B. TECH. DEGREE PROGRAMME IN CHEMICAL ENGINEERING

(Applicable from 2010 Admission onwards)

CURRICULUM AND SYLLABI

DEPARTMENT OF CHEMICAL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY CALICUT
KOZHIKODE– 673 601, INDIA.

Vision of the Institute:

"International standing of the highest caliber"

Mission of the Institute in pursuance of its vision:

To develop high quality technical education and personnel with a sound footing on basic engineering principles, technical and managerial skills, innovative research capabilities, and exemplary professional conduct to lead and to use technology for the progress of mankind, adapting themselves to changing technological environment with the highest ethical values as the inner strength.

Vision of the Chemical Engineering Department

To be a global leader in chemical engineering education, creating well qualified engineers of high caliber who can contribute to their profession and are equipped with necessary traits to handle future technological challenges pertaining to chemical engineering and allied fields.

Mission of the Chemical Engineering Department

- **Offer high quality education in scientific and engineering aspects of chemical engineering.**
- **Impart engineering and research skills to the students to make them innovative and competitive with the changing needs of industry and environment.**
- **Create awareness of social responsibilities in students to serve the society.**

CURRICULUM OF

B.Tech DEGREE PROGRAMME

IN CHEMICAL ENGINEERING

(Applicable from 2010 Admission onwards)

Department of Chemical Engineering

Curriculum of B.Tech Degree Programme in Chemical Engineering

Semester 1

S.No	Code	Course Title	L	T	P/S	C	Category
1	MA1001	Mathematics I	3	1	0	3	BS
2	PH1001/ CY1001	Physics/ Chemistry	3	0	0	3	BS
3	MS1001/ ZZ1003	Professional Communication/Electrical Science	3	0	0	3	HL/ES
4	ZZ1001/ ZZ1002	Engineering Mechanics /Engineering graphics	3 1	0	0 3	3	ES/TA
5	ZZ1004/ CH1001	Computer Programming/ Introduction to Chemical Engineering	2	0	0	2	ES/PT
6	ZZ1091/ ZZ1092	Workshop I/Workshop II	0	0	3	2	TA
7	PH1091/ CY1094	Physics Lab/Chemistry Lab	0	0	2	1	BS
8	ZZ1094/ ZZ1093/ ZZ1095	OT Courses (Value Edn, Phy.Edn, NSS)	0	0	0	3*	OT
		Total credits	**14/12**	**1**	**3/6**	**17+ 3***	

Semester 2

S.No	Code	Course Title	L	T	P/S	C	Category
1	MA1002	Mathematics II	3	1	0	3	BS
2	CY1001/ PH 1001	Chemistry/Physics	3	0	0	3	BS
3	ZZ1003/MH 1001	Electrical Sciences/Professional Communication	3	0	0	3	ES/HL
4	ZZ1002/ ZZ1001	Engineering Graphics/ Engineering Mechanics	1 3	0 0	3 0	3	TA/ES
5	ZZ1004/ CH1001	Introduction to Chemical Engineering /Computer Programming	2	0	0	2	PT/ES
6	ZZ1092/ ZZ1091	Work shop II/ Work shop I	0	0	3	2	TA
7	CY1094/ PH 1091	Chemistry Lab/Physics Lab	0	0	2	1	BS
		Total credits	**12/14**	**1**	**3/6**	**17**	

Semester 3

S.No	Code	Course Title	L	T	P/S	C	Category
1	MA 2001	Mathematics III	3	0	0	3	BS
2	CY 2001	Physical Chemistry	3	0	0	3	PT
3	CH 2001	Chemical Technology	3	0	0	3	PT
4	CH 2002	Process Calculations	3	0	0	3	PT
5	CH 2003	Fluid Mechanics	3	0	0	3	PT
6	ME 2091	Machine Drawing	0	0	3	2	PT
7	CH 2091	Chemical Technology Laboratory	0	0	3	2	PT
		Total credits	**15**	**0**	**6**	**19**	

Semester 4

S.No	Code	Course Title	L	T	P/S	C	Category
1	MA 2002	Mathematics IV	3	1	0	3	BS
2	CH 2004	Material Science	3	0	0	3	PT
3	CH 2005	Mechanical Operations	3	0	0	3	PT
4	CH 2006	Heat Transfer	3	0	0	3	PT
5	CH 2007	Chemical Engineering Thermodynamics I	3	0	0	3	PT
6	CY 2002	Organic Chemistry	3	0	0	3	PT
7	CH 2092	Fluid Mechanics Lab	0	0	3	2	PT
8	CH 2093	Mechanical Operations Lab	0	0	3	2	PT
		Total credits	**18**	**1**	**6**	**22**	

Semester 5

S.No	Code	Course Title	L	T	P/S	C	Category
1	CH3001	Chemical Engineering Thermodynamics II	3	0	0	3	PT
2	CH 3002	Mass Transfer-I	3	0	0	3	PT
3	CH 3003	Chemical Reaction Engineering	3	0	0	3	PT
4	CH 3004	Process Instrumentation	3	0	0	3	PT
5	CH 3005	Environmental studies	3	0	0	3	OT
6		Elective I	3	0	0	3	PT
7	CH 3091	Environmental and Pollution Control Lab	0	0	3	2	PT
8	CH 3092	Heat Transfer Laboratory	0	0	3	2	PT
		Total credits	**18**	**0**	**6**	**22**	

Semester 6

S.No	Code	Course Title	L	T	P/S	C	Category
1	CH3006	Mass Transfer II	3	0	0	3	PT
2	CH 3007	Process Dynamics & Control	3	0	0	3	PT
3	CH 3008	Chemical Process Equipment Design	2	0	2	3	PT
4		Elective II	3	0	0	3	PT
5		Elective III	3	0	0	3	PT
6	CH 3093	Chemical Reaction Engineering Lab	0	0	3	2	PT
7	CH 3094	Mass Transfer Laboratory	0	0	3	2	PT
		Total credits	**14**	**0**	**8**	**19**	

Semester 7

S.No	Code	Course Title	L	T	P/S	C	Category
1	CH 4001	Transport Phenomena	3	0	0	3	PT
2	CH 4002	Computer Aided Design	2	0	2	3	PT
3	ME 4104	Principles of Management	3	0	0	3	HL
4		Elective IV	3	0	0	3	PT
5		Elective V	3	0	0	3	GE
6	CH 4091	Process Dynamics & Control Lab	3	0	0	2	PT
7	CH 4092	Project	0	0	6	3	PT
		Total credits	**17**	**0**	**8**	**20**	

Semester 8

S.No	Code	Course Title	L	T	P/S	C	Category
1	MS 4005	Engineering Economics	3	0	0	3	HL
2	CH 4003	Chemical Process Optimization	3	0	0	3	PT
3		Elective VI	3	0	0	3	PT
4		Elective VII	3	0	0	3	PT
5		Elective VIII	3	0	0	3	GE
6	CH 4093	Seminar	0	0	3	1	PR
7	CH 4094	Project	0	0	6	5	PR
		Total credits	**15**	**0**	**9**	**21**	

Total Credit Requirements

Semester	Credits
I	37
II	
III	19
IV	22
V	22
VI	19
VII	20
VIII	21
Total	160

Category – wise Credits

Code	S1	S2	S3	S4	S5	S6	S7	S8	TOTAL
BS	7	7	3	3	0	0	0	0	**20**
ES	3	5	0	0	0	0	0	0	**8**
HL	3	0	0	0	0	0	3	3	**9**
TA	2	5	0	0	0	0	0	0	**7**
PT	2	0	16	19	19	19	11	9	**95**
PR	0	0	0	0	0	0	3	6	**9**
GE	0	0	0	0	0	0	3	3	**6**
OT	3*	0	0	0	3*	0	0	0	**6***
Total	**17+3***	**17**	**19**	**22**	**19+3***	**19**	**20**	**21**	**154+6***

Electives

Code	Course Title	L	T	P/S	C	Category
CH 4021	Energy Technology	3	0	0	3	PT
CH 4022	Petroleum Refining Operations and Processes	3	0	0	3	PT
CH 4023	Corrosion Engineering	3	0	0	3	PT
CH 4024	Biochemical Engineering	3	0	0	3	PT
CH 4025	Polymer Technology	3	0	0	3	PT
CH 4026	Food Technology	3	0	0	3	PT
CH 4027	Electrochemical Engineering	3	0	0	3	PT
CH 4028	Ceramic Technology	3	0	0	3	PT
CH 4029	Biotechnology	3	0	0	3	PT
CH 4030	Environment Impact Assessment and Clean Technology	3	0	0	3	PT
CH 4031	Process Automation	3	0	0	3	PT
CH 4032	New Enterprises Creation and Management	3	0	0	3	PT
CH 4033	Speciality Polymers	3	0	0	3	PT
CH 4034	Process Modelling and Simulation	3	0	0	3	PT
CH 4035	Fertilizer Technology	3	0	0	3	PT
CH 4036	Membrane Technology	3	0	0	3	PT
CH 4037	Mathematical Methods in Chemical Engineering	3	0	0	3	PT
CH 4038	Computational fluid dynamics	3	0	0	3	PT
CH 4039	Catalysis	3	0	0	3	PT
CH 4040	Professional Ethics & Human Values	3	0	0	3	PT
CH 4041	Micro Electronics Processing	3	0	0	3	PT
CH 4042	Risk Analysis and Hazop	3	0	0	3	PT
CH 4043	Operations Research	3	0	0	3	PT
CH 4044	Novel Separation Techniques	3	0	0	3	PT
CH 4045	Human Resource Management	3	0	0	3	PT
CH 4046	Project Engineering	3	0	0	3	PT
CH 4047	Drugs & Pharmaceutical Technology	3	0	0	3	PT
CH 4048	Fuel Cells	3	0	0	3	PT
CH 4049	Composite Materials	3	0	0	3	PT
CH 4050	Safety in Chemical Industries	3	0	0	3	PT
CH 4051	Computer Application in Chemical Engineering	3	0	0	3	PT

SYLLABI OF
B.Tech DEGREE PROGRAMME
IN CHEMICAL ENGINEERING

(Applicable from 2010 Admission onwards)

SYLLABI OF THE COURSES FOR B.TECH DEGREE IN

CHEMICAL ENGINEERING

(2010 Admission)

FIRST SEMESTER

MA1001 MATHEMATICS I

L	T	P	C
3	1	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course Outcomes:

CO1. Learn to find the solution of constant coefficient differential equations.
CO2. Acquire knowledge about the notion of convergence of numerical sequences and series and learn ways of testing convergence.
CO3. Learn the basic definition and properties of partial differentiation of functions of several variables and to learn to use this to solve problems related to maxima and minima.
CO4. Learn the basic results about the properties of Fourier transform and Fourier series and its convergence.
CO5. Learn the properties of Laplace transforms and to learn to use this to solve differential equations

Module I: Preliminary Calculus & Infinite Series (9L + 3T)

Preliminary Calculus : Partial differentiation, Total differential and total derivative, Exact differentials, Chain rule, Change of variables, Minima and Maxima of functions of two or more variables. Infinite Series : Notion of convergence and divergence of infinite series, Ratio test, Comparison test, Raabe's test, Root test, Series of positive and negative terms, Idea of absolute convergence, Taylor's and Maclaurin's series.

Module II: Differential Equations (13L + 4T)

First order ordinary differential equations: Methods of solution, Existence and uniqueness of solution, Orthogonal Trajectories, Applications of first order differential equations. Linear second order equations: Homogeneous linear equations with constant coefficients, fundamental system of solutions, Existence and uniqueness conditions, Wronskian, Non homogeneous equations, Methods of Solutions, Applications.

Module III: Fourier Analysis (10 L+ 3T)

Periodic functions : Fourier series, Functions of arbitrary period, Even and odd functions, Half Range Expansions, Harmonic analysis, Complex Fourier Series, Fourier Integrals, Fourier Cosine and Sine Transforms, Fourier Transforms.

Module IV: Laplace Transforms (11L + 3T)

Gamma functions and Beta functions, Definition and Properties. Laplace Transforms, Inverse Laplace Transforms, shifting Theorem, Transforms of derivatives and integrals, Solution of differential Equations, Differentiation and

Integration of Transforms, Convolution, Unit step function, Second shifting Theorem, Laplace Transform of Periodic functions.

Text Books

Kreyszig E, ‘Advanced Engineering Mathematics’ 8th Edition, John Wiley & Sons New York, (1999)

Reference Books

1. Piskunov, ‘Differential and Integral Calculus, MIR Publishers, Moscow (1974).

2. Wylie C. R. & Barret L. C ‘Advanced Engineering Mathematics’ 6th Edition, Mc Graw Hill, New York, (1995).

3. Thomas G. B. ‘Calculus and Analytic Geometry’ Addison Wesley, London (1998).

PH1001 PHYSICS

Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	0	3

Course Outcomes:

- CO1. Acquire knowledge and understanding of fundamental principles of modern physics relevant to problems of Chemical Engineering.
- CO2. Acquire knowledge of basic principles of Quantum Physics and Relativity.
- CO3. Acquire knowledge of the basic physics of a collection of particles and the emergent macroscopic properties.
- CO4. Apply principles of quantum and statistical physics to understand properties of semiconductors and magnetic materials.

Module 1 – Theory of Relativity (6 hours)

Frames of reference, Galilean Relativity, Michelson-Morley experiment, postulates of Special Theory of Relativity, Lorentz transformations, simultaneity, length contraction, time dilation, velocity addition, Doppler effect for light, relativistic mass and dynamics, mass energy relations, massless particles, Description of General Theory of Relativity.

Module 2 - Quantum Mechanics (10 hours)

Dual nature of matter, properties of matter waves, wave packets, uncertainty principle, formulation of Schrödinger equation, physical meaning of wave function, expectation values, time-independent Schrödinger equation, quantization of energy – bound states, application of time-independent Schrödinger equation to free particle, infinite well, finite well, barrier potential, tunneling, Simple Harmonic Oscillator, two-dimensional square box, the scanning tunneling microscope.

Module 3 – Statistical Physics (12 hours)

Temperature, microstates of a system, equal probability hypothesis, Boltzman factor and distribution, ideal gas, equipartition of energy, Maxwell speed distribution, average speed, RMS speed, applications – Lasers and Masers, Quantum distributions – many particle systems, wave functions, indistinguishable particles, Bosons and Fermions, Bose-Einstein and Fermi-Dirac distribution, Bose-Einstein condensation, Specific heat of a solid, free electron gas and other applications.

Module 4 – Applications to Solids (14 hours)

Band theory of solids, conductors, semi-conductors and insulators, metals – Drude model and conductivity, electron wave functions in crystal lattices, E-k diagrams, band gaps, effective mass, semiconductors, Fermi energy, doping of semiconductor, conductivity and mobility of electrons, Hall effect, Fundamentals of mesoscopic physics and nano technology: size effects, interference effect, quantum confinement and Coulomb blockade. Quantum wells, wires, dots, nanotubes, semiconductor nano materials, Magnetism: dipole moments, paramagnetism, Curie's law, magnetization and hysterisis, Ferromagnetism and Anti-Ferromagnetism.

Text Books

1. Modern Physics for Scientists and Engineers, J. R. Taylor, C.D. Zafiratos and M. A. Dubson, 2 nd Ed., Pearson (2007)
2. Concepts of Modern Physics Arthur Beiser, 6th Ed., Tata Mc Graw –Hill Publication (2009)

References

1. Quantum Physics of atoms, Molecules, Solids, Nuclei and Particle, Robert Eisberg and Robert Resnick, 2nd Ed., John Wiley(2006) 2. Solid state Devices, B. G. Streetman, 5th Ed., Pearson (2006)

MS1001 PROFESSIONAL COMMUNICATION

Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	0	3

Course Outcomes:

- CO1. Effectively communicate technical material in print.
- CO2. Present technical material orally with confidence and poise, including audiovisual materials.
- CO3. Communicate effectively in ways appropriate to the discipline, audience and purpose.
- CO4. Think critically and creatively to generate innovative and optimum solutions.
- CO5. Identify, evaluate and synthesize information from a range of sources to optimize process engineering design and development.
- CO6. Engage in continuous education, training and research, and take control of their own learning and development.
- CO7. Work effectively and efficiently individually and in teams.
- CO8. Be ‘career ready’ for the process engineering profession, demonstrate leadership qualities, and work ethically and professionally.

Module 1 (11 hours)

Verbal Communication: received pronunciation; how to activate passive vocabulary; technical/non-technical and business presentations; questioning and answer skills; soft skills for professionals; role of body postures, movements, gestures, facial expressions, dress in effective communication; Information/ Desk/ Front Office/ Telephone conversation; how to face an interview/press conference; Group discussions, debates, elocution.

Module 2 (9 hours)

Reading Comprehension: skimming and scanning; factual and inferential comprehension; prediction; guessing meaning of words from context; word reference; use and interpretation of visuals and graphics in technical writing.

Module 3 (11 hours)

Written Communication: note making and note taking; summarizing; invitation, advertisement, agenda, notice and memos; official and commercial letters; job application; resume and curriculum vitae; utility, technical, project and enquiry reports; paragraph writing: General – Specific, Problem – Solution, Process – Description, Data – Comment.

Module 4 (11 hours)

Short essays: description and argument; comparison and contrast; illustration; using graphics in writing: tables and charts, diagrams and flow charts, maps and plans, graphs; how to write research paper; skills of editing and revising; skills of referencing; what is a bibliography and how to prepare it.

