Single component vaporizer, Batch reactor, Ideal binary distillation column, Batch distillation with holdup, pH systems, Lumped parameter model of gas absorber, Model for heat exchanger, Model for interacting & non-interacting tanks, Model for biochemical reaction.

Simulation:

Approach and common numerical methods, simulation examples of isothermal CSTR, non-isothermal CSTR, Batch reactor

Course Outcomes:

CO1: Describe fundamentals of modelling and simulation, formulate mathematical models and perform degree of freedom analysis.

CO2: Derive the mathematical models for chemical engineering systems and solve them using any one of the softwares Polymath/C/C++/Matlab.

CO3: Apply simulation to get the output for the models of heat exchangers, distillation columns, reactor and process equipment.

Recommended books:

1. Luyben W. L., "Process Modeling Simulation and Control for Chemical Engineers", International Edition, McGraw Hill, (1990).
2. Rose L. M., "The Application of Mathematical Modelling to Process Development and Design", First Edition Applied Science Publisher Limited, London, (1974).
3. Bequette, "Process Dynamics- Modelling, Analysis and Simulation", PHI International, (2003).
4. Rase H. F., "Chemical Reactor Design for Process Plants, Vol II: Case Studies and Design Data", 1st Edition, John Wiley and Sons, New York, (1997).

5. Morton D. M., "Process Modelling", First Edition, Longman Publisher, (1986)

ENVIRONMENTAL IMPACT ASSESSMENT

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

Course Objectives: This subject will cover various aspects of Environment Impact Assessment methodologies, impact of development activities. Impact on surface water, Air and Biological Environment, Environment legislation Environment.

Course Outcomes:

- Identify the environmental attributes to be considered for the EIA study.
- Formulate objectives of the EIA studies.
- Identify the suitable methodology and prepare Rapid EIA.
- Identify and incorporate mitigation measures.

SECTION-A

UNIT–I

Basic concepts and principles ofEIA:InitialenvironmentalExamination,ElementsofEIA,-factorsaffecting E-I-A, Short-term and Long-term objectives of EIA, Impact evaluation and analysis, preparation of Environmental Base map, Classification of environmental parameters.

EIA guidelines 2006 (Notification of Government of India) — Merits and Demerits of EIA.

UNIT-II

E I A Methodologies: introduction, Criteria for the selection of EIA Methodology, E I A methods, Ad-hoc methods, matrix methods, Network method Environmental Media Quality Index method, overlay methods, cost/benefit Analysis.

Assessment of Impact of development Activities on Vegetation and wildlife, environmental Impact of Deforestation–Causes and effects of deforestation.

SECTION-B

UNIT- III

Procurement of relevant soil quality, Impact prediction, Assessment of Impact significance, Identification and Incorporation of mitigation measures.

UNIT– IV

Environmental Audit & Environmental legislation objectives of Environmental Audit, Types of environmental Audit, Audit protocel, stages of Environmental Audit, onsite activities, evaluation of Audit data and preparation of Audit report, Post Audit activities.

UNIT-V

The Environmental Protection Act, The water Act, The Air (Prevention & Control of pollution Act.), Motor Act, Wild life Act. Case studies and preparation of Environmental Impact assessment statement for various Industries.

TEXTBOOKS:

1. Larry Canter –Environmental Impact Assessment, McGraw-Hill Publications
2. Environmental Impact Assessment, Barthwal, R.R.New Age International Publications

REFERENCE BOOKS:

1. Sherman, J. Rosen, Manual for Environmental Impact Evaluation. Prentice Hall, New Jersey.
2. Erickson, P.A. Environmental Impact Assessment Principles and Applications.
3. Center, L.W., Environmental Impact Assessment Mc Graw Hill, New York.
4. Y. Anjaneyulu Environmental Impact Assessment Methodologies , B. S. Publications
5. Canter LW (1996) Environmental Impact Assessment. Mc Graw Hill, New York.
6. EnvironmentalPollutionbyR.K.KhitoliyaS.Chand,2014.
7. Glynn,J. and Gary, W.H.K. –Environmental Science and Engineering, Prentice Hall Publishers
8. SureshK.Dhaneja-Environmental Scienceand Engineering, S.K.Kataria & Sons Publication. New Delhi.
9. Bhatia,H.S.-Environmental Pollution and Control, Galgotia Publication(P) Ltd, Delhi.
10. Wathern,P.–EnvironmentalImpactAssessment:Theory&Practice,Publishers-Rutledge,London,1992.
11. Fundamentals of Ecology, E.P. Odum, W.B. Saunders & Co.
12. Das, R.C. and Behera, D.K. Environmental Science – Principles and practice, PHI, New Delhi. 2008.

Title	**Applications of Computational Fluid Dynamics**	**Credits**	3
THEORY			
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		
Course Objective	The objective of the course is focused to i. Make the students understand the applications of Computational Fluid Dynamics. ii. Study various solution algorithms and solution techniques for CFD. iii. Study the importance of grid generation and Simulation of CFD problems using CFD software.		
Course Outcomes	At the end of the course, the students will be able to: i. Apply finite difference and finite volume methods in CFD modelling. ii. Understand fundamentals of CFD, solve partial differential equations and finite difference equation. iii. Understand various solution algorithms for CFD iv. Generate and optimize the numerical grid. v. Simulate the CFD models and analyse its results		
SECTION- A			

Introduction to computational fluid dynamics (CFD), need for problem solving with CFD, understanding CFD approach, modelling and governing equations, mass, momentum and energy conservation equations, applications to different branches of Science and Engineering, specific applications to Chemical Engineering, various tools and software related to CFD.

Partial differential equations, classification, parabolic, hyperbolic and elliptical equations, illustrative examples. Approximate solution to differential equations, error minimization principles, variation principles and weighted residual approach.

Fundamentals of discretization, finite element method, finite difference and finite volume method, consistency, error and stability analysis, boundary conditions, illustrative examples.

SECTION- B

Grid generation: basic understating of mesh generation, types of grids, structured and unstructured mesh, factors effecting grid, guidelines on mesh quality and design, mesh reinforcement and adaptation, numerical grid generation, transformation and mapping.

Solution techniques: Explicit and implicit methods; First order and second order upwind schemes; QUICK scheme, SIMPLE, SIMPLER and MAC algorithm, pressure velocity coupling algorithms, velocity-stream function approach, Solution techniques for Navier-Stokes equation; SIMPLE type methods; fractional step methods.

Solution of finite difference equations, iterative methods, matrix inversion methods, Alternating direction implicit (ADI) method, operator splitting, fast Fourier transforms.

Simulation of CFD problems using CFD softwares, simulation of coupled heat, mass and momentum transfer problems. Turbulence modelling: Reynolds averaged Navier-Stokes (RANS) equations, RANS modelling, Reynolds stress model (RSM), Direct numerical simulation (DNS) and Large eddy simulation (LES).

Recommended Books

i. Anderson J. D. : Computational Fluid Dynamics, McGraw Hill, 1995.

ii. Ferziger J. H. and Peric M. : Computational Methods for Fluid Dynmaics, 3rd edition, Springer-Verlag, Berlin, 2003.

iii. Murlidhar K. and Sundararajan T. : Computational Fluid Flow and Heat Transfer, Narosa Publishing House, 1995.

iv. Ghosdastidar P.S. : Computer Simulation of Flow and Heat Transfer, McGraw Hill, 1998.

v. Blazek J. : Computational Fluid Dynamics: Principles and Applications, 3rd edition, Elsevier, Butterworth-Heinemann, 2015.

Title	**Fluidization Engineering**	**Credits**	3
THEORY			
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		
Course Objectives	i. The objective of the course is focused to make the students understand the fundamental aspects of fluidization engineering including its industrial applications. ii. To study fluidized bed behavior, Elutriation phenomena, expanded bed and spouted beds.		
Course Outcomes	At the end of the course, the students will be able to: i. Understand the fundamentals of fluidization including operational regimes and industrial applications. ii. Understand heat and mass transfer phenomenon taking place in fluidized beds. iii. Analyse and understand fluidized bed behaviour. iv. Understand expanded bed, elutriation and spouted bed. v. Analyse and understand the factors affecting fluidization performance.		

SECTION- A

Introduction: Phenomena and fundamentals of fluidization, history of fluidization, liquid like behavior of fluidized bed, advantages and disadvantages of fluidized bed, industrial applications like chemical reactions and catalysis; physical and mechanical processes.

Fluidization regimes, mapping, fluidized state spectrum, particulate and aggregative fluidization, minimum fluid voidage, channeling, slugging, pressure drop flow diagrams, fluidization performance: effect of bed height, height to diameter ratio, particle size distribution, gas velocity, fluid distributor design, dense bed viscosity.

Fluidized bed behavior:fixed bed and onset of fluidization: basics of fixed bed, minimum fluidization velocity estimation and correlations.

SECTION- B

Expanded bed: liquid solid system, voidage function, stratification, Richardson and Zaki correlation, gas solid system, fluidization efficiency, fluctuation ratio, Elutriation: definition, factors affecting elutriation, elutriation mechanism, terminal velocity. Dilute phase and moving solids: disperse-phase characteristics, Introduction to spouted bed, pressure drop flow diagram, Solids and fluid mixing.

Heat and mass transfer in fluidized beds:Heat transfer mechanism, heat transfer between dense phase and dilute phase fluidized beds, generalized correlation for fluidized bed mass transfer and its limitations.

***Books Recommended*:**

1. Leva, M. : Fluidization, McGraw Hill, New York, 1959.
2. Kunii, D. and Levenspiel, O. : Fluidization Engineering, 2nd Edition, Butterworth-Heinemann. 1991.

CHEMICAL PROCESS OPTIMIZATION

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

Course Objectives:

To study and apply optimization techniques in the chemical process industry.

Course Details

Introduction: Process optimization, Formulation of various process optimization problems and their classification, Basic concepts of optimization-convex and concave functions, Necessary and sufficient conditions for stationary points. **(10 hrs)**

Optimization of One Dimensional Functions: Unconstrained multivariable optimizationdirect search methods, Bracketing methods: Exhaustive search, Bounding phase, Region elimination methods- Interval halving, Fibonacci search, Golden section search, PointEstimation, Successive quadratic estimation methods. **(10 hrs)**

Indirect First Order and Second Order Methods: Gradient-based methods-NewtonRaphson, Bisection, Secant, Cubic spline, Root-finding using optimization Techniques. Multivariable Optimization Algorithms: Optimality criteria, Unidirectional search, Direct search Methods- Evolutionary optimization, Simplex search, Powell's conjugate direction, Gradient-based methods- Cauchy's (steepest descent) method, Newton's method. **(10 hrs)**

Constrained Optimization Algorithms: Kuhn-Tucker conditions, Transformation methods, Penalty function method, Method of multipliers, Sensitivity analysis, Direct search for constraint Minimization-Variable elimination method, Complex search method, Successive linear and quadratic programming, Optimization of staged and discrete processes. **(10 hrs)**

Non-traditional Optimization Techniques: Introduction to Simulated annealing, Genetic algorithms, Differential evolution. **(5 hours)**

Course Learning Outcomes (CLO):
Upon completion of this course, the students will be able to:
1. formulate the objective functions for constrained and unconstrained optimization problems.
2. use different optimization strategies.
3. solve problems using non-traditional optimization techniques.
4. use of different optimization techniques for problem solving.