Text Books

1. Adrian Doff and Christopher Jones: Language in Use – Upper intermediate, selfstudy workbook and classroom book. (Cambridge University Press)[2000]
2. Sarah Freeman: Written Communication (Orient Longman)[1978]
3. Mark Ibbotson: Cambridge English for Engineering (Cambridge University Press) November 2008
4. T Balasubramanian: English Phonetics for Indian Students: A Workbook (Macmillan publishers India) 2000

ZZ1002 ENGINEERING GRAPHICS

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course Outcomes:

CO1. Students' ability in legible writing letters and numbers will be improved.
CO2. Students' ability to perform basic sketching techniques and instrumental drawing will be improved.
CO3. Students will be able to draw orthographic projections of different objects irrespective of number of dimensions and to develop pictorial views.
CO4. Students' ability to present the scale drawings of the visualized objects will be increased.
CO5. Students' ability to produce engineered drawings of any newly designed object will be improved.
CO6. Students will become familiar with practice and standards in technical drawing.
CO7. Students will develop good communication skills and team work.

Module 1 (4Lecture+6drawing hours) Introduction to Engineering Graphics – Drawing instruments and their use Different types of lines - Lettering & dimensioning – Familiarization with current Indian Standard Code of Practice for Engineering Drawing. Scales, Plain scales, Diagonal scales, Vernier scales. Introduction to orthographic projections- Horizontal, vertical and profile planes – First angle and third angle projections – Projection of points in different coordinates – Projections of lines inclined to one of the reference planes

Module II Projections of lines inclined to both the planes – True lengths of the lines and their angles of inclination with the reference planes – Traces of lines. (4Lecture+6 drawing hours) Projection of plane lamina of geometric shapes inclined to one of the reference planes – inclined to both the planes, Traces of planes (2Lecture+3 drawing hours) Projections on auxiliary planes (2 lecture +3 drawing hours)

Module III Projections of polyhedra and solids of revolution, projection of solids with axis parallel to one of the planes and parallel or perpendicular to the other plane – Projections with the axis inclined to one of the planes. Projections of solids with axis inclined to both the planes – Projections of spheres and combination of solids. (4Lecture+6 drawing hours)

Module IV Sections of solids by planes perpendicular to at least one of the reference planes – True shapes of sections. (2 lectures, 3 drawing hours) Developments, development of the lateral surface of regular solids like, prisms, pyramids, cylinders, cones and spheres, development of truncated solids (2 lectures +3 drawing hours) Isometric projection – Isometric scale – Isometric views – Isometric projection of prisms, pyramids, cylinders, cones, spheres and solids made by combination of the above. (2 lectures +6 drawing hours)

Text book

Bhatt N. D, Elementary Engineering Drawing, Charotar Publishing House, Anand, 2002

References

1. Narayana K L & Kannaiah P, Engineering Graphics, Tata McGraw Hill, New Delhi, 1992
2. Luzadder W J, Fundamentals of Engineering Drawing, Prentice Hall of India, New Delhi, 2001
3. Thomas E French & Charkes J V, Engineering Drawing & Graphing Technology, McGraw Hill Book Co, New York, 1993
4. Venugopal K, Engineering Drawing & Graphics, New Age International Pvt. Ltd., New Delhi, 1994

ZZ1004 COMPUTER PROGRAMMING

Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
2	0	0	2

Course Outcomes:

CO1. Students are introduced to the concepts of structured programming and familiarization of the concepts of program flow, functions, using arguments and return values and how to run a C program.
CO2. The students will be able to develop algorithms to solve basic programming problems.
CO3. The student will be able to apply the computer programming techniques to resolve practical problems. Top-down approach to problem solving is deployed.
CO4. Learn to approach complex problems using basic solving methodology.
CO5. The course gives a firm foundation to the programming concepts and problem solving techniques needed in the general engineering discipline.
CO6. Efficient programming techniques results in reduced consumption of power and other resources.
CO7. Students are encouraged to program higher level programs, both individually and as a team, thereby making them realize the effectiveness of teamwork.
CO8. The course helps the students to develop problem analysis skill and identify the best way to solve a problem.
CO9. Group projects help the students to identify the different areas involved in solving a problem and divide the work among them efficiently.
CO10. The groundwork for a strong programming career in the computer science discipline is laid down by understanding the essence of writing efficient, maintainable, and portable code.

Module 1 (7 Hours) Data Types, Operators and Expressions: Variables and constants - declarations - arithmetic, relational and logical operators – Assignment operator and expressions – conditional expressions – precedence and order of evaluation. Control Flow: Statements and blocks – if-else, switch, while, for and do-while statements – break and continue statements, goto and labels.

Module 2 (7 Hours) Functions and Program structure: Basics of functions, Parameter passing – scope rules - recursion.

Module 3 (7 Hours) Pointers and Arrays: Single and multidimensional arrays - Pointers and arrays – address arithmetic - Passing pointers to functions.

Module 4 (7 Hours) Structures and Unions: Basics of structures, Structures and functions – Arrays of Structures – Pointers to structures – self referential structures – Type definitions – Unions. Input and Output: Standard input and output – Formatted output – variable length argument list – file access.

Text Book: 1. B. W. Kernighan and D. M. Ritchie, The C Programming Language (2/e), Prentice Hall, 1988.

References:

1. B.S. GottFried, Schaum's Outline of Programming with C(2/e), McGraw-Hill, 1996.

2. C. L. Tondo and S. E. Gimpel, The C Answer Book(2/e), Prentice Hall, 1988.

3. B. W. Kernighan, The Practice of Programming, Addison-Wesley, 1999.

ZZ1091 WORKSHOP-I

Assessment:
Continuous: 60 marks
End Semester: 40 marks

L	T	P	C
0	0	3	2

Course Outcomes:

- CO1. Identify and use tools used in masonry.
- CO2. Understand severe flaws if any in a masonry work.
- CO3. Understand specifications for selected building materials and judge its quality based on test results.
- CO4. Use chain survey and leveling instruments and understand surveying terms encountered in his professional life.

Introduction to Construction Materials: Cement, sand, coarse aggregate, structural steel, brick, timber, concrete – methods of testing (3 hours) Masonry: English bond – Flemish bond –wall –junction – one brick – one and a half brick - Arch construction. (6 hours) Plumbing: Study of water supply and sanitary fittings—water supply pipe fitting –tap connections - sanitary fittings. (3 hours) Surveying: Introduction to land surveying and linear measurements; Introduction to leveling. (9 hours)

Four exercises from the following list of Exercises are to be carried out.

1. a. Familiarization of wiring tools, lighting and wiring accessories, various types of wiring systems.
b. Wiring of one lamp controlled by one switch.
2. a. Study of Electric shock phenomenon, precautions, preventions; Earthing
b. Wiring of one lamp controlled by two SPDT Switch and one 3 pin plug socket independently.

3. a. Familiarization of types of Fuse, MCB, ELCB etc.
b. Wiring of fluorescent lamp controlled by one switch from panel with ELCB & MCB.

4. a. Study of estimation and costing of wiring b. Domestic appliance – Wiring, Control and maintenance: Mixer machine, Electric Iron, fan motor, pump motor, Battery etc.

5. a. Familiarization of electronic components colour code , multimeters.
b. Bread board assembling - Common emitter amplifier

6. a. Study of soldering components, solders, tools, heat sink.
b. Bread board assembling – phase shift oscillator

7. a. Soldering practice - Common emitter amplifier
b. Soldering practice - Inverting amplifier circuit
8. a. Study of estimation and costing of soldering –PCB: 3 phase connections
b. Domestic appliances – Wiring PCB, control, Identification of fault: Electronic Ballast, fan regulator, inverter, UPS etc.

Reference:

1. K B Raina & S K Bhattacharya: Electrical Design Estimating and costing, New Age International Publishers, New Delhi, 2005

PH 1091PHYSICS LABORATORY

Assessment:
Continuous: 60 marks
End Semester: 40 marks

L	T	P	C
0	0	2	1

Course Outcomes:

CO1. To develop experimentation skills and understand the importance of measurement practices in Science & Technology.
CO2. Develop analytical skills for interpreting data and drawing inferences.
CO3. Understand nature of experimental errors and practical means to estimate errors in acquiring data.

LIST OF EXPERIMENTS

1. Magnetic Hysteresis loss - Using CRO
2. Band gap using four probe method
3. Hall effect- determination of carrier density, Hall coefficient and mobility
4. Solar cell characteristics
5. Double refraction – measurement of principle refractive indices.
6. Measurement of N.A & Attenuation
7. Measurement of e/m of electron – Thomson's experiment
8. Determination of Planck's constant
9. Measurement of electron charge – Milliken oil drop experiment
10. Determination of Magnetic Field along the axis of the coil
11. Newton's rings
12. Laurent's Half shade polarimeter –determination of specific rotatory power
13. Study of P-N junction
14. Study of voltage-current characteristics of a Zener diode.
15. Laser – measurement of angle of divergence & determination of λ using grating
16. Measurement of Magnetic susceptibility- Quincke's Method / Gouy's balance.
17. Mapping of magnetic field NOTE: Any 8 experiments have to be done.

Reference:

1. Experiments in Engineering physics, Avadhanulu, Dani and Pokley, S. Chand & Company ltd (2002).
2. Experiments in Modern Physics, A.C. Melissinos, J. Napolitano, Academic Press (2003)
3. Practical physics, S.L. Gupta and V. Kumar, Pragathi Prakash (2005)

SECOND SEMESTER

MA1001 MATHEMATICS II

L	T	P	C
3	1	0	3

Assessment:
Continuous: 60 marks
End Semester: 40 marks

Course Outcomes:

CO1. Acquire knowledge about the ideas and techniques of linear algebra, and to illustrate some of their applications in engineering.
CO2. Acquire knowledge about the physical interpretation of the gradient, divergence &curl.
CO3. Acquire knowledge of vector calculus and to apply in an electromagnetic field.
CO4. Prepare to evaluate multiple integrals in rectangular, polar, spherical and cylindrical coordinates.

Module I (11 L + 3T)
Linear Algebra I: Systems of Linear Equations, Gauss' elimination, Rank of a matrix, Linear independence, Solutions of linear systems: existence, uniqueness, general form. Vector spaces, Subspaces, Basis and Dimension, Inner product spaces, Gram-Schmidt orthogonalization, Linear Transformations.

Module II (11 L+ 3T)
Linear Algebra II: Eigen values and Eigen vectors of a matrix, Some applications of Eigen value problems, Cayley-Hamilton Theorem, Quadratic forms, Complex matrices, Similarity of matrices, Basis of Eigen vectors – Diagonalization.

Module III (10L+3T)
Vector Calculus I: Vector and Scalar functions and fields, Derivatives, Curves, Tangents, Arc length, Curvature, Gradient of a Scalar Field, Directional derivative, Divergence of a vector field, Curl of a Vector field.
Module IV (11 L+4T)
Vector Calculus II: Line Integrals, Line Integrals independent of path, Double integrals, Surface integrals, Triple Integrals, Verification and simple applications of Green's Theorem, Gauss' Divergence Theorem and Stoke's Theorem.

Text Book:

Kreyzig E, Advanced Engineering Mathematics, 8th Edn, John Wiley & Sons, New York (1999).

Reference Books:

1. Wylie C. R & Barrret L. C, Advanced Engineering Mathematics, 6th Edn, Mc Graw Hill, New York (1995).
2. Hoffman K & Kunze R, Linear Algebra, Prentice Hall of India, New Delhi (1971).

CY1001 CHEMISTRY

L	T	P	C
3	0	0	3

Pre-requisites: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course Outcomes:

CO1. To acquire knowledge on the role of chemistry in solving the problems related to chemical engineering.
CO2. To acquire knowledge about the fundamental principles of bonding in materials.
CO3. To acquire knowledge on the characterization of materials by modern tools.
CO4. To acquire knowledge of the chemistry of bio-molecules.

Module 1: Chemical Bonding (8 hours)

Quantum mechanical methods in chemical bonding: molecular orbital theory, symmetry of molecular orbitals, MOs for homonuclear diatomic molecules, application of MO theory to heteronuclear diatomics, valence bond theory, hybridization, hybridization involving d orbitals, conjugated molecules, Huckel molecular orbital theory of conjugated systems, metallic bonding, band theory .

Module2: Spectroscopy (14 hours)
General features of spectroscopy, interaction of radiation with matter, theory and application of rotational, vibrational, Raman, electronic, mass, NMR, fluorescence and photoelectron spectroscopy.

Module 3: Transition Metal Chemistry (12 hours)
Bonding in transition metal complexes: coordination compounds, crystal field theory, octahedral, tetrahedral and square planar complexes, crystal field stabilization energies, Jahn-Teller theorem, spectral and magnetic properties. Bio-Inorganic chemistry: Trace elements in biology, heme and non-heme oxygen carriers, haemoglobin and myoglobin-cooperativity; Bohr effect, Hill coefficient, oxy and deoxy haemoglobin, reversible binding of oxygen.

Module 4: Aromaticity (8 hours)
Electron delocalization, resonance and aromaticity; molecular orbital description of aromaticity and anti-aromaticity, annulenes; ring current, NMR as a tool, diamagnetic anisotropy; aromatic electrophilic substitutions, aromatic nucleophilic substitutions, benzyne; reaction mechanisms, reactivity and orientation.

Text Books:

1. J. E. Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry, Principles of Structure and Reactivity, Harper Collins, New York 1997.
2. F. A. Cotton and G Wilkinson, Advanced Inorganic Chemistry, 5th Edition, Wiley Interscience, New York, 1988.
3. J. D. Lee, Concise Inorganic Chemistry, Chapman & Hall, London, 1996.
4. W. L. Jolly, Modern Inorganic Chemistry, McGraw-Hill International, 2nd Edition, New York, 1991.
5. R. T. Morrison and R N Boyd, Organic Chemistry, 6th Edition, Prentice Hall, New Delhi, 1999.
6. P. Bruice, Organic Chemistry, 3rd Edition, Prentice Hall, New Delhi , 2001.
7. F. Carey, Organic Chemistry, 5th Edition, McGraw Hill Publishers, Boston, 2003.
8. J. Mc Murray, Organic Chemistry, 5 th Edition, Brooks/ Cole Publishing Co, Monterey, 2000.
9. C.N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, McGrawHill, International, UK, 1995.
10. William Kemp, Organic Spectroscopy, 3 rd edition, Palgrave, New York, 2005.
11. R.M. Silverstein, F.X. Webster and D.J. Kiemle, Spectrometric Identification of Organic Compounds, 7 th edition, John-Wiley and Sons, New York, 2005.

12. D. L. Pavia, GM. Lampman, GS. Kriz and J.R Vyvyan, I, Spectroscopy, Cengage Learning India Pvt. Ltd, New Delhi, 2007.
13. B. R.Puri, L. R. Sharma and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing CO. Delhi, 2008.
14. P.W. Atkins, Physical Chemistry, 6 th Edition, Oxford University Press, Oxford, 1998.

EE1001 ELECTRICAL SCIENCES

Pre-requisites: None
Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	0	3

Course Outcomes:

- CO1. Analysis of Resistive Circuits and Solution of resistive circuits with independent sources.
- CO2. Two Terminal Element Relationships for inductors and capacitors and analysis of magnetic circuits.
- CO3. Analysis of Single Phase AC Circuits, the representation of alternating quantities and determining the power in these circuits.
- CO4. To acquire the knowledge about the characteristics and working principles of semiconductor diodes, Bipolar Junction Transistor.

Module – 1 (11 Hours)
Two Terminal Element Relationships Inductance - Faraday's Law of Electromagnetic Induction-Lenz's Law -Self and Mutual Inductance-Inductances in Series and Parallel-Mutual Flux and Leakage Flux-Coefficient of Coupling-Dot Convention-Cumulative and Differential Connection of Coupled CoilsCapacitance - Electrostatics-Capacitance-Parallel Plate Capacitor-Capacitors in series and parallel- Energy Stored in Electrostatic Fields-. v-i relationship for Inductance and Capacitance - v-i relationship for Independent Voltage and Current Sources – Magnetic Circuits MMF, Magnetic Flux, Reluctance- Energy Stored in a Magnetic Field-Solution of Magnetic Circuits. Analysis of Resistive Circuits Solution of resistive circuits with independent sourcesNode Analysis and Mesh Analysis-Nodal Conductance Matrix and Mesh Resistance Matrix and symmetry properties of these matrices-Source TransformationCircuit Theorems - Superposition Theorem-Thevenin's Theorem and Norton's TheoremMaximum Power Transfer Theorem

Module – 2 (10 Hours)
Single Phase AC Circuits Alternating Quantities- Average Value - Effective Value - Form and Peak factors for square, triangle, trapezoidal and sinusoidal waveforms - Phasor representation of sinusoidal quantities - phase difference -Addition and subtraction of sinusoids - Symbolic Representation: Cartesian, Polar and Exponential formsAnalysis of a.c circuits R, RL, RC, RLC circuits using phasor concept - Concept of impedance, admittance, conductance and susceptance – Power in single phase circuits – instantaneous power – average power – active power – reactive power – apparent power – power factor – complex power – Solution of series, parallel and series-parallel a.c circuits

Module - 3 (14 hrs)
Introductory Analog Electronics Semiconductor Diode: Principle, Characteristics - Applications: Rectifier Circuits - Zener Diode, LED, Photo diode, IR diode Bipolar Junction Transistor: Principle, Operation, Characteristics (CB, CE, CC) Principle of working of CE, CB and CC amplifiers, quantitative relations for midband operation, input and output resistance levels – qualitative coverage on bandwidth - cascading considerations. Introductory Digital Electronics Transistor as a switch – switching delays, inverter operation Digital Electronics : Number Systems and Conversions- Logic Gates and Truth Tables – Boolean Algebra – Basic canonical realizations of combinatorial circuits. Standard Combinatorial Circuit SSI and MSI packages (Adder, Code Converters, 7-Segment Drivers, Comparators, Priority Encoders etc) MUX-based and ROM-based implementation of combinatorial circuits.

Module - 4 (7 hours)
Measuring instruments Basics of electronic/digital voltmeter, ammeter, multimeter, wattmeter and energy meter. Measurement of Voltage, Current and Resistance. Introduction to Cathode Ray Oscilloscope - CRT, Block diagram of CRO

Text Books

1. Electric Circuits, James W Nilsson and Susan A Riedel, Pearson, 8th Edn, 2002
2. Electronic Devices and Circuit Theory, Robert L Boylestead & L Nashelsky, Pearson, 9th Edition, 2007
3. Digital Design , Morris Mano , PHI, 3rd Edition, 2005

4. Golding & Widdis, Electrical Measurements an Measuring Instruments;- Wheeler Publishers 5th edition, 1999.
5. Rangan, Sarma and Mani, Instrumentation Devices and Systems, Tata McGraw Hill, 1997
6. A.K. Sawhney: A course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai and Co,16th Edition, 2006

Reference Books

1. Electric Circuits & Networks, Suresh Kumar K.S, Pearson Education, 2009
2. Microelectronics, Adel S Zedra and Kennath C Smith, Oxford University Press, 2004

ZZ1001 ENGINEERING MECHANICS

Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	3	3

Course Outcomes:

CO1. Analyze statically determinate structures, including trusses using equations of equilibrium.
CO2. Find space-time relationship (kinematics) of particles.
CO3. Solve dynamic problems of particle using Newton's law, energy method and impulse-momentum approach.
CO4. Solve dynamic problems of particle using Newton's law, energy method and impulse-momentum approach.
CO5. Solve elementary problems in vibration.

Part A--Statics
MODULE 1 (12 hours)
Fundamentals of mechanics: idealisations of mechanics, vector and scalar quantities, equality and equivalence of vectors, laws of mechanics. Important vector quantities: Position vector, moment of a force about a point, moment of a force about an axis, the couple and couple moment, couple moment as a free vector, moment of a couple about a line. Equivalent force systems: Translation of a force to a parallel position, resultant of a force system, simplest resultant of special force systems, distributed force systems. Equations of equilibrium: Free body diagram, free bodies involving interior sections, general equations of equilibrium, problems of equilibrium, static indeterminacy.

MODULE 2 (10 hours)
Applications of Equations Equilibrium: Trusses: solution of simple trusses, method of joints, method of sections; Friction forces: laws of Coulomb friction, simple contact friction problems. Properties of surfaces: First moment, centroid, second moments and the product of a plane area, transfer theorems, rotation of axes, polar moment of area, principal axes, concept of second order tensor transformation.

Part B—Dynamics
MODULE 3 (10 hours)
Kinematics of a particle: Introduction, general notions, differentiation of a vector with respect to time, velocity and acceleration calculations, rectangular components, velocity and acceleration in terms of cylindrical coordinates, simple kinematical relations and applications. Particle dynamics: Introduction, rectangular coordinates, rectilinear translation, Newton's law for rectangular coordinates, rectilinear translation, cylindrical coordinates, Newton's law for cylindrical coordinates.

MODULE 4 (10 hours)
Energy and momentum methods for a particle: Analysis for a single particle, conservative force field, conservation of mechanical energy, alternative form of work-energy equation, Linear momentum, impulse and momentum relations, moment of momentum.Vibrations: Single degree of freedom systems, free vibration, undamped and damped, forced vibration, sinusoidal loading, introduction to multi degree of freedom systems, illustration using two degree-of-freedom systems.

Text Book
I. H. Shames, Engineering Mechanics—Statics and Dynamics, 4th Edition, Prentice Hall of India, 1996.

Reference Books
1. F.P. Beer and E.R. Johnston, Vector Mechanics for Engineers – Statics, McGraw Hill Book Company, 2000.
2. J.L. Meriam and L.G. Kraige, Engineering Mechanics – Statics, John Wiley & Sons, 2002

CH1001 INTRODUCTION TO CHEMICAL ENGINEERING

Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
2	0	0	2

Course Outcomes:

- CO1. Understand the need of chemical engineers in the modern era
- CO2. Understand the history and development of chemical industry since origin
- CO3. Understand the role and functions of chemical engineers in the engineering industry
- CO4. Ability to represent the a chemical industry in terms of process flow diagram
- CO5. Ability to understand various unit operations and unit processes.
- CO6. Ability to understand the basic transport process in chemical engineering
- CO7. Ability to outline various measurement techniques, devices and control in process industries
- CO8. Ability to know the basics of interdisciplinary engineering fields
- CO9. Ability to understand the need of mathematics and computers in chemical engineering
- CO10. Ability to know the future challenges in chemical engineering

Module 1 (8 hours)
Definition, Origins and Development of the Chemical Process Industry. The Present Day Chemical Industry, The systematic Analysis of Chemical, Processes, Representation of a Chemical Process in terms of Flow sheet. Scale of Chemical Processes.

Module 2 (6 hours)
Definition, Origin and History of Chemical Engineering. Functions of a Chemical Engineer. Professional and General Aspects of Chemical Engineering. Difference in Chemical Engineering Science & Technology.

Module 3 (8 hours)
Brief description of important Chemical Industries in terms of Unit Operations and Unit Processes. Analyses of Flow Charts in terms of Chemical Engineering subjects. Measuring Techniques, Devices and Control in Process Industries. Pollution and its Abatement.

Module 4 (6 hours)
Conceptual Developments in Chemical Engineering and the associated persons. The use of Mathematics and Computers in Chemical Engineering. Future challenges in Chemical Engineering.

Reference

1. Bhatt B.I., Vora S.M, Stoichiometry. 3rd Edition. Tata MCGraw-Hill, 1977
2. S.K Ghosal, S.K. Sanyal and Dutta.S, Introduction to Chemical Engineering TMH Publications, 1998.
3. W.L Badger and J.T Banchero, Introduction to Chemical Engineering McGraw-Hill Edition.
4. George T Austin, Shreve’s Chemical Process Industries-International Student Edition, 5th Edn., McGraw Hill Inc., 1985.
5. Gopal Rao, R. and Sittig, M., Dryden’s Outlines of Chemical Technology, 3rd Edn., Affiliated East-West Publishers, 1997
6. Richard M Felder, Ronald W Rousseau, Elementary Principles of Chemical Processes, 3rd Edn., Wiley Publishers.
7. Jacob A Moulijn, Michiel Makkee, Annelies Van Diepen, Chemical Process Technology, Wiley Publishers.

ZZ1092 WORKSHOP PRACTICE-II

Assessment:
Continuous: 60 marks
End Semester: 40 marks

L	T	P	C
0	0	3	2

Course Outcomes:

CO1. The student is exposed to the practical field, which any professional must go through to be a real professional, even though he/she may not be opting for this job after graduation.

CO2. The student is made familiar with the basis manufacturing processes- Casting, Forming, Joining and Machining.

CO3. The student learns about the properties of different materials- Hardness, ductility, sharpness, heat resistance, grain orientation, application, and the specific tolls used for converting to useful forms, by observation, demonstrations, and self studies.

CO4. The student also learns about the various measuring devices, including scales, Vernier calipers, micrometers, etc. which are used in the metrology field.

CO5. The skill of sequencing the operations so as to execute a task with least time and least rejection too is learnt. This makes him/her confidence to command over the subordinates while employed as a leader.

CO6. The student learns how to substantiate the academic knowledge which he acquires through classrooms with practicals.

CO7. How to carry out a task as a member in a group team, is a professional team, is also experienced.

The course is intended to expose the student to the manufacturing processes through hands on training in the sections of Central Workshop. After the course, the student acquires the skill in using various tools, measuring devices, and learns the properties of different materials at varying conditions.

1) Carpentry: Study of tools and joints – plaining, chiseling, marking and sawing practice, one typical joint- Tee halving/Mortise and Tenon/ Dovetail

2) Fitting: Study of tools- chipping, filing, cutting, drilling, tapping, about male and female joints, stepped joints- one simple exercise of single V joint for welding exercise.

3) Welding: Study of arc and gas welding, accessories, joint preparation, Exercise of a single V joint

4) Smithy: Study of tools, forging of square or hexagonal prism/ chisel/bolt

5) Foundry: Study of tools, sand preparation, moulding practice.

6) Sheet Metal work: Study of tools, selection of different gauge sheets, types of joints, fabrication of a tray or a funnel

7) Plumbing Practice: Study of tools, study of pipe fittings, pipe joints, cutting, and threading

8) Lathe Exercise: Study of the basic lathe operations, a simple step turning exercise.

References

1) Chapman W.A.J., Workshop Technology. Parts 1 & 2, 4th Edition, Viva Books P. Ltd., New Delhi, 2002
2) Hajra Choudhury.Workshop Technology Vol 1 & 2, Media Promoters & Publishers P.Ltd, Bombay, 2004
3) Welding Handbook. Miami, American Welding Society, 2000
4) Metals Handbook. Vol 6, Welding, Brazing & Soldering. Metals Park, Ohio, American Society of Metals, 1998
5) Serope Kalpakjian. Manufacturing Engineering & Technology. Pearson Steven R. Schmid Education (Asia) Inc., Delhi, 2002.
6) Anderson J., Shop Theory. Tata McGraw Hill, New Delhi, 2002
7) Olson D.W., Wood and Wood working. Prentice Hall India. 1992
8) Douglass J.H., Wood Working with Machines. McKnight &McKnight Pub. Co. Illinois, 1995
9) Tuplin W.A., Modern Engineering Workshop Practice Odhams Press, 1996
10) P.L. Jain. Principles of Foundry Technology. 4th Edition, Tata McGraw Hill, 2008.
11) R.K.Singal, Mridul Singal, Rishi Sringal. Basic Mechanical Engineering. 2007

CY1094 CHEMISTRY LABORATORY

Pre-requisites: Nil
Assessment:
Continuous: 60 marks
End Semester: 40 marks

L	T	P	C
0	0	2	1

Course Outcomes:

CO1. To acquire practical knowledge on the basic chemistry principles for apply in chemical engineering.
CO2. To acquire practical knowledge of the techniques for the preparation and characterization of materials.
CO3. To acquire knowledge on electrochemical techniques.
CO4. To acquire training in accurate and precise data collection.

Potentiometric and conductometric titrations, complexometric and iodimetric estimations, polarimetry, determination of pH, single step organic / inorganic preparations, colorimetry, determination of eutectic point.

References:

1. G.H Jeffery, J Bassett, J Mendham, R.C Denny, Vogel's Text Book of Quantitative Chemical Analysis, Longmann Scientific and Technical, John Wiley, New York.
2. J.B Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
3. A.I Vogel, A.R Tatchell, B.S Furnis, A.J Hannaford, P.W.G Smith, Vogel's Text Book of Practical Organic Chemistry, Longman and Scientific Technical, New York, 1989.

THIRD SEMESTER

MA2001 MATHEMATICS III (PROBABILITY & STATISTICS)

Prerequisite: MA1001 Mathematics I

L	T	P	C
3	1	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course Outcomes:
- CO1. Acquire knowledge about important probability distributions and their properties.
- CO2. Acquire knowledge about statistical parameter estimation.
- CO3. Acquire knowledge about statistical hypotheses tests.
- CO4. Acquire knowledge about regression and correlation analysis.
- CO5. Acquire knowledge about ANOVA principles and methods.

Module 1 (11L + 4 T)

Probability distributions: Random variables - binomial distribution, hyper- geometric distribution, mean and variance of a probability distribution, Chebyshev's theorem, - Poisson distribution, geometric distribution, normal distribution, uniform distribution, gamma distribution, beta distribution, Weibull distribution, joint distribution of two random variables.

Module 2 (11L + 3 T)

Sampling distributions and Inference concerning means: Population and samples, the sampling distribution of the mean (σ known and σ unknown), sampling distribution of the variance, maximum likelihood estimation, point estimation and interval estimation, point estimation and interval estimation of mean and variance, tests of hypothesis, hypothesis concerning one mean, inference concerning two means.

Module 3 (10 L + 3 T)

Inference concerning variances proportions: Estimation of variances , hypothesis concerning one variance, hypothesis concerning two variances, estimation of proportions, hypothesis concerning one proportion, hypothesis concerning several proportions, analysis of r x c tables, Chi – square test for goodness of fit.

Module 4 (10 L + 4 T)

Regression Analysis: Bi-variate normal distribution- joint-marginal and conditional distributions. Curve fitting, method of least squares, estimation of simple regression models and hypothesis concerning regression coefficients, correlation coefficient- estimation of correlation coefficient, hypothesis concerning correlation coefficient, estimation of curvilinear regression models
Analysis of variance: General principles - completely randomized designs, randomized block diagram, Latin square designs, analysis of covariance.

Reference

1. Johnson, R. A., Miller and Freund's Probability and Statistics for Engineers, 6th edn., PHI, 2004.
2. Levin R. I. & Rubin D. S.,Statistics for Management, 7th edn, PHI, New Delhi, 2000.
3. S.M. Ross, Introduction to Probability and statistics for Engineers, 3rd edn, Academic Press (Elsevier), Delhi, 2005.

CY2001 PHYSICAL CHEMISTRY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course Outcomes:

CO1. To acquire knowledge on the role of physical chemistry in solving the problems related to Chemical Engineering.
CO2. To acquire knowledge in kinetics and mechanisms of chemical reactions.
CO3. To acquire knowledge about the fundamental principles of thermodynamics involved in various chemical process.
CO4. To acquire knowledge about the fundamentals of electrochemistry and its applications
CO5. To acquire knowledge about the surface chemistry of different processes.

Module 1: Chemical Kinetics (12 hours)

Arrhenius theory – determination of Arrhenius parameters, collision theory of bimolecular gas phase reactions, derivation of rate equation, collision theory of unimolecular reactions, Lindeman's equation, Hinshelwood's modification, transition theory, Eyring's equation, comparison of the theories, kinetics of opposing, consecutive, parallel reactions (first order examples), chain reactions, H_2, Cl_2& H_2-Br_2 reaction, steady state approximation, branching chain – $H_2 + O_2$ reaction, explosion limits, kinetics of reaction in solution – role of solvent – primary and secondary salt effects, mechanism of heterogeneous catalysis, enzyme catalysis, MichaelisMenten theory, Koshland's induced fit model.

Module 2: Chemical thermodynamics (10 hours)

Concept of free energy and entropy, conditions for spontaneity of process, conditions for equilibrium, derivation of law of chemical equilibrium from thermodynamics , van't Hoff reaction isotherm, study of dissociation equilibria $PCl_5 \rightarrow PCl_3 + Cl_2$, degree of dissociation from density measurements, thermodynamics of dilute solutions, derivation of depression of freezing point and elevation of boiling point from thermodynamical consideration , lowering of vpor pressure and osmotic pressure, van't Hoff's laws of osmotic pressure, van't Hoff theory of dilute solution, association and dissociation of solutes – van't Hoff's factor phase rule, definition giving examples, derivation from thermo dynamics, simple eutectic system.

Module 3: Electrochemistry (10 hours)

Debye Huckel theory of strong electrolytes (derivation of equation not required), Debye Huckel limiting law, ionic strength theory of conductometric titrations, thermodynamics of cell reactions, enthalpy – entropy, free energy changes from emf of cells, Nernst equation, potentiometric titration – theory, electrode kinetics, structure of electrode surface, Helmholts Perrin, Guoy – Chapman and Stern models, Butter – Volmer and Tafel equations, polarography – half wave potential, diffusion current, DME, Ilkovic equation – analytical applications.

Module 4: Chemistry of surfaces (10 hours)

Adsorption – Langmuir adsorption isotherm, BET equation, Gibbs adsorption isotherm, reactions at surfaces, unimolecular and bimolecular reactions, Langmuir Himshelwood mechanism, colloidal surfactants – classification anionic, cationic and non-inorganic surfactants, micelles, structure, CMC determination, stabilizing action of surfactants, sol-gel transformations, emulsions – applications of colloidal surfactants.

Reference

1. P. W. Atkins and J. D. Paula, Physical Chemistry, 7th Edition, Oxford University press: New York 2002.
2. A. W. Adamson and A. P. Gast, Physical Chemistry of Surfaces, 6th Edition, John Wiley: New York, 1997.
3. K. J. Laidler, Chemical Kinetics, 3rd Edition, Pearson Education: New Delhi, 2004.
4. G. K. Vemullapalli, Physical Chemistry, Edition Prentice Hall: New Delhi 2004.
5. Jom Bockris and AKN Reddy, Modern Electro Chemistry-Vol I and II.