Text Books:
1. Edgar, T. F., Himmelblau, D. M. and Lasdon, L.S. Optimization of Chemical Processes, McGraw-Hill (2001).
2. Babu, B.V., Process Plant Simulation, Oxford University Press (2004)

Reference Books:
1. Kalyanmoy, D., Optimization for Engineering Design, Prentice Hall (1998).
2. Reklaitis, G. V., Ravindran, A., and Ragsdell, K. M., Engineering Optimization - Methods and Applications, John Wiley (1983).
3. Pike, R. W., Optimization for Engineering Systems, Van Nostrand Reinhold (1986).
4. Box, G. E. P., Hunter, W. G., Hunter, J. S., Statistics for Experimenters - An Introduction to Design, Data Analysis, and Model Building, John Wiley (1978).

CRYSTAL PHYSICS

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

Course Objectives:
During this course students will understand
a) basics of crystal structure and correlate the same with different material properties.
b) They will be able to describe the concepts of lattice dynamics and crystal binding forces and correlate the same with thermal properties.

Syllabus Details

1. **CRYSTAL STRUCTURES** - Periodic array of atoms, Lattice, basis, primitive cell, two and three dimensional lattice types, miller indices, examples of crystal structures (NaCl, CsCl structures), Hexagonal closed packed, diamond, zinc sulfide structures, X-ray diffraction of crystal, Bragg's Law, reciprocal lattice, diffraction condition, Laue equation, structure factor, atomic form factor. **(12 hours)**

2. **CRYSTAL BINDING** – *van-der-waals* interaction, repulsive interaction, equilibrium lattice constant, cohesive energy, ionic crystals, covalent crystals, electrostatic energy, Madelung constant. **(10 hrs)**

3. **PHONONS AND CRYSTAL VIBRATIONS** - monoatomic basis, first Brillouin zone, dispersion relation, two atoms per primitive basis, quantization of elastic waves, phonon momentum, inelastic scattering by phonon. **(10 hrs)**

4. **THERMAL PROPERTIES** - phonon heat capacity, density of states, Einstein model, Debye model of heat capacity, inharmonic crystal interaction, thermal expansion. Thermal conductivity, Umklapp Processes. **(10 hours)**

Course Outcomes:
By the end of the course
1) Students will be able to solve the problems based on crystal structure and thermal properties of solids

2) Understand and apply the basic concepts of crystal binding and crystal vibrations in different phenomena.

ADVANCED PHYSICS

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

Course Objectives:
At the end of this course the students should be able to describe and implement concepts and principles of Quantum Mechanics required for in depth understanding of Physical phenomena of materials in relation to applications in Engineering. The students should be able to solve numerical problems in Nuclear and Solid State physics

Course Details
Module1:
Quantum theory of light, X-rays - production, spectrum &diffraction(Bragg's Law), photoelectric effect, compton effect, pair production, photons & gravity, black holes, deBroglie hypothesis, particle diffraction, uncertainty principle and applications. Postulates of quantum mechanics, Schrodinger theory, time-dependent and timeindependent Schrodinger equation, wave function, Born interpretation and normalization, expectation values. **(10L+4T hours)**

Module 2:
Particle in a box (infinite well potential), finite potential step and barrier problems, tunneling, linear harmonic oscillator (one-dimensional). Hydrogen atom, radiative transitions and selection rules, electron spin, Stern-Gerlach experiment, Spin-orbit coupling, exclusion principle, symmetric and anti-symmetric wave functions. Alpha decay, Zeeman Effect, Correspondence Principle, Angular Momentum in Quantum Mechanics **(10L+4T hours)**

Module 3:
Natural radioactivity, successive radioactive transformations, radioactive equilibrium, radioactive series, radiometric dating.
Nuclear force and its characteristics, Elementary description of shell model, explanation of magic numbers, liquid drop model and semi-empirical binding energy formula. Nuclear fission, fission products, mass and energy distribution of fission products, neutron emission and energy distribution of neutrons emitted in fission, theory of fission process, nuclear reactors - classification, neutron cycle in thermal reactors and fourfactor formula for neutron reproduction, nuclear fission - controlled thermonuclear reactions.
Artificial radioactivity and its application, Beta-decay (energy spectrum & discovery of neutrino), fusion reactions in stars. **(10L+4T hours**

Module 4:
Band theory of solids, Kronig-Penney Model (qualitative), conductors, insulators and semiconductors, p-type and n-type semiconductors, statistics of electrons and holes, Hall effect (for single as well as both type of charge carriers) **(7L+1T hours)**

Module 5:
Occurrence of superconductivity, destruction of superconductivity, Meissner effect, type I and type II superconductors, heat capacity, isotope effect, thermodynamical considerations, London equations & penetration depth, coherence length, BCS theory (elementary description), applications of superconductors. High temperature superconductivity, Josephson junctions. **(8L+2T hours)**

Course Outcomes:
By the end of this course:
1. Students will be able to solve numerical problems in Quantum Mechanics, Nuclear and Solid State Physics.

2. Students will be aware of latest developments in certain areas of Physics like condensed matter physics, superconductivity etc. which have important applications for societal needs.
3. Students will be able to correlate the various phenomena with quantum mechanical concepts.

Suggested Books:

1) "Concepts of Modern Physics", Arthur Beiser, McGraw Hill Education (India) Pvt. Ltd., New Delhi. 2013
2) "Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles", Robert Eisberg and Robert Resnick, Wiley India Pvt. Ltd., New Delhi , 2013
3) "Introductary Nuclear Physics", Kenneth S Krane, Wiley India Pvt. Ltd., New Delhi 2014
4) "Modern Physics", J. Bernstein, P.M. Fishbane and S.G. Gasiorowicz, Pearson, Education India Pvt. Ltd., New Delhi

Energy Materials

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

Objectives of the course

To learn the operating principle of several environmentally friendly energy technologies. To identify the material issues relevant to these technologies and to evaluate various operational aspects associated with these technologies.