CH2001 CHEMICAL TECHNOLOGY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Understand the objectives of chemical process engineer in chemical industry
CO2. Able to identify the different unit operations and unit processes in a given process flow diagram
CO3. Acquire thorough knowledge about some important process industries (chloro-alkali, fertilizers, soaps and detergents, sugar manufacture, petroleum, paper and fermentation etc)
CO4. Knowing the chronological developments in the chemical process industry in global scenario
CO5. Able to appreciate the importance of physical, chemical and physic-chemical transformations of the material in process industries
CO6. Recognize the importance of process economics in the industry

Module 1 (9hours)

Chlor-alkali industries,manufacture of soda ash- manufacture of sodium bicarbonate , manufacture of chlorine and caustic soda, sulphur and sulphuric acid,mining and manufacture of sulfur, manufacture of sulphuric acid, cement, types and manufacture of Portland cement, manufacture of paints and pigments.

Module 2 (9 hours)

Nitrogen fertilizers, synthetic ammonia, nitric acid, urea, ammonium chloride, ammonium sulphate, phosphorous fertilizers, phosphate rock, phosphoric acid, super phosphate and triple super phosphate, MAP, DAP, potassium fertilizers, potassium chloride and potassium sulphate.

Module 3 (10 hours)

Soaps and detergents, raw material, manufacturing of detergents, biodegradability, purification of fatty acids, soap manufacture, glycerine manufacture, oils and fats- expression, solvent extraction, hydrogenation of oils, manufacture of sugar, starch and starch derivatives, manufacture of pulp, paper and paperboards, fermentation industries, industrial alcohol, absolute alcohol, beers, wines.

Module 4 (14 hours)

Fuel and industrial gases, petroleum refining to produce naphtha, fuel hydrocarbons and lubricants, processes for the production of petrochemical precursors, ethylene, propylene, butadiene, acetylene, synthetic gas, benzene, toluene and xylene. (Cracking-Catalytic reforming and separation of products), polymers, production of thermoplastic and thermosetting materials such as polyethylene, polypropylene, phenolic resins and epoxy resins, natural and synthetic rubbers, rubber compounding.

Reference

1. George T Austin, Shreve's Chemical Process Industries- International Student Edition, 5thEdn.., McGraw Hill Inc., 1985.
2. GopalRao, R. and Sittig, M., Dryden's Outlines of Chemical Technology, 3rdEdn, Affiliated East-West Publishers, 1997.
3. Shukla, S.D. and Pandey, G.N., Text book of Chemical Technology, Vol.I, 1977.
4. Jacob A. Moulijn, MichielMakkee and Annelies van Diepen , Chemical Process Technology, 1stEdn, 2001.

CH2002 PROCESS CALCULATIONS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Learn and apply the components of effective problem solving.
- CO2. Apply the concepts of dimensional consistency to determine the units of any term in a function (add, subtract, multiply and divide units) and conversion from one set of units to another.
- CO3. Convert a given composition in mass (weight) percent to mole percent and vice-versa.
- CO4. Define and apply the concepts of: excess reactant, limiting reactant, conversion, degree of completion, selectivity, and yield in a selection.
- CO5. Know how to select a good basis and why, to do the Material Balance and analysis of problems with and without Chemical Reactions.
- CO6. Solve problems with Recycle, Bypass, Purge.
- CO7. Apply the gas laws to solve problems related to ideal gases and mixtures
- CO8. Define relative saturation (humidity), molal saturation (humidity), absolute saturation (humidity), and humidity by formulae involving partial pressures of the gas components.
- CO9. State the energy balance in words and write the balance in mathematical symbols for closed and open systems.
- CO10. Apply the energy balance to solve particular problems with and without chemical reactions.

Module 1 (9 hours)

Introduction, conversion of units, dimensional consistency, number of significant figures, precision and accuracy, conversion of units, mole concept and mole fraction, weight fraction and volume fraction, concentration of liquid solutions, molarity, molality, normality, ppm, density and specific gravity, composition relationships, stoichiometric principles.

Module 2 (11 hours)

General material balance equation for steady and unsteady state- simplifications for steady-state processes without chemical reaction, element balance, material balance problems involving multiple subsystems, recycle, bypass and purge calculations

Module 3 (12 hours)

Material balance problems with chemical reactions, concept of limiting, excess reactants, fractional conversion and percentage of conversion, percentage yield, Orsat analysis, ultimate and proximate analysis of fuels, excess air, air-fuel ratio calculations, material balance problems involving simultaneous equations.

Module 4 (10 hours)

Energy balance, heat capacity, estimation of heat capacities, calculation of enthalpy changes (without phase change), enthalpy change for phase transitions, general energy balance, thermochemistry, Hess's law of summation- heat of formation, reaction, combustion, solution and mixing, theoretical flame temperature

Reference

1. Narayanan K.V, and Lakshmikuttyamma, B., Stoichiometry & Process Calculations, Prentice Hall Publishing, Delhi, 2006.
2. Himmelblau, D.H, Basic Principles and Calculations in Chemical Engineering, 5th Edn., Prentice Hall, New York, 1990.

3. Bhatt B.I, and Vora S.M, Stoichiometry, 4^{th}Edn., Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2001.
4. Hougen, O.A, Watson, K.M and Ragatz R.A, Chemical Processes Principles (Part-1): Material and Energy Balances, 2^{nd}Edn, Asia Publication House, New Delhi, 2001.
5. Felder, R.M. and Rousseau, R.W., Elementary Principle and Chemical Processes, 3^{rd}Edn, John Wiley & Sons Inc., 2000.

CH2003 FLUID MECHANICS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Understand the need of fluid mechanics for chemical engineers.
- CO2. Understand the basic terms and their concepts of fluid flow
- CO3. Understand the significance of Newton's law of viscosity and Reynolds number
- CO4. Ability to develop a dimensional number for the fluid flow.
- CO5. Ability to analyze laminar and turbulent frictional flow in pipes and piping networks.
- CO6. Ability to analyze boundary layer flows
- CO7. Ability to analyze fluid flow in chemical engineering equipment (packed bed, fluidized bed), Including fluid drag on particles.
- CO8. Ability to select and troubleshoot the flow meters by understanding the principles of it.
- CO9. Ability to select and troubleshoot the pumps and valves by understanding the principles of it.
- CO10. Understand the basic concepts of computational fluid dynamics

Module 1 (10 hours)
Introduction, fluid statics, pressure-density-height relationships, pressure measurement, Newtonian and non-Newtonian fluids, time dependent fluids, Reynold's number, experiment and significance, dimensional analysis, dimensional number, forces arising out of physical similarity.

Module 2 (11 hours)

Kinematics of fluid flow, stream line, stream tube, velocity potential, momentum balance, forces acting on stream tubes, potential flow, Bernoulli's equation, correction for fluid friction, correction for pump work, flow of incompressible fluids in pipes, laminar and turbulent flow through closed conduits, velocity profile and friction factor for smooth and rough pipes, head loss due to friction in pipes, fittings etc., introduction to compressible flow, isentropic flow through convergent and divergent nozzles and sonic velocity.

Module 3 (11 hours)

Flow of fluids through solids, form drag, skin drag, drag co-efficient, flow around solids and packed beds, friction factor for packed beds, Ergun's equation, motion of particles through fluids, motion under gravitational and centrifugal fields, fluidization, mechanism, types, general properties, applications, measurement of fluid flow, orifice meter, venture meter , pilot tube, rotameter, weirs and notches, wet gas meter and dry gas meter, hot wire and hot film anemometers.

Module 4 (10 hours)
Transportation of fluids, fluid moving machinery performance, selection and specification, airlift and diaphragm pump, positive displacement pumps, rotary and reciprocating pumps, centrifugal pumps and characteristics, computational methods in fluid flow, comparison of CFD methodologies.

Reference

1. Warren L. McCabe, Jullian Smith C. and Peter Harriott, Unit Operations of Chemical Engineering, 6th edition, McGraw-Hill, New York, 2001.
2. Coulson J M and Richardson J F, Chemical Engineering, Vol. I and II, Pergamon Press, NY, 1990.
3. De Nevers N H, Fluid Mechanics for Chemical Engineers, McGraw Hill, NY, 1991.
4. John F.Douglas, Fluid Mechanics, Fifth edition, Prentice Hall, 2005

ME2091MACHINE DRAWING

L	T	D	C
0	0	3	2

Prerequisite: ZZ1002 Engineering graphics

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. To develop an ability to visualise geometric shapes and objects, and to apply the basic knowledge acquired in Engineering Graphics course to a specific engineering domain.
CO2. To enable the students to appreciate the intricacies of machine components, assemblies and their functional aspects.
CO3. To introduce the concept of Geometric Dimensioning and tolerancing in order to enable the students to prepare production drawings.
CO4. To learn the use of computers and software tools in machine drawing.

Module 1 (9 hours)

Introduction to machine drawing: principles of orthographic projections applied to machine drawing – first angle and third angle projections, methods of dimensioning and conversion of pictorial projections into orthographic projections, sectional views, rules and conventions of sectioning, full sectional, half sectional, partial sectional and revolved sectional views of simple machine parts, welded joints, types of welds, nomenclature of welds, welding symbols, drawing of welded machine parts with details of welding, screwed fastenings, screw thread forms, V and square threads, nomenclature of threads, conventional representation of threads, hexagonal and square headed bolts and nuts, locking arrangements of nuts, various types of machine screws and set screws, foundation bolts.

Module 2 (9 hours)

Pipe joints, coupler joint, nipple joint, union joint, socket and spigot point, integral and screwed flanged joints, hydraulic joint and expansion joint, shaft joints, cotter and pin joints, socket and spigot joint, gib and cotter joint, sleeve and cotter joint and knuckle joint, couplings and keys, muff couplings, flanged couplings, flexible coupling, Oldham's coupling and universal coupling, parallel and tapered sunk keys, hollow and flat saddle keys, feather key and pin key, bearings, solid journal bearings, bush bearings, plummer block, foot step bearing and pedestal bearing.

Module 3 (15 hours)

Assembly drawings, types, accepted norms – i.c. engine parts: piston, connecting rod – steam engine parts: eccentric, stuffing box, parts of a lathe, tail stock, tool post, miscellaneous assemblies: vices, screw jack, valves.

Module 4 (9 hours)

Surface texture, nomenclature of surface texture, designation of surface texture, selection of surface characteristics, limits, fits and tolerances, nomenclature, classification of fits, systems of fits and tolerances, designation, selection of fits and tolerances, working/production drawings working drawings of simple machine elements, computer aided drafting, simple exercises using cad packages.

Reference

1. Bhatt N.D., and Panchal V.M., Machine Drawing, Charotar Publishing House, 2006.
2. Narayana K.L., Kannaiah P., and Reddy K.V., Machine Drawing, Wiley Eastern.
3. John K.C., and Varghese P.I., Machine Drawing, VIP Publication
4. Gill P.S., A Text Book of Machine Drawing, Karlson Publication
5. Pippenger J., and Hicks T., Industrial Hydraulics, McGraw Hill
6. Sidheswar N., Kannaiah P., and Sastry V. V. S., Machine Drawing, Tata McGraw Hill

CH2091 CHEMICAL TECHNOLOGY LABORATORY

Assessment:
Continuous: 60 marks
End Semester: 40 marks

L	T	D	Cr
0	0	3	2

Lab Outcomes

CO1. Acquire the knowledge to determine acid value of given oil sample
CO2. Acquire the knowledge to calculate the available chlorine content in bleaching powder
CO3. Evaluate the Saponification value of oil samples
CO4. Development of soap and analysis the soap characteristics such as moisture content, alkali content and total fatty matter (TFM)
CO5. Acquainted with the fuels testing methods such as smoke, flash and fire point and to determine the smoke, Flash and Fire point using respective apparatus.
CO6. Acquire knowledge about different viscosity measurement methods to determine viscosity of different oils
CO7. Acquire knowledge in analysis of sucrose content in sugar sample
CO8. Acquire the knowledge to determine available lime content in calcium hydroxide
CO9. Acquire the knowledge to determine Iodine value of oil sample and to classify the oil on the basis of iodine value

1. Preparation of soap
2. Preparation of dyes and pigments
3. Analysis of raw materials, intermediates and products such as
    a. Common salt
    b. Lime
    c. Urea
    d. Soda ash
    e. Alum
    f. Coal
    g. Vegetable oils
    h. Sugar
    i. Bleaching powder
4. Testing of fuels
    a. Orsat analysis
    b. Reid’s vapour pressure
    c. Redwood viscometer
    d. Flash and Fire point
    e. Bomb calorimeter
    f. Gas calorimeter

FOURTH SEMESTER

MA2002 MATHEMATICS IV

Prerequisite: MA1001 Mathematics I
MA1002 Mathematics II

L	T	P	C
3	1	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course Outcomes:

- CO1. Acquire the knowledge to solve differential equations using power series and Frobenius method
- CO2. Acquire knowledge about the ability to solve problems using partial differential equations.
- CO3. To know the properties of analytic and harmonic functions.
- CO4. Understanding Cauchy's integral theorem and its consequences.
- CO5. Acquire the knowledge to compute residues and integrals using the residue theorem.

Module 1 (11L + 4T)

Series Solutions and Special Functions: Power series solutions of differential equations, theory of power series method, Legendre equation, Legendre polynomials, Frobenius method, Bessel's equation, Bessel functions, Bessel functions of the second kind, Sturm- Liouville's problems, orthogonal eigen function expansions.

Module 2 (12L + 4T)

Partial differential Equations: Basic concepts, Cauchy's problem for first order equations, linear equations of the first order, nonlinear partial differential equations of the first order, Charpit's method, special types of first order equations, classification of second order partial differential equations, modeling: vibrating string, wave equation, separation of variables, use of Fourier series, D'Alembert's solution of the wave equation, heat equation: solution by Fourier series, heat equation: solution by Fourier integrals and transforms, Laplace equation, solution of a partial differential equations by Laplace transforms.

Module 3 (10L + 3T)

Complex Numbers and Functions: Complex functions, derivative, analytic function, Cauchy- Reimann equations, Laplace's equation, geometry of analytic functions: conformal mapping, linear fractional transformations, Schwarz, Christoffel transformation, transformation by other functions.

Module 4 (9L + 3T)

Complex Integration: Line integral in the Complex plane, Cauchy's Integral Theorem, Cauchy's Integral formula, derivatives of analytic functions, power series, functions given by power series, Taylor series and Maclaurin's series, Laurent's series, singularities and zeros, residue integration method, evaluation of real integrals.

Reference

1. Kreyszig E, Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons, New York, 1999.
2. I.N. Sneddon, Elements of Partial Differential Equations, Dover Publications, 2006.
3. Wylie C. R. &Barret L. C., Advanced Engineering Mathematics, 6th Edition, McGraw Hill, New York, 1995.
4. Donald W. Trim, Applied Partial Differential Equations, PWS – KENT Publishing Company, 1994.

CH2004 MATERIAL SCIENCE

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Able to classify the materials based on the bonding of atoms
- CO2. Understating the importance of selection materials for engineering purpose
- CO3. Knowing about the atomic structure and bonding in solids
- CO4. Knowing the different crystalline forms, their geometry, and imperfections
- CO5. Understanding the phase transformation of materials
- CO6. Understanding the corrosion phenomena from the fundamentals of electrochemical engineering
- CO7. Knowing the relation between stress and strain and correlating the mechanical properties with the nature of material
- CO8. Able to demonstrate the different failure mechanisms such as fracture, crack initiation and creep and fatigue in solids
- CO9. Able to demonstrate the electrical, thermal and magnetic properties of materials from the atomic structure point of view
- CO10. Able to correlate the structure and properties of materials

Module 1 (10 hours)
Classification of materials and Crystal properties
Classes of engineering materials, selection of materials, structure of atoms and molecules, bonding in solids, types of bonds and comparison of bonds, structure and imperfections in crystals, crystal structure, crystal geometry, structure of crystalline solids, methods of determining crystal structures, imperfections in crystals, types of imperfection, point imperfection

Module 2 (9 hours)
Phase diagrams and transformations
Phase rule- single and binary phase diagrams, lever rule, micro structural changes during cooling, AI_2O_3, Cr_2O_3, Pb-Sn, Ag-Pt and $Fe\text{-}Fe_3C$ Systems phase diagrams, phase transformations, corrosion- theories of corrosion, control and prevention of corrosion

Module 3 (11 hours)
Mechanical properties and deformations of materials
Types of metal alloys, deformations-concept of stress and strain, elastic and plastic deformation in materials, stress-strain curves, dislocations in metals- characteristics, slip systems, slip in single crystals, deformation by twinning, multiplication of dislocations, fracture- ductile and brittle, fatigue- S-N curve, crack initiation and propagation, creep, Griffith’s criterion.