Detailed contents

Module 1: Energy requirements in a global scale and in the Indian context. (3 Hours)
Module 2: Evaluation of energy sources from the perspective of clean energy. Carbon equivalent (2 Hours)
Module 3: Introduction to different types of energy storage and conversion devices and technologies. Synthesis and characterization of materials used for these technologies, Properties desired in the materials, Techniques to evaluate the properties and performance, failure modes and analysis, environmental impact of the following technologies:
Fuel cells (10 Hours)
Batteries (10 hours)
Super-capacitors (3 hours)
Solar energy conversion devices (7 Hours)
Wind (3 Hours)
Mechanical Energy storage (2 Hours)

Suggested books

1. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, 2004

Course Outcomes

After completing this course the student should be able to:

1) Evaluate an energy technology for environmental friendliness
2) Explain the operating principle of several energy technologies
3) Indicate the material requirements for these energy technologies
4) Demonstrate the ability to understand the characterization, performance, and failure data related to these technologies

Materials Characterization

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

Objectives of the course

- To obtain knowledge on various structural and microstructural characterization techniques of materials.
- To study the principles, theory and practice of various characterization techniques

Detailed contents

Module 1:

Structural Characterization: X ray diffraction Symmetry, Lattice, points groups, Bravais lattices, crystal systems, X-ray generation, Bragg Law, factors influencing intensity, Techniques, Indexing, precise lattice parameter determination, residual stress measurement (18 hours)

Module 2:

Microstructural Characterization: Optical Microscopy: Introduction, Contrast, Magnification, Resolution, Numerical aperture, Coherent and incoherent waves, Rayleigh and Abbe's criterion for resolution, Different lens defects, Depth of field, Depth of focus, Bright field microscopy, Dark field microscopy, Phase contrast microscopy, Sample preparation for metallography (18 hours)

Module 3:

Scanning electron microscopy: Electron Specimen interaction, Magnification, Resolution, Depth of field, Construction and principles, Contrast, sample preparation, Different detectors, contrast and image quality (12 hours)

Module 4:

Transmission Electron Microscopy: Construction and principles, sample preparation, Different modes, lens defects and it correction, principles of Diffraction, Ewald spheres, Indexing, Kikuchi lines, Imaging, application on materials Chemical Characterization: Basic principles of spectroscopic techniques: EDS, WDS, XPS, and EELS (12 hours)

Suggested books

1. Fundamentals of Light Microscopy and Electronic Imaging : Douglas B. Murphy and Michael Davidson, Wiley-Blackwell, 2012
2. Scanning Electron Microscopy and X-Ray Microanalysis: A Text for Biologists, Materials Scientists, and Geologists by Joseph Goldstein and Dale E. Newbury, Springer 2011
3. Elements of X-ray diffraction: B.D. Cullity, Pearson Education 2014,
4. Electron microscopy and analysis: P. J. Goodhew, J. Humphreys, R. Beanland, 3rd edition, CRC Press 2000.

Course Outcomes:

After completing this course the student will be able to:

1. Determine crystal structures of materials
2. Analyse microstructure of materials at different length scales
3. Analyse defects and fracture surfaces of the tested materials
4. Indicate instrumentation associated with and operating principles of various techniques

Nanomaterials

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

Objectives of the course

To recognize the differences between nanomaterials and conventional materials and to become familiar with a wide range of nanomaterials, their synthesis, characterization, properties and applications

Detailed contents

Module 1: History of nanomaterials (2 Hours)

Module 2: Discussion of the Feynman talk "There is plenty of room at the bottom" (4 Hours)

Module 3: Synthesis routes for nano and ultra fine grained materials: bottom up and top down approaches (2 Hours)

Module 4: Specific synthesis routes such as vapor deposition, sol-gel, rapid solidification processing, high energy ball milling, cryo rolling, and equal channel angular extrusion (6 Hours)

Module 5: Thermodynamics of nanomaterials (3 hours)
Module 6: Mechanical property aspects of nanomaterials, inverse Hall-Petch relationship (2 Hours)
Module 7: Specific nano materials and their applications such as:
Carbon nanostructures (Nanotubes, nanohorns, graphene, buckyballs etc) (6 Hours)
Semiconducting nanomaterials – Quantum confinement, Quantum wells, quantum wires and quantum dots. (3 Hours)
Magnetic nanomaterials – super paramagnetism (2 hours),
Ferroelectric, nano ceramics (2 Hours)
Superplasticity (2 Hours)
Nanocomposites (2 Hours)

Module 8: Characterization techniques from the perspective of nanomaterials (4 Hours)

Suggested books

1. Introduction to Nanomaterials, Charles Poole and Frank Owens, Wiley 2007

Course Outcomes

After completing this course, the student should be able to:

1) Indicate the differences between nanomaterials and conventional materials
2) Indicate how specific synthesis techniques can result in nanomaterials
3) Give examples of specific nanomaterials and explain the scientific reasons for the properties displayed by them
4) Describe how specific characterization techniques can be used to analyze nanomaterials

Functional Materials

Objectives of the course

To introduce the student to functional materials and the science behind the performance of the functional material. To enable the student to understand the applications of functional materials

Detailed contents

Module 1: Characteristics and types of functional materials. Crystal structure and Properties. – Effect of size on properties, effect of interfaces on properties (6 Hours)
Module 2: Band structure, Semiconductor devices – Theory, examples and applications of Optically active materials (10 Hours)
Module 3: Dielectrics, piezo- and ferroelectric materials: (10 Hours)
Module 4: Magnetic materials and storage applications. (4 Hours)
Module 5: Smart materials (5 Hours)
Module 6: Applications in electronic, communication, aerospace, automotive, energy industries (5 Hours)

Suggested books

1. Functional Materials: Electrical, Dielectric, Electromagnetic, Optical and Magnetic applications; Deborah D L Chung, World Scientific Publishing, 2010

Course Outcomes

After completing the course the student will be able to:

1) Indicate the various type of functional materials
2) Explain the principle of operation of the functional material
3) Indicate the applications of the functional materials

Open Elective Lab.