Module 4 (12 hours)
Electrical-Magnetic and Thermal properties of materials
Electrical properties of materials, semi conductivity and polarization, piezo and ferroelectricity, frequency and temperature dependence of dielectric constant, magnetic properties-paramagnetism, diamagnetism, ferri and ferromagnetism, soft and hard magnetic materials, thermal properties- specific heat capacity, thermal conductivity, thermal expansion, optical fibres, lasers, properties and applications of ceramics and composites

Reference

1. Callister, Materials Science and Engineering: An Introduction, 8th Edition, John Wiley and sons inc., Jan 2010
2. Raghavan V., Material Science and Engineering Prentice Hall of India, 1996.
3. Van Vlack M., Materials Science for Engineers, Addison Welsey Publishing Company, 1980.
4. HajraChoudhary, S.K., Material Science and Processes, 2nd Edn., Indian Book Distributing Co., 1982.
5. Rose M. Shepard, John Wulff, The Structure and Properties of Materials, Vol.4 (Electronic properties), Wiley, 1984.
6. Adrianus J. Dekker, Electrical Engineering materials, Prentice Hall of India, 1992.
7. Anderson, J.C., Keith D. Leaver, Rees D. Rawlings, Patrick S. Leevers,Materials Science for Engineers, 5th Edn., Nelson Thornes Ltd., 2003.

CH2005 MECHANICAL OPERATIONS

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Understand the fundamentals in characterization and classification of solids
- CO2. Analyse the sieving performances using different sieve size
- CO3. Acquire complete knowledge about different size reduction equipment and their working mechanisms
- CO4. Calculate the crushing efficiency of different size reduction equipment using crushing laws
- CO5. Acquaint with theories of sedimentation and settling characteristics
- CO6. Acquire knowledge about theory of filtration and calculate the filtration time, specific cake and medium resistance of filtration processes
- CO7. Acquire knowledge about agitation and different types of agitated vessels
- CO8. Acquire knowledge of different means of conveying solids and their storage

Module 1 (11 hours)

Properties and handling of particulate solids, characterisation of solid particles, standard screen series, mixed particle size and screen analysis, calculation based on screen analysis. Properties of particulate masses, pressure in masses of particles. Size reduction, principles of comminution, particle size distribution in comminuted products, energy and power requirements in comminution, Rittinger's law, Kick's law, Bond's crushing law and work index, size reduction equipment, crushers, grinders, ultrafine grinders (jaw crusher, gyratory crusher, smooth roll crusher, roller mills, attrition mills, revolving mills, fluid energy mills), equipment operation

Module 2 (12 hours)

Mechanical separations, screening, comparison of ideal and actual screens, capacity and effectiveness of screens, filtration, principles of cake filtration, pressure drop through filter cake, filter medium resistance, constant pressure filtration, constant rate filtration, continuous filtration, filter aids, washing of filter cakes, equipment of liquid-solid filtration, principles of centrifugal filtration, separations based on the motion of particles through fluids, gravity settling processes, batch sedimentation, differential settling methods, centrifugal settling processes, cyclone separation, centrifugal decanters, principles of centrifugal sedimentation

Module 3 (10 hours)

Agitation and mixing of liquids, introduction, agitation equipment, axial and radial flow impellers and flow patterns in agitated vessels, power consumption in agitated vessels, blending and mixing: mixing of solids and paste, types of mixers. Magnetic separation, electrostatic separation, jigging, heavy media separation, froth floatation process, additives used in floatation, floatation cells, flocculation, briquetting, pelletization and granulation.

Module 4 (9 hours)

Storage and conveying of solids, bins, hoppers and silos, flow out of bins, design consideration of bins, loading and unloading of solids, bucket elevators, apron conveyors, belt conveyors- types of belt conveyors, selection considerations

Reference

1. McCabe , W.L. and Smith, J.C., Unit Operation of Chemical Engineering, 5th Edn., McGraw Hill, New York, 1993.
2. Coulson, J.M. and Richardson, J.F., Chemical Engineering, Vol. II, 4th Edn., Butterworth - Heinemann, 1991.
3. Raymond A. Kulweic, Materials Handling Handbook, 2nd Edn., Wiley-Interscience Publications, 1985.
4. Badger and Banchero, Introduction to Chemical Engineering, 1st Edn., McGraw Hill, NewYork, 1954.
5. Perry, R.H. and Green , W.D., Perry's Chemical Engineers' Hand Book, 7th Edn., McGraw Hill International Edn., New York, 2000.

CH2006 HEAT TRANSFER

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Define different modes of heat transfer.
CO2. Understand the concepts of one-dimensional and multi-dimensional; steady and unsteady state conduction heat transfer, and relevant boundary and initial conditions.
CO3. Use analytical and graphical (temperature charts) techniques in solving specific transient heat conduction problems, including lumped and one-dimensional systems.
CO4. Understand the analysis of forced convection heat-transfer problems for laminar and turbulent flows in internal and external configurations, including the basics of the boundary layer concept.
CO5. Learn to select and use of various empirical correlations for dimensionless and dimensional forced convection heat transfer coefficient.
CO6. Learn concept of temperature-dependent buoyancy which causes natural free convection, and understand the dimensionless Grashof number used in correlations for free convective heat transfer calculations.
CO7. Understand phase-change phenomena and latent heat of vaporization, including free convective, nucleate and film boiling, as well as dropwise and film condensation.
CO8. Learn basic methodology in designing heat exchangers, including the log-mean temperature difference, over-all heat transfer coefficient, and the effectiveness-NTU methods.
CO9. Analyze and design single and multiple effect evaporators.
CO10. Calculate radiation heat transfer between black bodies, and gray body surfaces and understand the view factors concept.

Module (10 hours)

Importance of heat transfer in chemical engineering operations, modes of heat transfer, Fourier's law of heat conduction, steady-state conduction through walls (single and multi-layers), heat flow through a cylinder and sphere, unsteady state heat conduction, heat transfer in extended surfaces.

Module 2 (12 hours)

Concepts of heat transfer by convection, counter-current and parallel flows, energy balances, overall heat transfer coefficient, log-mean temperature difference, individual heat transfer coefficient, calculation of overall heat transfer coefficients from individual coefficients, fouling factors, analogies between transfer of momentum and heat – Reynolds analogy, Prandtl and Coulburn analogy, dimensional analysis in heat transfer, heat transfer coefficient for flow through pipe, non circular conduit, flow past flat plate, flow through packed beds, heat transfer by natural convection.

Module 3 (10 hours)

Heat transfer to fluids with phase change, heat transfer from condensing vapours, drop-wise and film type condensation, Nusslet equations for film type condensation, condensation for superheated vapours, heat transfer to boiling liquids, boiling of a saturated liquid, maximum flux and critical temperature drop, minimum flux and film boiling, sub-cooled boiling, theory of evaporation, single effect and multiple effect evaporation, design calculation for single and multiple effect evaporation.

Module 4 (10 hours)

Radiation heat transfer- emissive power, blackbody radiation, emissivity, laws of radiation, radiation between surfaces, heat transfer equipments, parallel and counter flow heat exchangers, single pass and multi-pass heat exchangers, plate heat exchangers, design of heat exchangers.

Reference

1. McCabe, W.L. and Smith, J.C., Unit Operation of Chemical Engineering, 6thEdn., McGraw Hill, New York, 2001.
2. Holman, J.P., Heat Transfer, 8thEdn., McGraw Hill, 1997.
3. Gupta C.P and Prakash R, Engineering Heat Transfer, Nemchand and Brothers, Roorkee, 1989.
4. Kern, D.Q., Process Heat Transfer, McGraw Hill Co. Inc, 1999.
5. Coulson, J.M. and Richardson, J.F., Chemical Engineering, Vol 1, 4thEdn., Asian Books Pvt Ltd., India, 1998.

CH2007 CHEMICAL ENGINEERING THERMODYNAMICS I

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Introduction to the course, including importance of professional ethics, engineering design, communications Understand the terminology associated with engineering thermodynamics and have knowledge of contemporary issues related to chemical engineering thermodynamics
CO2. Knowledge of phase equilibria in two-component and multi-component systems
CO3. Ability to estimate thermodynamic properties of substances in gas or liquid state of ideal and real mixture
CO4. Ability to predict intermolecular potential and excess property behaviour of multi-component systems

Module 1 (10 hours)

Terminologies of thermodynamics – definitions and fundamental concepts, property, Energy, work, Zeroth law of thermodynamics, thermodynamic properties of fluids and their representation, Ideal gas law, Van der Waals equation of state, first law of thermodynamics – Joules experiment, internal energy, energy balance for closed systems, state functions, path functions, equilibrium, phase rule, reversible process,

Module 2 (12 hours)

Constant volume process, constant pressure process, enthalpy, heat capacity at constant volume & constant pressure, mass and energy balances for open systems, Energy balance for steady state flow processes Volumetric properties of fluids – PVT behavior of pure substances, PV diagram, critical behavior, single phase region, Virial equation of state, compressibility factor, Ideal gas, Equations for process calculations, Ideal gas, adiabatic process, polytropic process, irreversible process, applications of Virial equation of state, cubic equation of state, equation of state parameters and determinations, theory of corresponding states, generalized correlations for gases and liquids

Module 3 (6 hours)

Heat effects – sensible, temperature dependence, latent heat, heat of reaction, heat of formation, heat of combustion, temperature dependence of heat of reaction

Module 4 (14 hours)

Second law of thermodynamics – statements, available and unavailable energies, entropy – calculation of entropy changes, applications of second law – refrigeration, flow processes and liquefaction processes, steam power cycles and internal combustion engine cycles, third law of thermodynamics, Entropy from microscopic point of view

Reference

1. Smith, J.M. and Van Ness, H.C Introduction to Chemical Engineering, Thermodynamics, McGraw Hill Book Co., London, 2000.
2. Narayanan, K.V., A Textbook of Chemical Engineering Thermodynamics, Prentice Hall of India, 2005.
3. Kyle, B.G., Chemical and Process thermodynamics, 3rd Edn, Prentice Hall of India, 1999.
4. S.I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, 4th Edn, Wiley India, 2006.
5. J.M. Prausnitz, R.N. Lichtenthaler and E.G. Azevedo, Molecular Thermodynamics of Fluid-Phase Equilibria, 3rd Edn, Prentice Hall, 1998.
6. J.W. Tester and M. Modell, Thermodynamics and its Applications, 3rd Edn, Prentice Hall, 1999.
7. R.C. Reid, J.M. Prausnitz and B.E. Poling, Properties of Gases and Liquids, 4th Edn, McGraw-Hill, 1987.
8. R. Balzheiser, M. Samuels, and J. Eliassen, Chemical Engineering Thermodynamics, Prentice Hall, 1972.
9. K. Denbigh, Principles of Chemical Equilibrium, 4th Edn, Cambridge University Press, 1981.

CY2002 ORGANIC CHEMISTRY

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

- CO1. To acquire knowledge on the role of organic chemistry in solving the problems related to chemical Engineering.
- CO2. To develop an understanding in synthetic organic chemistry.
- CO3. To acquire knowledge on the fundamental aspects of physical organic chemistry for understanding chemical engineering process.
- CO4. To develop an ability to design experiments in organic chemistry.
- CO5. To acquire knowledge about the methods of functional group transformation for developing chemical processes.

Module 1 (10 hours)
Stereochemistry: Concept of chirality and molecular dissymmetry, recognition of symmetry elements and chiral centers, prochiral relationship, homotopic, enantiotopic and disteriotopic groups and faces, racemic modifications and their resolution, R and S nomenclature, geometrical isomerism E and Z nomenclature, conformational analysis : cyclohexane derivatives, stability and reactivity, conformational analysis of disubstitutedcyclohexanes.

Module 2 (10 hours)
Study and description of reaction mechanisms: Definition of reaction mechanism, thermodynamic data, kinetics, substituent effects, linear free energy relationships, Hammett equation and related modifications, basic mechanistic concepts like kinetic vs thermodynamic control, Hammond postulate, Curtin-Hammett principle, isotope effects, acid-base catalysis, and nucleophilic catalysis, nucleophilic substitution, various types, stability and reactivity of carbocations, nucleophilicity and basicity, leaving group effect, steric effects in substitution reactions, classical and non-classical carbocations.

Module 3 (10 hours)
Pericyclic reactions: Definition, classification, electrocyclic, cycloaddition, sigmatropic reactions, electrocyclic reactions, examples of ring closing and ring opening reactions of butadiene and hexatriene, cycloaddition reactions – [$2\pi+2\pi$] and [$4\pi+ 2\pi$] cycloadditions, Woodward Hoffmann rules, FMO approach, stereochemical aspects and synthetic utility of the above reactions, sigmatropic rearrangement limited to Cope and Claisen rearrangements: examples and synthetic utility.

Module 4 (12 hours)
Functional groups interconversions: Functionalization of alkenes: hydroboration- dihydroxylation, epoxidation, oxidative cleavage, oxidation: oxidation of hydrocarbons, alcohols and ketones, reduction: catalytic hydrogenation, reduction by dissolving metals, reduction by hydride transfer reagents.

Reference

1. T.W. Graham Solomon and Craig B. Fryhle, Organic Chemistry**,**Wiley International, New York, 2004.
2. R.T Morrison and R.N.Boyd, Organic Chemistry**,** PrenticeHall-Inc., New Jersey, 1992.
3. E.L. Eliel, S.H. Wilen, Stereochemistry of Organic Compounds**,** Wiley-Interscience, New York, 1994.
4. Peter Sykes, Advanced Organic Chemistry, Reaction Mechanisms **,**Longman and Scientific Technical , New York, 1985.
5. Ian Fleming, Pericyclic Reactions,Oxford science publications, Cambridge, 1999.
6. Roc Normen and J.M. Coxon, Principles of Organic Synthesis, Nelson Thornes, UK, 1993.
7. Hendrickson Cram and Hammond, Organic Chemistry, McGraw Hill, New York, 1990.
8. W. Carruthers and I. Coldham, Modern Methods of Organic Synthesis, Cambridge University Press, UK, 2000.
9. Jerry March, Advanced Organic Chemistry, Reactions, Mechanisms and Structure, John-Wiley and Sons Inc., New York, 1992.
10. F.A. Carey, R.J. Sunburg, Advanced Organic Chemistry, Part B: Reactions and Synthesis, Kluwer Academic/Plenum Publishers, New York, 2001.
11. F.A. Carey and R.J. Sundberg, Advanced Organic Chemistry PART A Structure and Mechanisms**,** Kluwer Acdemic and Plenum Publishers, New York, 2000.

CH2092 FLUID MECHANICS LABORATORY

Assessment:
Continuous: 60 marks
End Semester: 40 marks

L	T	P	C
0	0	3	2

Lab Outcomes

CO1. Make velocity measurements using flow meters
CO2. Demonstrate Reynolds experiment and understand the laminar and turbulent flow behaviour
CO3. Conduct experiments and calculate the major and minor losses in fluid flow due to friction and pipe fittings
CO4. Calculate discharge through weirs and notches
CO5. Demonstrate practical understanding of boundary layers, separation and drag.
CO6. Demonstrate and understand the fluid flow behaviour in packed bed and fluidized bed systems.
CO7. Produce a working model through experience gained in fluid mechanics and explain its operation

1. Measurement of viscosity and surface tension of liquids
2. Reynolds experiment to demonstrate laminar and turbulent flow
3. Verification of Bernoulli's principle
4. Flow through orifice and mouthpiece
5. Losses due to friction in pipe lines
6. Losses in pipe fittings, expansion and contraction
7. Terminal settling velocities in viscous medium
8. Flow through packed bed
9. Flow through fluidized bed
10. Orificemeter
11. Venturimeter
12. Flow through weirs and notches
13. Characteristics of centrifugal pump
14. Pitot static tube set-up

CH2093 MECHANICAL OPERATIONS LABORATORY

L	T	P	C
0	0	3	2

Assessment:
Continuous: 60 marks
End Semester: 40 marks

Lab Outcomes

- CO1. Acquire the knowledge to determine the particle size by pipette method.
- CO2. Understand the engineering principles of unit operation like sieve analysis crushers, and grinders.
- CO3. Understand the principles, laws and mechanism of different comminuting methods
- CO4. Acquire the knowledge to determine the crushing efficiency of different size reduction equipments like crushers and grinders
- CO5. Calculate the filtration area, cake resistance and membrane resistance of Leaf filter, Plate and frame filter and Rotary vacuum filter
- CO6. Calculate the reduction ratio and product crushing efficiency of ball mill
- CO7. Understand the operating principles and important features of Ribbon Blenders
- CO8. Acquaint with theories of sedimentation and to study settling characteristics of batch settling.

1. Sieve analysis
2. Leaf filter
3. Plate and frame filter press
4. Sedimentation
5. Elutriation
6. Jaw crusher
7. Ball mill
8. Cyclone separator
9. Rotary vacuum filter
10. Roll crusher
11. Hammer mill
12. Ribbon mixer
13. Pulverizer

FIFTH SEMESTER

CH3001 CHEMICAL ENGINEERING THERMODYNAMICS II

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Able to select an appropriate equation of state for representing the P-V-T behaviour of gases at high pressure and/or liquids
- CO2. Able to calculate changes in U, H, and S for ideal gases, and also for non-ideal gases through the use of residual properties
- CO3. Understand the criteria of phase equilibrium for a pure substance and use it to relate the enthalpy of phase change to the saturation pressure curve via the Clapeyron equation
- CO4. Understand the utility of fugacity as a transformation of the chemical potential that is mathematically well behaved and not as a replacement for pressure
- CO5. Familiar with the various ways (P-T, P-x-y, T-x-y and x-y) for representing phase equilibrium behaviour of mixtures
- CO6. Understand the criteria of phase equilibrium for mixtures and the assumptions behind Raoult's law and the ideal solution as well as what things will make them fail.
- CO7. Know how to incorporate non-ideal behaviour into phase equilibrium calculations through two different approaches: the gamma-phi approach and the equation of state approach. They will understand the advantages and disadvantages of each approach
- CO8. Able to select appropriate solution models for use in either of these two approaches and to make the typical phase equilibrium calculations (BUBL P, BUBL T, DEW T and DEW P) using both of these approaches.
- CO9. Exposed to different techniques for measuring phase equilibria and have experience making actual measurements using the total pressure method.

Module 1 (10 hours)

Thermodynamic properties of ideal and real gases, departure functions and their calculations, multi component mixtures, partial molar properties, chemical potential, fugacity and fugacity coefficient and their estimation, thermodynamic properties of real gas mixtures, mixing rules, prediction of PVT properties and estimation of fugacity for real gas mixtures, fugacity of liquid and solid.

Module 2 (12 hours)

Properties of solutions, ideal solution, phase diagram and phase equilibrium, Margules equations, Wilson equations, Vapor-Liquid equilibrium – basic equation, reduction of VLE data, VLE at low to moderate pressures, azeotropic data, high pressure VLE, multi component vapor-liquid equilibria, bubble point and dew point calculations, VLE diagrams for ideal and azeotropic mixtures.

Module 3 (12 hours)

Chemical reaction equilibria – equilibrium constant, effect of temperature on equilibrium constant, homogeneous gas phase reactions, effect of operating conditions on degree of conversion at equilibrium, adiabatic reaction temperature, equilibrium with simultaneous reactions, homogeneous liquid phase reactions, heterogeneous reactions.

Module 4 (8 hours)

Introduction to molecular thermodynamics - molecular theory of fluids, second Virial coefficients from potential functions, Internal energy – microscopic view, thermodynamic properties & statistical mechanics, Hydrogen bonding and charge transfer complexing, behavior of excess properties, molecular basis for mixture behavior, vapor liquid equilibria by molecular simulation

Reference

1. YVC Rao, Chemical Engineering Thermodynamics, Universal Press India Pvt. Ltd, 2001
2. Sandler SI, Chemical, Biochemical and Engineering Thermodynamics, Wiley Publications, 2006.
3. Smith JM, Van Ness HC and Abbott MM, Introduction to Chemical Engineering Thermodynamics, 6^{th} Edn, McGraw Hill Publications, 2005.

CH3002 MASS TRANSFER I

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Understand the principles of molecular diffusion and basic laws of mass transfer.
CO2. Ability to determine mass transfer rates using Fick's Law
CO3. Estimate diffusion coefficients
CO4. Ability to determine convective mass transfer rates
CO5. Analyze the Similarity of mass, heat and momentum transfer – Analogy
CO6. Understand the humidification processes and use of psychometric chart
CO7. Analyze and design constant rate drying systems
CO8. Ability to design gas absorption systems
CO9. Ability to o design cooling towers
CO10. Analyze and design crystallization systems

Module 1 (8 hours)

Molecular diffusion in gases and liquids, steady state diffusion under stagnant and laminar flow conditions, diffusivity measurement and prediction, multi-component diffusion, molecular diffusion in solids and its applications, eddy diffusion, theories of mass transfer, analogy equations.

Module 2 (8 hours)

Mass transfer coefficients, interphase mass transfer, relationship between individual and overall mass transfer coefficients, steady state co current and countercurrent mass transfer processes, stages, cascade and stage efficiencies, stage wise and differential contactors, NTU and NTP concepts.

Module 3 (14 hours)

Humidification operations, humidity charts-Lewis relation, humidification and dehumidification equipments, enthalpy transfer concepts, theory and design of cooling towers, Gas absorption – absorption factor, limiting gas-liquid ratio, tray tower absorber and calculation of no. of theoretical stages, packed tower absorbers – HETP, HTU, NTU calculations.

Module 4 (12 hours)

Drying- theory and mechanism of drying, drying curves, classification of dryers, design of batch and continuous dryers, Cystallization, theory, classification of crystallizers, design of continuous crystallizers.

Reference

1. Treybal R.E, Mass Transfer Operations, 3rd Edn., International Student Edition, McGraw Hill International,1981.
2. McCabe, W.L. and Smith, J.C., Unit Operation of Chemical Engineering, 6th Edn., McGraw Hill, New York,2001.
3. C.J. Geankoplis, "Transport Processes and Separation. Process Principles", 4th ed., Prentice Hall, NJ, 2003.
4. Sherwood T.K., Pigford R.L and White C.R, Mass Transfer, McGraw Hill, New York, 1975.
5. Foust, A.S., Wenzel, L.A., Clump, C.W., Naus, L. and Anderson, L.B., Principles of Unit Operations, 2nd Edn., Wiley, 1980.

CH 3003 CHEMICAL REACTION ENGINEERING

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Able to develop an understanding of the basic concepts involved in using reaction rate equations and kinetic constants.
- CO2. Perform derivations of rate equations for non-elementary reactions both in homogenous and in heterogeneous reacting systems.
- CO3. Able to understand the role of temperature and concentration in the rate equation.
- CO4. Perform constant volume batch reactor calculations
- CO5. Develop calculations using the integral method and applying differential method of analysis using reactions with different orders
- CO6. Perform derivations of design equations and calculations in batch, continuous CSTR and PFR reactors.
- CO7. Determine optimal reactor configurations and operating policies for systems involving multiple reactions.
- CO8. Perform analysis of reactors involving non-ideal flow based on residence time distribution theory.
- CO9. Able to represent flow in real vessels for scale up using dispersion model and tanks in series models.

Module 1 (9 hours)

Introduction, kinetics of homogeneous reaction, law of mass action, definition of the rate of reaction, reaction rate constant and the reaction order, elementary reaction and molecularity, non-elementary reaction, search for a mechanism, enzymatic reaction fundamentals, temperature dependency from Arrhenius law, collision theory and transition state theory.

Module 2 (12 hours)

Analysis of rate data, batch reactor data, differential method of rate analysis, integral method, method of initial rates, method of half lives and least square analysis with linearization of the rate law, finding the rate law, conversion and reactor sizing, general mole balance equation, batch reactors, continuous flow reactors, industrial reactors, definition of conversion and design equations for batch and flow systems, applications for space time and space velocity, stoichiometric table.

Module 3 (12 hours)

Isothermal reactor design, design structure for isothermal reactors, scale-up of liquid phase, batch reactor data to design of a CSTR, batch operation, design of CSTRs, tubular reactors, multiple reactors system, mixed flow reactors of different sizes in series, design for multiple reactions, conditions for maximizing the desired product in parallel reactions, maximizing the desired product in parallel reactions, maximizing the desired product in series reactions, conditions for maximizing the desired product in series and parallel reactions.

Module 4 (9 hours)

Non, ideal flow, residence time distribution studies, C- E, F and I curves, conversion calculations directly from tracer studies, models for non-ideal flow-dispersion and tanks in series multi-parameter models.

Reference

1. Scott Fogler H, Elements of Chemical Reaction Engineering, 3rd Edn., Prentice Hall of India, 1999.
2. Octave Levenspiel, Chemical Reaction Engineering, 2nd Edn., Wiley Eastern Limited, 1985.
3. Smith J.M., Chemical Engineering Kinetics, McGraw Hill, 3rd Edn., 1981.
4. Froment, G.F. and Bischoff, K.B., Chemical Reactor Analysis and Design, John Wiley and Sons, 1979.

CH 3004 PROCESS INSTRUMENTATION

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	0	3

Course outcomes:

- CO1. Understand the principles involved in measurements, Attain knowledge on different measurement methods employed in industrial processing and manufacturing.
- CO2. Induce analytical and empirical approach to the measurement problems
- CO3. Attain the knowledge in calibration methods of instruments and processes.
- CO4. Acquire the knowledge and understanding of different pressure measurement devices
- CO5. Acquire the knowledge and understanding of different temperature measurement devices
- CO6. Acquire the fundamental concepts and understand working principle of level and flow rate measurement devices.
- CO7. Acquaint with the various latest analytical instruments and its method to analyze gas and liquid compositions
- CO8. Understand the primary features and importance of measurement systems such as density, specific gravity, moisture, humidity, pH and thermal conductivity.

Module 1 (10 hours)

Characteristics of measurement system, classification, performance characteristics, dynamic calibration, errors, statistical error analysis, reliability and related topics, pressure measurement, manometers, elastic types, bell gauges, electrical types, vacuum measurement, differential pressure transmitters.

Module 2 (10 hours)

Temperature measurement, definitions and standards, techniques and classification- temperature measurement using change in physical properties, electrical type temperature sensors, radiation thermometry.

Module 3 (11 hours)

Flow measurement, head types-area flow meters, mass flow meters, positive displacement type flow meters, electrical type flow meters and solid flow measurement. Level measurement, float types- hydrostatic types, thermal effect types, electrical methods and solid level measurement, density and viscosity measurement.

Module 4 (11 hours)

Instruments for analysis, spectroscopic analysis by absorption, emission, mass, diffraction and color, gas analysis by thermal conductivity, chromatography, moisture analysis and liquid composition analysis, measurement of PH.

Reference

1. Eckman, D.P., Industrial Instrumentation, Wiley Eastern Ltd., New York, 1990.
2. Patranabis, Principles of industrial instrumentation, Tata Mcgraw Hill, 2008**.**
3. Jain, R.K., Mechanical and Industrial Measurements, Khanna Publishers, 2005.
4. Tattamangalam R. Padmanabhan, Industrial Instrumentation: Principles and Design, Springer Publishing Company, 2009.

CH3005 ENVIRONMENTAL STUDIES

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	0	3

Course outcomes:

CO1. Understand the importance of an individual in conservation of environment.
CO2. Know about natural resources like forest, water and mineral and the problems associated with it.
CO3. Classify energy resources and understand the need of alternate energy
CO4. Understand the concept of an ecosystem, ecological pyramids, food chains and food webs
CO5. Discuss the importance of biodiversity, threats to biodiversity and conservation
CO6. Classify the types of pollution and understand their causes, effects and control measures.
CO7. Acquire knowledge on wasteland, environmental protection acts and family welfare programs
CO8. Asses and report a real time problem in the environment and a solution for it.

Module 1 (10 hours)

Multidisciplinary nature of environmental studies, definition, scope and importance, need for public awareness, natural resources, renewable and non-renewable resources, natural resources and associated problems, forest resources, use and over-exploitation, deforestation, case studies. timber extraction, mining, dams and their effects on forest and tribal people, water resources, use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems, mineral resources, use and exploitation, environmental effects of extracting and using mineral resources, case studies, food resources, world food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies, energy resources, growing energy needs, renewable and non renewable energy sources, use of alternate energy sources, case studies, land resources, land as a resource, land degradation, man induced landslides, soil erosion and desertification, role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles.

Module 2 (14 hours)

Ecosystems, concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids, introduction, types, characteristic features, structure and function of the following ecosystems, forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries), biodiversity and its conservation – introduction, definition, genetic, species and ecosystem diversity, bio geographical classification of India, value of biodiversity, consumptive use, productive use, social, ethical, aesthetic and option values, biodiversity at global, national and local levels, India as a mega-diversity nation, hot-sports of biodiversity, threats to biodiversity, habitat loss, poaching of wildlife, man-wildlife conflicts, endangered and endemic species of India, conservation of biodiversity-in-situ and ex-situ conservation of biodiversity.

Module 3 (8 hours)

Environmental pollution – definition, cause, effects and control measures of, air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards, solid waste management, causes, effects and control measures of urban and industrial wastes, role of an individual in prevention of pollution, pollution case studies, disaster management, floods, earthquake, cyclone and landslides.

Module 4 (13 hours)

Social issues and the environment, from unsustainable to sustainable development-urban problems related to energy, water conservation, rainwater harvesting, watershed management, resettlement and rehabilitation of people, its problems and concerns. Case studies, environmental ethics, issues and possible solutions- climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. Wasteland reclamation, consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act. Issues involved in enforcement of environmental legislation- public awareness. Human population and the environment, population growth, variation among nations, population explosion – Family Welfare Programme, environment and human health, human rights, value education, HIV/AIDS, women and child welfare, role of information technology in environment and human health, case studies.

Field work

•Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain
• Visit to a local polluted site-urban/rural/industrial/agricultural
• Study of common plants- insects, birds.
• Study of simple ecosystems-pond- river, hill slopes, etc.
(Field work Equal to 5 lecture hours)

Reference

1. Clark R.S., Marine Pollution, Clanderson Press, Oxford
2. Mhaskar A.K., Matter Hazardous, Techno-Science Publication.
3. Miller T.G. Jr., Environmental Science, Wadsworth Publishing Co.
4. Trivedi R. K. and P.K. Goel, Introduction to air pollution, Techno-Science Publication
5. Agarwal, K.C, Environmental Biology, Nidi Publ. Ltd. Bikaner, 2001
6. BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad –380 013, India
7. Brunner R.C. , Hazardous Waste Incineration, McGraw Hill Inc. 1989
8. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T., Environmental Encyclopedia, Jaico Publ. House, Mumabai, 2001
9. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
10. Down to Earth, Centre for Science and Environment
11. Gleick, H.P., Water in Crisis, Pacific Institute for Studies in Development, Environment & Security. Stockholm Environmental Institute Oxford University Press, 1993.
12. Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay
13. Heywood, V.H &Waston, R.T., Global Biodiversity Assessment, Cambridge University Press, 1995.
14. Jadhav, H &Bhosale, V.M., Environmental Protection and Laws. Himalaya Pub. House, Delhi, 1995.
15. Mckinney, M.L. & School, R.M., Environmental Science Systems & Solutions, Web enhanced edition, 1996.
16. Odum, E.P., Fundamentals of Ecology, W.B. Saunders Co. USA, 1971.
17. Rao M N. &Datta, A.K, Waste Water treatment. Oxford & IBH Publ. Co. Pvt. Ltd., 1987
18. Sharma B.K., Environmental Chemistry, Goel Publ. House, Meerut, 2001.
19. Survey of the Environment, The Hindu (M)
20. Townsend C., Harper J, and Michael Begon, Essentials of Ecology, Blackwell Science
21. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media.
22. Wanger K.D., Environmental Management, W.B. Saunders Co., Philadelphia, USA,1998
    (M)Magazine

CH3091ENVIRONMENTAL AND POLLUTION CONTROL LABORATORY

L	T	P	C
0	0	3	2

Assessment:
Continuous: 60 marks
End Semester: 40 marks

Lab Outcomes

CO1. Acquire the knowledge and understanding of the methods and technologies to reduce the effects of pollution
CO2. Test and assess water, air, soil, hazardous materials and biological samples
CO3. Understand the Basic concepts of water and waste water quality standards
CO4. Acquire a working knowledge of parameters to be examined in water and waste waters for various purposes
CO5. Get a working knowledge of preparation of standard solutions and reagents
CO6. Do experimental projects on water, air, soil quality monitoring

1. Estimation of COD,BOD and DO
2. Estimation of alkalinity, hardness and chloride ions in water
3. Characterization of wastewater
4. Estimation of ferrous and sulphate ions in a given sample using spectrophotometer
5. Sampling and analysis of solid waste
6. Sampling and analysis of flue gas
7. Bacterial growth kinetics
8. Electro-deposition of heavy metals
9. Flocculation studies
10. Clarifier
11. Bio-leaching
12. Determination of Sludge Volume Index

CH3092 HEAT TRANSFER LABORATORY

L	T	P	C
0	0	3	2

Assessment:
Continuous: 60 marks
End Semester: 40 marks

Lab Outcomes

CO1. Ability to measure the thermal conductivity of different common metallic materials.
CO2. Ability to measure the quantity of heat transfer between fluids and solid boundaries.
CO3. Ability to measure the amount of heat exchanged between fluids flowing within heat exchangers
CO4. Ability to carry out simple experimental work in radioactive heat transfer

1. Heat conduction
2. Natural convection
3.Forced convection
4. Thermal radiation-determination of emissivity
5. Double pipe heat exchanger
6. Shell and tube heat exchanger
7. Fin tube heat exchanger
8. Plate Heat exchanger
9. Heat transfer in agitated vessels
10. Open pan evaporator
11. Heat pipe demonstrator
12. Fluidized bed heat transfer

SIXTH SEMESTER

CH3006 MASS TRANSFER II

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Understanding of simple, steam, fractional , azeotrophic and extractive distillation
- CO2. Understanding of binary and multicomponent distillation
- CO3. Ability to design distillation - tray/packed tower
- CO4. Understanding of liquid/solid -liquid separation processes, solvent selection and phase equilibrium principles
- CO5. Ability to design extraction unit
- CO6. Ability to design leaching unit
- CO7. Understanding of adsorption mechanism and adsorption equilibrium
- CO8. Ability to analyze and design adsorption systems
- CO9. Understand membrane-based separation processes
- CO10. Ability to analyze and design membrane separation systems

Module 1 (14 hours)

Distillation, vapour liquid equilibrium data- methods of distillation, batch, continuous, flash distillation, differential distillation, steam distillation, continuous rectification, continuous fractionation – stage wise and continuous contact operations. Multistage tray tower, method of McCabe and Thiele, enriching section, exhausting section, introduction of feed, location of feed tray, total reflux, minimum reflux ratio, optimum reflux ratio, reboilers and condensers, multicomponent distillation, azeotropic distillation and extractive distillation.