Title	**Process Modelling & simulation**			**Credits**	1.5
Max.Marks	**End term**	**Mid term**	**Practical:50**		
Pre requisites	**-**				
Course objectives	To study the modeling & simulation techniques of chemical processes and to gain skills in using process simulators. Chemical Process Modeling considers a systematic approach to the creation of information systems of modeling and design of complex chemical-technological processes. The students are introduced to the methods of computer simulation of engineering systems as used within the chemical and refinery industry, for the prediction of the (steady-state) behavior and performance of various technology processes.				
Course outcomes	By the end of the course, students will be able to: To calculate the different physicochemical and thermodynamic properties chemicals; To describe chemical engineering processes in mathematical form and create simulation models of various types; To implement optimization process and chemicals.				

Practical

Functional design, property estimate as inputs for design. System concepts for computer aided design, computer aided flow sheet design. (7 hrs)

Process analysis. Process variables selection, equipment design through the selection of free parameters subject to constraints and other parameters, modular design. Simulation optimality. Dynamic design including control stability. (8 hrs)

Typical equipments to be considered: heat exchangers, distillations columns, reactor and process equipments. (30 hrs)

***Books Recommended*:**

1. Luyben, W.L. : Process Modeling, Simulation & Control, Mc Graw-Hill Book Co.
2. Franks, R.G. E. : Modeling and Simulation in Chemical Engineering, Wiley Interscience.
3. Mischke, C. : Computer Aided Design, Prentice Hall.

Paper Title: Departmental Elective (Theory)

Course Duration: 60 Lectures of one hour each.

Title	**NUMERICAL METHODS IN CHEMICAL ENGINEERING**		
THEORY			
Course Outcomes	CO1: Learn evaluating error in calculations, use of numerical methods for solving algebraic and transcendental equations and using various methods to carry out numerical differentiation and numerical integration. CO2: Understanding the concept of Finite Differences and Learn to use this for Interpolation and Inverse Interpolation with equispaced and unequispaced data. Learn to use Least Square Curve Fitting Procedure. CO3: Solve numerically ordinary differential equations of First and Higher order/Simultaneous differential equations using different methods. CO4: To Find the solution of linear system of equations by Direct and Iterative methods. Learn to solve partial differential equations using Finite difference approximation method.		
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		
SECTION- A			
Errors in Numerical Calculations, Solution of Algebratic and Transcendental Equations: The Bisection Method, The method of False Position, The Iteration Method, Newton-Raphson Method. Interpolation: Finite Differences, Differences of a Polynomial, Newton's Formulae for Interpolation, Central Difference Interpolation Formulae, Interpolation with Unevenly Spaced Points, Divided Differences and their Properties, Inverse Interpolation, Curve Fitting, Least-Squares Curve Fitting Procedures, Weighted Least Squares Approximation. Numerical Differentiation and Integration: Trapezoidal Rule, Simpson's 1/3 –Rule, Simpson's 3/8-Rule, Weddle's Rules and Romberg Integration.			
SECTION- B			
Solution of Linear Systems, Gaussian Elimination Method, Gauss-Jordan Method, Jacobi Iteration Method, Gauss-Seidel Iteration Method. Numerical Solution of Ordinary Differential Equation: Taylor's Series Expansion Method, Picard's Method, Euler's Method, Runga-Kutta Methods, Predictor-Corrector Methods, Simultaneous and Higher Order Equations. Numerical Solution of Partial Differential Equations: Finite-Difference Approximation to Laplace's Equation, Parabolic Equations and Hyperbolic Equations			
Recommended Books 1. Hildebrand, F.B. : Introduction to Numerical Analysis. 2. Scarborough, J.B. : Numerical Mathematical Analysis, Oxford and ISH Pub. Co. 3. Chopra, S.C., & Canale, R.P. : Numerical Methods for Engineers. 4. Sastry, S. S. : Introductory Methods of Numerical Analysis, 4th Edition, Prentice Hall.			

***Books Recommended*:**

1. Askelland, Donald R. : The Science & Engineering of Materials, PWSKENT.
2. Shackleford, J.F. : Introduction to Material Science for Engineers, Mc Millan.
3. Van-Vlack, L.H. : Elements of Material Science & Engineering, Addison Wesley
4. Raghavan, V. : Material Science & Engineering, Prentice Hall of India
5. Callister Jr. William D. : Materials Science and Engineering- An Introduction, Wiley

PETROLEUM PROCESSING ENGINEERING (Theory)

Course Objectives: The course aims at understanding the basic concepts of Petroleum Refining , refining operations and processes. Various aspects of refinery operations such as petroleum sources, technology and techniques, reaction mechanism, catalysts used and safety.

COURSE Outcomes

CO1: Define Origin, exploration & drilling of petroleum crude, Crude pretreatment: Refining and distillation of petroleum crude, composition and classification of petroleum crude.
CO2: Describe Properties and specifications of petroleum products such as LPG, gasoline, naphtha, kerosene, diesel, lubricating oils and waxes.
CO3: Illustrate separation processes, Describe Solvent extraction processes and solvent dewaxing.
CO4: Describe Conversion Processes, cracking and refining, alkylation, polymerization, isomerisation and hydroprocessing, Safety and pollution considerations in refineries.

THEORY		**Time**	3 Hours
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		

Section-A

Introduction to petroleum industry, world petroleum resources, petroleum industry in India. Origin, exploration & drilling of petroleum crude. Transportation of crude and products.
Crude pretreatment: Refining and distillation of petroleum crude, composition and classification of petroleum crude, methods of evaluation: ASTM, TBP and EFV distillation. Properties and specifications of petroleum products such as LPG, gasoline,naphtha, kerosene, diesel, lubricating oils and waxes.

Section-B

Separation Processes: Design and operation of topping and vacuum distillation units and tube still furnaces. Solvent extraction processes for lube oil base stock and for aromatics from naphtha and kerosene steams, solvent dewaxing.
Conversion Processes: Thermal cracking: visbreaking and coking processes, catalytic cracking, thermal reforming and catalytic reforming, alkylation, polymerization, isomerisation and hydroprocessing.
Safety and pollution considerations in refineries.

Books Recommended:

1. Nelson, W.L. : Petroleum Refinery Engineering, 5th Edition, McGraw Hill, 1985.
2. Rao, B.K. : Modern Petroleum Refining Processes, 5th Edition, Oxford & IBH Publishing 2009.
3. Guthrie, V.B. : Petroleum Products Handbook, McGraw Hill, 1960.
4. Hobson, G.D., Pohl. W. : Modern Petroleum Technology, 5th Edition, John Wiley, 1984.

Title	**Transport Phenomena**		
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		
Objectives	▪ Explain the physical properties of a fluid and their consequences on fluid flow and heat transfer, expressed in terms of the Reynolds number, Nusselt number, and other dimensionless quantities. ▪ Use conservation principles of mass, momentum, and energy to develop models of fluid flow and heat transfer systems that can be used to predict the behavior of real world systems.		
Course outcomes	CO1: Ability to understand the chemical and physical transport processes and their mechanism of heat, mass and momentum transfer analysis CO2: analyse any transport related problem mathematically and predict the physical behaviour		

	of the process CO3: formulate problems along with appropriate boundary conditions and develop steady and time dependent solutions.

Section-A

Unit-1

Introduction – mechanisms of momentum transport and their transport properties. Development of mathematical modeling and differential equations through shell momentum balance for solving problems of momentum transport in one dimension and solve these problems by using equation of change-flow of a falling film, flow through circular tube, annulus, couette viscometer. (15 hrs)

Unit-2

Interphase momentum transport- definition of friction factor for flow in tubes, around spheres. (2 hrs)

Section-B

Unit-3

Mechanisms of energy transport and their transport properties. Development of mathematical modeling and differential equations through shell energy balance for solving problems of energy transport- heat conduction with electrical heat source, nuclear and viscous source, composite wall, cooling fin. (12hrs)

Unit-4

Mechanisms of mass transport and their transport properties. Development of mathematical modeling and differential equations through shell mass balance for solving problems of mass transport- diffusion through stagnant gas film, heterogeneous and homogeneous chemical reaction. (11 hrs)

Unit-5

Emphasis on tha analogy between momentum, heat and mass traner with respect to transport mechanims and governing equations. (5 hrs)

Books Recommended:

1. Bird, R.B., Stewart, W.E. and Lightfoot, E.N.: Transport Phenomena, 2nd Edition, John Wiley & Sons, 2005.
2. Weity, J.R. Wilson, R.E. and Wicks, C.E. : Fundamentals of Momentum Heat and Mass Transfer, 4th Edition, John Wiley & Sons, 2001.
3. Bennett.C.O. and Myres J.E.: Momentum, Heat and Mass Transfer, McGraw Hill.

PLANT UTILITIES(Theory)

THEORY		**Time**	3 Hours
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		
Course Objective	To teach the students about requirement and use of main utilities like compressed air, steam, water and refrigerants, which are required in process plants.		
Course Outcome	CO1: Understand the selection of different utilities to run process plant. CO2: Analyze the use of compressed air through air compressore and vacuum pumps. CO3: Analyse of use of steam and or boiler. CO4: To analyse the power generation through IC engines and turbines. CO5: Understand the importance refrigeration and water resources.		

SECTION-A

Importance of Process utilities in Chemical Plant.

Compressed air and Vacuum: Reciprocating air compressors, vacuum pumps, air receivers, piping systems.

Steam: Boiler, steam handling and distribution steam nozzles.

SECTION-B

Refrigeration: Air refrigeration cycle, vapour compression cycle, liquification processes.

Power Generation: Internal Combustion engines. Gas turbines, steam power plants.

Water: Water Resources, storage & distribution of water reuse & conservation of water.

***Books Recommended*:**

1. Jouganson, R. : Fan Engineering, Buffalo Rorge Co., 1970.
2. Wangham, D.A. : Theory and Practice of Heat Engines, ELBSCambridgeUniversity Press, 1960.
3. Lyle, O. : Efficient Use of Steam, HMSO, 1963.
4. Stoccker, W.F. : Refrigeration and Air Conditioning, Mc-Graw Hill, 1950.
5. Kurl, W.F. J.H.M. : Reuse of Water in Industry, Butterworth, London.

PETROCHEMICAL TECHNOLOGY (Theory)

THEORY		**Time**	3 Hours
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		

Section-A

General Introduction: Definition, history and economic perspective of petrochemical industry, raw materials for petrochemical industry-petroleum, natural gas, coal, bio-mass, agro-residues, etc.

First Generation Petrochemicals: Petrochemicals based on aliphatic, olefinic, acetylene,aromatics, etc. Hydrocarbons-processing and applications.

Second Generation Petrochemicals: Products based on Synthesis Gas, Method, Ethanol,Ethylene Oxide, Vinyl Chloride, Propylene Oxide, Isopropyl Alcohol, Acetone, AllylAlcohol, Glycerol, Phenol, Aniline.

Section-B

Nylon Monomers, Polyester Monomers, Styrene, Other Monomers - Bisphenol A, Epichlorophydrin, diisocyanates, Pentaerythritol, etc. - properties,process technologies and applications. .