Module 2 (8 hours)

Liquid extraction, liquid-liquid equilibrium data, single stage extraction, counter-current multistage extraction (without reflux only) stage efficiency, stage type extractors: agitated vessel, mixer settler cascades, sieve tray towers, spray towers, packed towers, design of extraction towers.

Module 3 (8 hours)

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

Module 4 (12 hours)

Adsorption – types, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, adsorption operations – stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves, novel separation processes, membrane separation- reverse osmosis, dialysis, ion exchange, techniques and applications.

Reference

1. Treybal R.E, Mass Transfer Operations, 3rdEdn., International Student Edition, McGraw Hill International, 1981.
2. McCabe, W.L. and Smith, J.C., Unit Operation of Chemical Engineering, 7thEdn., McGraw Hill, New York, 2005.
3. Seader, J.D and Henley, EJ, Separation Process Principles, 2ndEdn, Wiley, 2010.
4. Geankoplis C.J, Transport Processes and Unit Operations, 3rdEdn., Prentice Hall Inc., 1993.
5. Binay K. Dutta, Principles of Mass Transfer and Separation Processes, PHI Learning Private Limited, New Delhi 2009.
6. Foust, A.S., Wenzel, L.A., Clump, C.W., Naus, L. and Anderson, L.B., Principles of Unit operations, 2ndEdn., Wiley, 1980.

CH 3007 PROCESS DYNAMICS AND CONTROL

L	T	P	C
3	0	0	3

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Get a working knowledge about controllers
- CO2. Get an understanding of stability
- CO3. Check the stability of systems
- CO4. Understand and interpret control diagrams
- CO5. Get a knowledge of control valves
- CO6. Study response of systems
- CO7. Get an understanding of tuning
- CO8. Get a working knowledge of more complex control systems like model based controls.

Module 1 (12 hours)

General principles of process control, basic control elements, degree of freedom and fixing of control parameters, simple system analysis, Laplace transformation and transfer functions, block diagrams, linearization, effect of poles, zeros and time delays on system response, response of first order systems, transfer function, transient response, step response, impulse response, sinusoidal response, physical examples of first order systems, liquid level, mixing process, linearization, response of first order systems in series, non-interacting systems, interacting systems, higher order systems, second order and transportation lag, under damped systems, step response, impulse response, sinusoidal response.

Module 2 (11 hours)

The control system, block diagram, servo problem and regulator problem, negative feed-back and positive feed-back, controllers and final control elements, ideal transfer functions, proportional, proportional integral and proportional integral derivative controllers, on-off controllers, supervisory control and data acquisition (SCADA), distributed control system (DCS).

Module 3 (10 hours)

Stability, root locus, frequency response using Bode and Nyquist plots, control system design by frequency response, Bode stability criterion, gain and phase margins, Z-N controller settings, advanced control strategies, cascade control, feed forward control, ratio control, Smith predictor, internal model control

Module 4 (9 hours)

Control tuning and process identification, tuning rules (Ziegler-Nichol Rules and Cohen-Coon rules), process identification, step testing, semi-log plots for modeling control valves, control valve construction, valve sizing, valve characteristics, effective valve characteristics.

Reference

1. Coughanowr, D.R , Process System Analysis and Control, 2nd Edn., McGraw Hill International Editions, 1991.
2. Seborg,D.E., Edgar,T.F and Mellichamp,DA, Process Dynamics and Control, John Wiley and Sons, 2nd ed., 2004.
3. Bequette, B.W, Process Control: Modeling, Design and Simulation, Prentice Hall, New Delhi, 2003.
4. Luyben, W.L, Process Modeling Simulation and Control for Chemical Engineers, 2nd ed., McGraw Hill, 1990.
5. Stephanopoulos, G, Chemical Process Control: An Introduction to Theory and Practice, Prentice Hall, New Delhi, 1984.

CH3008 CHEMICAL PROCESS EQUIPMENT DESIGN

L	T	P	C
2	0	2	3

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Integrate the knowledge acquired in different chemical engineering courses in the design of a chemical plant.
CO2. Develop understanding of process design development and general design considerations. Prepare process flowsheets for design showing reactors, distillation columns, and other process equipment.
CO3. Conduct preliminary feasibility study of the plant design assigned
CO4. Perform economic analysis for process. Calculate capital investment, product cost, and profitability for process.
CO5. Select and calculate reaction and separation operations, Can draw PFD, layout and calculate material and energy balance,
CO6. Design the equipment such as pressure vessels - tall vessels, self supporting vessels, and skirt (and other support for vertical vessels).
CO7. Design heat exchanging equipment's such double pipe heat exchanger, shell and tube heat exchanger, plate heat exchanger, condenser, single and multiple effect evaporators and drier based on standards by TEMA, IS codes etc..
CO8. Calculate and specify design parameters for tray and packed distillation columns including minimum reflux ratio, number of stages, feed stage, and column diameter.
CO9. Can do the mechanical design and process design for absorption and distillation towers.
CO10. Ability to do the Process and mechanical design of reactors and filters.

Module 1 (6 + 6 hours)
Design of pressure vessels-tall vessels, self supporting vessels, design of skirt (and other support for vertical vessels).

Module 2 (8 + 8 hours)
Process and mechanical design of heat exchangers- evaporators and dryers.

Module 3 (8 + 8 hours)
Process and mechanical design of tray and packed distillation and absorption columns.

Module 4 (6 + 6 hours)
Process and mechanical design of reactors and filters.

Reference

1. Joshi, M.V. and Mahajan, V.V., Process Equipment Design, 3rd Edn., Macmillan & Co. India, 2003.
2. Dawande, S.D., Process Design of Equipments, Central Techno Publications, Nagpur, 2000.
3. Indian Standard Specifications IS-803, 1962; IS-4072, IS-2825, 1969. Indian Standard Institution, New Delhi, 1967.
4. Sham Tickoo, AUTOCAD 2000, Galgotia Publications, New Delhi, 2001.
5. Perry, R.H. & Green, D.W., Chemical Engineers Handbook, 7th Edn., McGraw Hill, 1998.

CH 3093 CHEMICAL REACTION ENGINEERING LAB

Assessment:
Continuous: 60 marks
End Semester: 40 marks

L	T	P	C
0	0	3	2

Lab Outcomes

CO1. Able to determine the order and kinetics of simple reactions
CO2. Knowing the procedures for calculating the parameters of Arrhenius rate law expression
CO3. Knowing about the different reactors and the mode of operation
CO4. Able to study the residence time distribution (RTD) characteristics of all basic reactors including packed column reactor

1. Exposure to different hardware elements used in reactorsKinetics of hydrolysis of ethyl acetate
2. Dynamics of saponification of ethyl acetate
3. Kinetics study in isothermal batch reactor
4. Kinetics study in isothermal semi batch reactor
5. Kinetics study in continuous stirred tank reactor
6. Kinetics study in Plug flow reactor
7. RTD study in continuous stirred tank reactor
8. RTD study in Plug flow reactor
9. RTD study in packed bed reactor
10. Adsorption Isotherms

CH 3094 MASS TRANSFER LAB

L	T	P	C
0	0	3	2

Assessment:
Continuous: 60 marks
End Semester: 40 marks

Lab Outcomes

CO1. Able to understand the mass transfer principles, phase equilibrium
CO2. Understanding the diffusivity coefficients in mass transfer
CO3. Understanding the mass and heat transfer happening through cooling tower, forced dryer, wetted wall column study
CO4. Able to understand the mass transfer coefficients from leaching, adsorption
CO5. Able to demonstrate separation processes such as simple distillation, steam distillation to estimate the composition in products

1. Distillation
2. Diffusivity coefficient determination
3. Mutual solubility data
4. Extraction
5. Batch drying
6. Mass transfer in packed tower
7. Mass transfer in spray tower
8. Ion-exchange apparatus
9. V.L.E data
10. Adsorption
11. Absorption studies in packed bed
12. Batch crystallizer
13. Cooling tower
14. Leaching

SEVENTH SEMESTER

CH4001 TRANSPORT PHENOMENA

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Knowing the mechanisms of momentum, heat and mass transfer each at molecular, micro and macro levels
CO2. Able demonstrate the applications of the transport phenomena in understanding and developing the allied processes
CO3. Able to make out the balances of the momentum in the shells and derive expressions for velocity profiles, momentum fluxes at surfaces and average velocity
CO4. Able to make out the balances of the energy in the shells and derive expressions for temperature profiles, energy fluxes at surfaces and average temperature
CO5. Able to make out the balances of the mass in the shells and derive expressions for concentration profiles, mass fluxes at surfaces and average temperature
CO6. Able to demonstrate and apply the equation of continuity, equation of motion and equation of energy (isothermal and non-isothermal)
CO7. Understand the methods of determining mass transfer coefficients
CO8. Understand the mass transfer in turbulent flow

Module 1 (11 hours)

General overview of transport phenomena including various applications, transport of momentum, heat and mass , transport mechanism, level of transport, driving forces, molecular transport (diffusion), convective transport (microscopic), unit systems, temperature, mole, concentration, pressure, gas laws, laws of conservation, energy and heat units.

Module 2 (11 hours)

Shell Momentum balances- velocity profiles, average velocity, momentum flux at the surfaces, equations of change (isothermal), equation of continuity, equation of motion, equation of energy (isothermal).

Module 3 (9 hours)

Shell energy balances- temperature profiles, average temperature, energy fluxes at surfaces, Equations of change (non-isothermal), equation of continuity, equation of motion for forced and free convection, equation of energy (non-isothermal).

Module 4 (11 hours)

Shell mass balances- concentration profiles, average concentration, mass flux at surfaces, Equations of change (multi-component), equations of continuity for each species, equation of energy (multi-component)

Reference

1. Bird,R.B., Stewart, W.E. and Lighfoot, E.W., Transport Phenomena, 2ndEdn.,John Wiley, 2002.
2. Brodkey, R.S. and Hershey, H.C., Transport phenomena, McGraw Hill, 1988.
3. Wilty, J.R., Wilson R.W and Wicks,C.W, Fundamentals of Momentum Heat and Mass Transfer, 3rdEdn., John Wiley, New York, 1984.
4. Slattery, J.S, Advanced Transport Phenomena, Cambridge University Press, London, 1992.
5. Leal,L. G. Laminar Flow and Convective Transport Processes, Butterworth-Heineman, 1992.

CH4002 COMPUTER AIDED DESIGN

Prerequisite: CH3008 Chemical Process Equipment Design

L	T	P	C
2	0	2	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Understand integrated process design by Design of energy - integrated separations, process synthesis integration.
- CO2. Understand the hierarchical approach in process synthesis, basis, variables and data required for design.
- CO3. Understand the phenomena that could occur in recycle systems such as high sensitivity and state multiplicity.
- CO4. Understand the multiple steady states, separation system design.
- CO5. Understand about various separation system synthesis, design and modes of separation system for various solutions.
- CO6. Understand the challenges in the design of future separation processes.
- CO7. Understand the process Simulation, steady state dynamic simulation for various processes.
- CO8. Understand about process engineering packages and simulation using computer programming.
- CO9. Able to learn design via various case study approaches.

Module 1 (6 + 6 hours)

Integrated process design – design guidelines, pinch point analysis, residue curve maps, process synthesis and integration, process synthesis by hierarchical approach, basis of design, data collection, design variables, snow ball effects, multiple steady states, separation system design, HAZOP study

Module 2 (8 + 8 hours)

Synthesis of separation systems – separation system design, vapor recovery and gas separation, liquid separation, simple distillation, complex separations – azeotropic distillation, reactive distillation, pressure swing distillation, heat integration, challenges in the design of future separation processes

Module 3 (8 + 8 hours)

Process Simulation, steady state dynamic simulation of simple distillation unit using aspen plus- open loop dynamics and control structure synthesis, closed loop dynamics, introduction to process engineering packages and simulation of simple distillation unit using computer programming, reactor/ separator/ recycle systems, introduction to plant wide control

Module 4 (6 + 6 hours)

Learning design via case study approach – phenol hydrogenation to cyclohexane, alkylation of benzene to cumene, isobutane alkylation, vinyl acetate monomer process.

Reference

1. Dimian, AC and Bildea CS, Chemical Process Design: Computer Aided Case Studies, Wiley VCH, 2008.
2. Seider, WD., Seader, JD., Lewin, DR and Widagdo S, Product and Process Design Principles: Synthesis, Analysis and Design, Wiley VCH, 2008.

ME4104 PRINCIPLES OF MANAGEMENT

Prerequisite: Nil

Total Hours: 42

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Able to demonstrate critical thinking when presented with managerial problems and express their views and opinions on managerial issues in an articulate way.
CO2. Understand the major internal features of a business system and the environment in which it operates.
CO3. Able to identify and explain the importance of the management process and identify some of the key skills required for the contemporary management practice.
CO4. Able to describe the communications process; discuss barriers to communication and suggest remedies to overcome communications difficulties.

Module 1 (9 Hours)
Introduction to management theory, Characteristics of management, Management as an art/profession, Systems approach to management, Task and responsibilities of a professional manager, Levels of managers and skill required. Management process – planning – mission – objectives – goals – strategy – policies – programmes – procedures.

Module 2 (9 Hours)
Organizing – principles of organizing – organization structures, Directing – delegation – span of control – leadership – motivation – communication, Controlling.

Module 3 (12 Hours)
Decision making process – decision making under certainty – risk – uncertainty – models of decision making, Project management – critical path method – programme evaluation and review technique – crashing.

Module 4 (12 Hours)
Introduction to functional areas of management, Operations management, Human resources management, Marketing management, Financial management.

References

1. Koontz, H., and Weihrich, H., *Essentials of Management: An International Perspective*, 8th ed., McGraw Hill, 2009.
2. Hicks, *Management: Concepts and Applications*, Cengage Learning, 2007.
3. Mahadevan, B., *Operations Management, Theory and Practice*, 2nd ed., Pearson Education Asia, 2009.
4. Kotler, P., Keller, K.L., Koshy, A., and Jha, M., *Marketing Management*, 13th ed., Pearson Education Asia, 2009.
5. Khan, M.Y., and Jain, P.K., *Financial Management: Text, Problems and Cases*, Tata-McGraw Hill, 2007.

CH4091 PROCESS DYNAMICS AND CONTROL LAB

Assessment:
Continuous: 60 marks
End Semester: 40 marks

L	T	P	C
0	0	3	2

Lab Outcomes

CO1. Able to identify the order of the system and obtaining the time constant
CO2. Understanding the importance and procedure of calibration of instruments
CO3. Supervising the flow, pressure and level control under computer assisted control
CO4. Able to identify the different control valves and exemplify their characteristics
CO5. Study of the variables and their dynamic relationship in interacting and non-interacting systems
CO6. Exposure to different hardware elements used in process control.

1. First order system
2. Second order system
3. Time constant of a thermocouple
4. Calibration of resistance thermometer
5. Two capacity liquid level process with interaction
6. Two capacity liquid level process without interaction
7. Computer controlled level process analyzer
8. Computer controlled flow process analyzer
9. Computer controlled pressure process analyzer
10. Control valve characteristics

CH4092 PROJECT

L	T	P	C
0	0	6	3

Course outcomes:

CO1. Able to understand the knowledge and application of process systems engineering methodologies for the systematic design and analysis of processes, including their control, safety, and environmental impact through problem solving, and it strives to broaden the experience of students
CO2. Able to produce and resolve designs or plans for problem related with chemical industries.
CO3. Able to understand the experimental and theoretical models for predicting the behaviour of fluid flow and heat transfer in materials and biological systems, as well as chemical reactions and mass transfers that take place in multi-component mixtures.
CO4. Able to supervise the operation of chemical plants, redesign chemical processes for pollution prevention, or be involved in the research and development of new products or processes in high technology areas.
CO5. Able to Prepare and present structured presentations and reports.

Group consisting of three to four students. The topic of the project has to be different from that of the mini project. The assessment of the project will be done twice during a semester: mid-way through the semester and at the end of the semester, by a committee consisting of three to four faculty members. The students will present their project work before the committee. The complete project report is not expected at the end this semester. However a three or four page typed report based on the work done should be submitted by the students to the assessing committee. The project guides will award the grades to the individual students depending on the group average marks awarded by the committee.

EIGHTH SEMESTER

MS4005 ENGINEERING ECONOMICS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Course outcomes:

CO1. Able to evaluate the economics of the management, operation, and growth and profitability of engineering firms and analyze operations of markets under varying competitive conditions.
CO2. Able to equip themselves to carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives.
CO3. To analyze cost/revenue data and carry out make economic analyses in the decision making process to justify or reject alternatives/projects on an economic basis.
CO4. Produce a constructive assessment of a social problem by drawing the importance of environmental responsibility and demonstrate knowledge of global factors influencing business and ethical issues.
CO5. Helps to use models to describe economic phenomena; analyze and makepredictions about the impact of government intervention and changing market conditions on consumer and producer behavior and well-being.

Module 1 (9 hours)

General foundations of economics, engineering economics, nature of the firm, forms of organizations objectives of firms, demand analysis and estimation, individual, market and firm demand, determinants of demand, elasticity measures and business decision making, price, income and cross elasticities of demand, theory of the firm, Production functions in the short and long run, law of variable proportions , returns to scale.

Module 2 (11 hours)

Cost concepts , short run and long run costs , fixed , variable and semi variable costs , economies and diseconomies of scale , real and pecuniary economies , product markets , market structure, competitive market, imperfect competition (monopoly, monopolistic & oligopoly) and barriers to entry, pricing in different markets, differential pricing.