Third Generation Petrochemicals: Important Polymers such as Polyethylene, Polypropylene and their Copolymers and other Derivatives Rubbers, Diene Polymers, Styrene Polymers,Vinyl Polymers and Condensation Polymers - properties, process technologies and applications.

***Books Recommended*:**

1. Steiner, H.: Introduction to Petroleum Chemicals, Pergamon Press.
2. Waddane, A.L. : Chemicals from Petroleum, John Murry.
3. Topchiev, A.V. : Synthetic Materials from Petroleum, Pergamon Press.
4. Astle, M.J. : The Chemistry of Petrochemicals, Reinhold.
5. Maiti, S.: Introduction to Petrochemicals, Oxford and IBH Pub. Co. Ltd., New Delhi, 1992.
6. Frank, H.G. &Stadelhofer, J.W.: Industrial Aromatic Chemistry, Springer Verlag Berlin, 1987.

BIOCHEMICAL ENGINEERING (Theory)

Course Outcomes

CO1: Gaining knowledge about metabolic pathways and cell growth.
CO2: Understanding the concept of enzyme kinetics and their applications.
CO3: Designing and creating new processes and fermented products that are better economically and technologically.
CO4: Understanding the basic calculations for heat and mass transfer and yield of product.

THEORY		**Time**	3 Hours
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		

Section-A

Isolation and Utilization of Enzymes: Purification, immobilization, application of enzyme technology.
Kinetics of Enzyme-Catalyzed Reactions: The substrate, enzyme kinetics, factors affecting enzymatic activity and enzymatic reactions in heterogeneous reactions.
Metabolic Pathways and Energetics of the Cell: The concept of energy coupling, aerobic and anaerobic metabolism, photosynthesis and biosynthesis, transport across cell membranes.
Cellular Genetics and Control: Growth and reproduction of a single cell, alteration of cellular DNA, commercial applications.

Section-B

Kinetics of Substrate Utilization. Product Yield and Biomass Production: Growth cycle for batch cultivation and its mathematical modeling, products synthesis kinetics, thermal death kinetics of cells and spores.
Transport Phenomena in Microbial Systems: Gas-liquid mass transfer, determination of oxygen transfer rates, mass transfer, surface-area correlations for mechanically agitated vessels, scaling of mass transfer equipment, particulate mass transfer, heat transfer.
Design and Analysis of Biological Reactors: The ideal continuous-flow stirred-tank reactor (CSTR), residence time distribution, different types of reactors, relationship between batch and continuous biological reactors. Fermentation technology, product manufacture by fermentation, reactors for biomass production.

Books Recommended:

1. Balley & Ollis : Biochemical Engineering Fundamentals, McGraw Hill Book Co., 1986.
2. Aiba Humphrey & Millis : Biochemical Engineering, Academic Press, 1973.
3. Whitaker Stanbury & Whitaker, Hall : Principles of Fermentation Technology, Adita Books, New Delhi, 1997.

FOOD PROCESSING (Theory)

THEORY		**Time**	3 Hours
Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.		

SECTION A

Kinetics of biological reactions, determination of reaction order, changes of quality during processing/ storage of foods. Application of Arrhenius equations to biological reactions. Engineering Properties of foods, and their importance. Food processing equipment and their design. Steady state and unsteady state heat transfer. Numerical, graphical methods during heat transfer and their analysis. Unsteady state equations. Food quality deterioration and their modelling.
Principles of Refrigeration. Calculation of refrigeration load. Natural refrigeration, Vapour compression refrigeration. Mollier Chart, Rating of Systems, Compressors, evaporators, Condensers, Expansion valve. Pump, Absorption refrigeration.
SECTION B
Thermal Processing of foods. Pasteurization and sterilization, D value, F value, Z value. Process time calculation. Cook value and quality retention. Time temperature integrators (TTI). Microbial survival curve. Lethality, Ball method. Process calculation by graphical method. Freezing of foods, optimization of freezing time.

Reference Books

Heldman and Singh. 1995. Introduction to Food Engineering. Academic Press.
McCabe WL, Smith JC and Harriott P. 1993. Unit operations of Chemical Engineering. McGraw Hills.

INDUSTRIAL ENVIRONMENTALMANAGEMENT

Note for the Examiner	The examiner will set seven questions of equal marks. The first question ,which is compulsory, will cover the entire syllabus, having ten conceptual questions of one mark each or five questions of two marks each. Rest of paper will be divided into two parts (SECTIONS) having three questions each and candidate is required to attempt at least two questions from each part.The duration of End Term exam will be 3 hrs.

PreRequisites: **Environmental Engineering**

Course Objectives: This subject will cover various aspects of Industrial Environment Management ,different methodologies, impact of development activities. Management of Industrial Environment, Environment legislation and Environment regulations for industries.

COURSE OUTCOMES (CO):

At the end of this course, students are expected to be able to:

A. Explain the ecological principles and philosophy of environmental management in the perspective of sustainable industrial development.
B. Explain the sources of industrial pollution, their characteristics, and their impact on the environment.
C. Determine environmental quality standard parameters and evaluate the industrial environment quality.
D. Apply the principles and philosophy of managing industrial environment in industrial environmental management systems.

SECTION-A

UNIT-I

Agroindustry, environment and sustainable development, Environmental Management System as a framework for industrial environmental management, Methods for identifying environmental aspects, Methods for evaluating significant environmental impacts, Characteristics and impact of industrial pollutants: liquid wastes, Characteristics and impact of industrial pollutants: solid wastes, Characteristics and impact of industrial pollutants: air pollutants.

UNIT-II

Interpretation of pollutant characteristics: Air Pollution Control, Interpretation of pollutant characteristics: Water Pollution Control, Principles of industrial environmental management: proactive approach, life cycle framework and life cycle assessment methodology, output control approach, Industrial Ecology, Plan preparation for environmental management and monitoring.

SECTION-B

UNIT-III

Disaster Management plan on site & off site, Environmental Auditing: Scope, Objectives and Procedures for environmental auditing. Environmental Management System (EMS): EMS standards, The ISO 14000 series, The ISO 14001. Pollution control norms at source – Coastal Zone Regulation restrictions – Zoning atlas – Medium related standards (Ambient standards)

UNIT-IV

Preventive Environment Management– Cleaner production and Clean technology, closing the loops, zero discharge technologies – Four Stages and nine approaches of Pollution Prevention - Getting management commitment – Analysis of Process Steps- source reduction, raw material substitution, toxic use reduction and elimination, process modification –Material balance – Technical, economical and environmental feasibility evaluation of Pollution Prevention options in selected industries –Preventive Environmental Management over Product cycle.

TEXT BOOKS:

1. Christopher Sheldon and Mark Yoxon, "Installing Environmental management Systems – a step by step guide" Earth scan Publications Ltd, London, 1999.
2. Barrow, C.J. 2000. Environmental Management: Principles and Practice. Routledge, London.
3. ISO 14001/14004: Environmental management systems – Requirements and Guidelines – International Organization for Standardization, 2004
4. ISO 19011: 2002, "Guidelines for quality and/or Environmental Management System auditing, Bureau of Indian Standards, New Delhi, 2002

REFERENCE BOOKS

1. Henry, J.G and G.W. Heinke.1996. Environmental Science and Engineering, 2nd Edition. Printice-Hall International, Inc., New Jersey.
2. Asafu-Adjaye, J.2000. Environmental Economic for Non-Economist. World Scientific. Singapore
3. Nathanson, J.A. 1997. Basic Environmental Technology: Water Supply, Waste Management, and Pollution Control, 2nd Edition. Printice-Hall, Ohio.

4. Waver, G. 1996. Strategic Environmental Management: Using TQEM and ISO 14000 for Competitive Advantages, John Wiley and Sons, Inc., New York
5. Petts, J & G. Eduljee. 1994. Environmental Impact Assessment for Waste Treatment and Disposal Facilities. Wiley Publishers, New York
6. World Bank.2000. Greening industry: New Roles for Communities, Market and Government. Oxford University Press. New York
7. Philipp Weir and Jörg Bentlage, Environmental Management Systems and Certification, Baltic University Press, Uppsala 2006
8. Lennart Nilsson, Per Olof Persson Lars Rydén, Siarhei Darozhka and Audrone Zaliauskiene, Cleaner Production-Technologies and Tools for Resource Efficient Production, Baltic University Press, Uppsala, 2007
9. Paul L Bishop 'Pollution Prevention: Fundamentals and Practice', McGraw- Hill International, Boston, 2004.
7. Marek

Department Elective Lab.

Title	**PETROLEUM PROCESSING ENGINEERING (PRACTICAL)**		
Course Assessment Methods	The students will be assessed based upon the practical assignments and viva voce.		
Course Objectives	The students will get the practical exposure of calculating different properties of petroleum products like smoke point, flash point, cloud point, pour point, aniline point, viscosity index, ASTM distillation, softening point, etc.		
Course Outcomes	Upon successful completion of the course, the students will be able to: CO1: Determine flash point (Closed–cup) and smoke point for kerosene, ASTM distillation curve for gasoline, diesel oil. CO2: Determine aniline point, diesel index, cetane number and cloud point for diesel oil, pour point for furnace oil. CO3: Determine viscosity at different temperatures using Ostwald viscometer for hydrocarbon solvents, viscosity index of lubricating oil by Redwood viscometer. CO4: Determine water content in petroleum products by Dean and Starks method.		
PRACTICAL			
1. To plot ASTM distillation curve for gasoline, diesel oil.			
2. To determine Flash point (Closed – cup) and smoke point for kerosene.			
3. To determine Aniline point, Diesel Index and cetane number for diesel oil.			
4. To determine pour point and cloud point for furnace oil and diesel oil.			
5. To determine viscosity at different temperatures using Ostwald viscometer for hydrocarbon solvents.			
6. To determine softening point and penetration number for asphalt and grease samples.			
7. To determine viscosity index of lubricating oil by Redwood viscometer.			
8. To determine water content in petroleum products by Dean and Starks method.			
Recommended Books:	Rao, B.K.: Modern Petroleum Refining Processes, 5th Edition, Oxford & IBH Publishing Co., 2009.		

Title	**CHEMICAL ENGINEERING COMPUTATION LAB.**		**Credits**	1.5
Code	PEC 151	**Semester:-**4th	**L T P**	- - 3
Max.Marks	**End term**	**Mid term** **Practical: 50**	**Elective**	N
Pre requisites	**-**			
Course Assessment Methods	The students will be assessed based upon the practical assignments and viva voce.			
Objectives	Students will learn to use MATLAB to solve Chemical Engineering numerical problems			
Course Outcomes	CO1: Determination of solution of linear and non-linear algebraic and transcendental equations using computer programs or MATLAB. CO2: To carryout Numerical differentiation & integration using computer programs. CO3: To find solution of Ordinary and partial differential equations using computer programs. CO4: Carryout Interpolation and least squares approximation using computer programs.			
Practical				
Topic				**No. of hours**
Errors analysis, Solution of linear and non-linear algebric equations.				**9**
Numerical differential & integration.				**9**
Interpolation.				**9**

Least squares approximation	**9**
Ordinary and partial differential equations	**9**
Recommended Books:	
1. Grewal, B.S. : Numerical Methods in Engineering and Science, Khanna Publishers, N. Delhi, 2001. 2. Sastry, S.S. : Introductory Methods of Numerical Analysis, Prentice Hall of India.	