Module 3(11 hours)

Break even analysis, time value of money, discounting and compounding, interest rates, depreciation, replacement and maintenance analysis–types of maintenance, types of replacement problem, determination of economic life of an asset, replacement of an asset with a new asset, capital budgeting.

Module 4 (11 hours)

Macroeconomic aggregates, gross domestic product, economic indicators, models of measuring national income, inflation, fiscal and monetary policies, monetary system, money market, capital market, Indian stock market, development banks, changing role of Reserve Bank of India.

Reference

1. Gregory.N.Mankiw, Principles of Macro Economics, Cengage Learning,4th Edition, 2007.
2. Gupta, S.B., Monetary Economics, S. Chand & Co., New Delhi,4th Edition, 1998.
3. Guruswamy,S., Capital Markets, Tata McGraw Hill, New Delhi,2nd edition, 2009.
4. James L.Riggs, David D. Bedworth, Sabah U. Randhawan , Engineering Economics, Tata Mcgraw, Hill 4th Edition , 2004.
5. Misra, S.K. and V.K. Puri, Indian Economy – Its Development Experience, Himalaya Publishing House, Mumbai, 27th Edition, 2009.
6. Pindyck, R.S,, D.L Rubinfield and P.L. Mehta , Microeconomics, Pearson Eductaion,6th Edition, 2008.
7. Samuelson, P.A. and W.D. Nordhaus ,Economics,Tata McGraw Hill, New Delhi. 1998.
8. William .J.Baumol and Alan.S. Blinder, Micro Economics Principles & Policy, Cengage Learning, Indian Edition 9th edition, 2009.

PN : Supplementary materials would be suggested / supplied for select topics on Indian economy

CH4003 CHEMICAL PROCESS OPTIMIZATION

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	0	3

Course outcomes:

CO1. Able to apply the knowledge of optimization and optimum design and an overview of optimization methods.
CO2. Ability to solve various multivariable optimization problems and solve chemical process optimization issues using MATLAB.
CO3. Develop skills to Implement the theory and applications of optimization techniques in a comprehensive manner for solving linear and non-linear, geometric, dynamic, integer and stochastic programming techniques.
CO4. Identify, formulate and solve a practical engineering problem of their interest by applying or modifying an optimization technique.

Module 1 (11 hours)

The nature and organization of optimization problems, scope and hierarchy of optimization, examples of applications of optimization in chemical industry, essential features of optimization, general procedures for solving optimization problems, basic concepts of optimization, continuity of functions, unimodalvs multimodal functions, convex and concave functions, convex region, necessary and sufficient conditions for an extremum of an unconstrained function, interpretation of the objective function in terms of its quadratic approximation.

Module 2 (10 hours)

Optimization of unconstrained function, one dimensional search, numerical methods for optimizing a function of one variable, scanning and bracketing procedures, Newton, Quasi, Newton and Secant methods of uni, dimensional search, region elimination methods, polynomial approximation methods, one dimensional search applied in a multidimensional problem, evaluation of uni, dimensional search methods, unconstrained multivariable optimization , direct methods, indirect methods–1st order, 2nd order; secant methods.

Module 3 (11 hours)

Linear programming and applications, basic concepts in linear programming, degenerate LPs–graphical solution, natural occurrence of linear constraints, simplex method of solving linear programming problems, standard LP form, obtaining a first feasible solution, revised simplex method, LP applications in chemical industry.

Module 4 (10 hours)

Non, linear programming with constraints, Lagrange multiplier method, necessary and sufficient conditions for a local minimum, quadratic programming- generalized reduced gradient method, optimization of stage and discrete processes, dynamic programming , integer and MP.

Reference
1. Edgar, T.F. and Himmelblau, D.M., Optimization of Chemical Processes, McGraw Hill, 1989.
2. Urbanier, K. and McDermott, C., Optimal Design of Process Equipment John Wiley, 1986.
3. Reklaitis, G.V., Ravindran, A., Ragsdell, K.M., Engineering Optimization, John Wiley, New York, 1980.
4. Biles, W.E. and Swain, J.J., Optimization and Industrial Experimentation, Inter Science, New York, 1980.
5. Seinfield, J.H., Lapidus, L., Process Modelling, Estimation and Identification, Prentice Hall, Englewood Cliffs, new Jersey, 1974.

CH4093 SEMINAR

L	T	P	C
0	0	3	1

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Ability to take a piece of writing through the process of revision in order to advance their ideas and communicate more effectively with their readers.
CO2. Ability to discern the assignment's intended audience and objectives and respond appropriately.
CO3. Develop skills to construct a paper consistent with expectations of the discipline, including an appropriate organization, style, voice, and tone.
CO4. Ability to prepare appropriately to participate effectively in class discussion.
CO5. Ability to follow discussions, oral arguments, and presentations, noting main points or evidence and tracking threads through different comments.
CO6. Able to challenge and offer substantive replies to others' arguments, comments, and questions, while remaining sensitive to the original speaker and the classroom audience.

Each student will be assigned a topic of interest in Chemical Engineering. A report is to be submitted to the coordinator previous to presenting the topic. The presentation will be for a duration of approximately thirty minutes, which will be followed by discussion. The topic is to be selected from outside the purview of prescribed textbooks preferably from peer reviewed journals.

CH4094 PROJECT WORK

L	T	P	C
0	0	10	5

Course outcomes:

CO1. Able to understand the knowledge and application of process systems engineering methodologies for the systematic design and analysis of processes, including their control, safety, and environmental impact through problem solving, and it strives to broaden the experience of students

CO2. Able to produce and resolve designs or plans for problem related with chemical industries.

CO3. Able to understand the experimental and theoretical models for predicting the behaviour of fluid flow and heat transfer in materials and biological systems, as well as chemical reactions and mass transfers that take place in multi-component mixtures.

CO4. Able to supervise the operation of chemical plants, redesign chemical processes for pollution prevention, or be involved in the research and development of new products or processes in high technology areas.

ELECTIVES

CH4021 ENERGY TECHNOLOGY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Enhance the knowledge on present and future energy challenges in our society.
- CO2. Provide an overview of renewable and non renewable energy resources.
- CO3. Able to understand the principles and technologies involved in harnessing energy from solar, wind and various renewable energy sources.
- CO4. Understand the fundamentals of converting biomass into energy and the system associated with it.
- CO5. Study the principles of electrochemical energy conversion in fuel cell and classify based on operation.
- CO6. Get an idea of various storage devices for energy
- CO7. Perform energy audits in process plants and to do process integration of various unit operations.

Module 1 (10 hours)

Energy, units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, electrical energy from conventional energy resources, thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, fluidized bed combustion.

Module 2 (12 hours)

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

Module 3 (10 hours)

Biomass energy resources , thermochemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.

Module 4 (10 hours)

Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.

Reference

1. Sukhatme. S.P.- SolarEnery, Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.
2. Rai, G.D., Non, conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 1999.
4. Arora, S.C. and Domkundwar, S., A course in Power Plant Engineering, DhanpatRai and Sons, New Delhi, 1998.
5. NejatVezirog, Alternate Energy Sources, IT, McGraw Hill, New York, 1983.

6. Goldmberg, J., Johansson, Reddy, A.K.N. and Williams, R.H., Energy for sustainable world, John Wiley, 1987.
7. Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.
8. Sukhatme, S.P., Solar Energy, Tata McGraw Hill, 2008.
9. Mittal, K.M., Non, conventional Energy Systems, Wheeler Pub, 1999.
10. Venkataswarlu, D., Chemical Technology, I.S.Chand.
11. Pandey, G.N., A Textbook on Energy System and Engineering, Vikas Pub, 1994.
12. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
13. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2002.

CH 4022 PETROLEUM REFINING OPERATIONS AND PROCESSES

Prerequisite: Nil

L	T	P	C
3	0	0	3

Course outcomes:

CO1. Have a knowledge on the past, present and future of petroleum industry nationally and globally
CO2. Study the nature of crude oil components and understand the various process of refining.
CO3. Understand the process technology involved in production and storage of LPG and LNG from its raw material.
CO4. Acquire an knowledge of process involved in converting crude oil to various products
CO5. Know the principles and technologies involved in Fluid catalytic cracking, hydro desulphurization and other processes in cracking of crude oil and gas.
CO6. Provide an overview on the manufacture of petrochemicals

Module 1 (11 hours)

Indian petroleum industry , prospects and future , composition of crude and classification of crude oil, evaluation of crude oil and testing of petroleum products, refining of petroleum, atmospheric and vacuum distillation, thermal cracking, visbreaking, coking – catalytic cracking (FCC), hydrocracking, air blowing of bitumen.

Module 2 (10 hours)

Treatment techniques for removal of sulphur compounds to improve performance, production and treatment of LPG, LNG technology, sweetening operations for gases including merox, ethanolamine, copper chloride, etc., storage and stability, product treatment processes – various solvent treatment processes, dewaxing, clay treatment and hydrofining.

Module 3 (10 hours)

Cracking of naphtha and gas for the production of ethylene , propylene isobutylene and butadiene, production of acetylene from methane, catalytic reforming of petroleum feed stocks, extraction of aromatics, next generation processes, introduction, thermal (carbon rejection) processes, asphalt coking technology process, comprehensive heavy ends reforming refinery processes, deep thermal conversion process, ET –ii process, eureka process, fluid thermal cracking process, high conversion soaker cracking process, catalytic cracking processes: asphaltresidue treating process, heavy oil treating process, reduced crude oil conversion process, residual fluid catalytic cracking process, shell FCC process, S&W fluid catalytic cracking process, hydrogen addition processes, asphaltenic bottoms cracking process, hydrovisbreaking (hycar) process, solvent processes, deasphalting process, deep solvent deasphalting process, demax process

Module 4 (11 hours)

Isomerization, alkylation and polymerization, process types, chemistry, commercial processes, catalysts, production of petrochemicals like dimethyl terephathalate (DMT), ethylene glycol, synthetic glycerine, linear alkyl benzene (LAB), acrylonitrile, methyl methacrylate (MMA), vinyl acetate monomer, phthallic anhydride, maleic anhydride, phenol, acetone, methanol, formaldehyde, acetaldehyde and pentaerythritol, production of carbon black.

Reference

1. BhaskaraRao- B.K., Modern Petroleum Refining Processes, 2nd Edn., Oxford and IBH Publishing Company, New Delhi, 1990.
2. Nelson, W.L., Petroleum Refinery Engineering, 4th Edn., McGraw Hill, New York, 1995.
3. BhaskaraRao, B.K., A Text on Petrochemicals, 1st Edn. Khanna Publishers, New Delhi, 1987.
4. Practical Advances in Petroleum Processing: Volume 1 & 2 by C.S. Hsu and P.R. Robinson, Springer Publications, 2006.
5. G.N. Sarkar, Advanced Petroleum Refining, Khanna Publishers, 2008.
6. R.E. Maples, Petroleum Refinery Process Economics, PennWell Corporation, 2000.
7. Ram Prasad, Petroleum Refining Technology, Khanna Publishers, 2010.

CH4023 CORROSION ENGINEERING

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	0	3

Course outcomes:

- CO1. Describe qualitatively the important forms (mechanisms) of corrosion, including uniform corrosion and the many forms of localized corrosion.
- CO2. Describe the corrosion resistance of important engineering materials in common environments
- CO3. Understand the use of electrochemical anodic polarization to induce and evaluate passivity.
- CO4. Be able to recognize the classic cases of especially favourable and especially unfavourable combinations.
- CO5. Understand and explain the common methods of corrosion control: materials selection and design, coatings, inhibitors, galvanic and electrochemical protection.
- CO6. Locate and utilize electrochemical data to postulate and formulate electrochemical half-cell and cell reactions for corrosion processes.
- CO7. Understand and explain the use of electrochemical tests in corrosion testing: cathodic and anodic polarization experiments.
- CO8. Understand and explain the role of passivity in the corrosion resistance of materials such as stainless steel.

Module 1 (11 hours)

Introduction , Definition of corrosion, environment, corrosion damage, appearance, maintenance and operating costs, plant shut downs, contamination of product, loss of valuable products, effects on safety and reliability, classification of corrosion principle – introduction, rate expression, electrochemical reaction, polarization passivity, environmental affect, effect of oxygen and oxidizers, velocity, temperature, corrosive concentration, effect of galvanic coupling, metallurgical aspects, metallic properties, ringworm corrosion.

Module 2 (11 hours)

Modern theory – principles, thermodynamics, cell potentials and EMF series, applications of thermodynamics to corrosion, electrode kinetics, exchange current density, activation polarization, combined polarization, concentration polarization, mixed potential theory, mixed electrodes, passivity forms of corrosion – uniform attack, galvanic corrosion, revise corrosion, pitting, inter granular corrosion and hydrogen damage.

Module 3 (10 hours)

Corrosion control aspects, electrochemical methods of protection – theory of cathodic protection, design of cathodic protection, sacrificial anode, impressed current anode, anodic protection, corrosion inhibitors for acidic neutral and alkaline media , cooling water system – boiler water system organic coating, surface preparation, natural, synthetic resin, paint, formulation and application design aspects in corrosion prevention, corrosion resistance materials.

Module 4 (10 hours)

Corrosion testing, monitoring and inspection, laboratory corrosion test, accelerated chemical tests for studying different forms of corrosion, electrochemical methods of corrosion rate measurements by DC and AC methods, corrosion monitoring methods, chemical and electrochemical removal of corrosion products, newer techniques to study corrosion process, inspection methods by NDT, surface analytical techniques such as AES, ESCA, SEM, evaluation of paints by conventional and electrochemical methods.

Reference

1. Roberge P R , Corrosion Engineering, McGraw Hill, New York, 1999.
2. Fontana, Corrosion Engineering, Int. Student Edn., 3rdEdn., McGraw Hill, 1986.
3. Uhling H H and Revie R W, Corrosion Control, John Wiley & sons. INC., 1985.
4. Banerjee S N, Introduction to Science of Corrosion and its Inhibition, Oxonian Inhibitors, Oxonian Press Ltd., New Delhi, 2004.
5. Trethewy& Chamberlain, Corrosion for Science and Engineering, Longman Sc& Tech; 2nd revised edition edition, 1996.

CH 4024 BIOCHEMICAL ENGINEERING

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	0	3

Course outcomes:

- CO1. Understand the basic importance and need for biochemical engineering.
- CO2. Acquire the knowledge of enzyme catalyzed reaction and inhibition mechanisms
- CO3. Get a working knowledge of different immobilization methods.
- CO4. Gets an integrated approach of chemical engineering with basic life sciences in developing processes and products.
- CO5. Familiar with kinetics of cell growth and product formation.
- CO6. Gets knowledge about different types of bioreactor, its industrial applications and scale up criteria.
- CO7. Understand the engineering principles of transport phenomena in bioprocess, downstream processes and environmental technology.

Module 1 (10 hours)

Introduction – role of biochemical engineer, biological process, definition of fermentation, enzyme kinetics, nomenclature and commercial applications of enzymes, simple enzyme kinetics, enzyme reactor with simple kinetics, inhibition of enzyme reactions, other influences on enzyme activity.

Module 2 (10 hours)

Immobilised enzyme – immobilization techniques-effect of mass transfer resistance, industrial application of enzymes, carbohydrates, starch conversion, cellulose conversion.

Module 3 (11 hours)

Cell cultivation – microbial cells, cultivations, cell growth measurement, cell immobilization, cell kinetics and fermenter design – introduction, definitions, growth cycle for batch cultivation, stirred tank fermenter, ideal continuous stirred tank fermenter (CSTF), multiple connected fermenters in series, CSTF with cell recycling, alternative fermenters.

Module 4 (11 hours)

Sterilization , sterlization method, thermal death kinetics, design criterion batch, continuous and air sterilization, agitation and aeration – basic mass transfer concepts, correlation coefficient, mass transfer coefficient, mean interfacial area, gas holdup, power consumption, oxygen absorption rates, scale, up, downstream processing – solid liquid separation, cell rupture, recovery, purification of bio, products.

Reference

1. James M.Lee- Biochemical Engineering, Prentice Hall, 1992.
2. James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, 2nd Edn.,McGraw Hill International, 1986.
3. Michael L. Shuler and FikretKargi, Bioprocess Engineering, Basic Concepts, 2nd Edn., Prentice Hall of India, New Delhi, 2002.

CH4025 POLYMER TECHNOLOGY

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	0	3

Course outcomes:

CO1. Able to understand the basic classifications of polymers.
CO2. Understand the different types of polymerization.
CO3. Analyze various techniques of carrying out polymerization
CO4. Derive the copolymer equation and apply it.
CO5. Understand the principles and technologies involved in preparation of various polymers
CO6. Analyze the polymer with different testing methods and checking its properties
CO7. Illustrate the different techniques used to determine the molecular weight of polymers
CO8. Describe the various polymer processing techniques

Module 1 (12 hours)

Introduction, classification of polymers, general properties, addition polymerization, step polymerization, copolymerization, kinetics of polymerization: addition polymerization, free radical, anionic and cationic polymerization, derivation of copolymer equation, techniques of polymerization: bulk polymerization, solution polymerization, suspension polymerization, emulsion polymerization, with merits and demerits of each.

Module 2 (11 hours)

Different types of polymers, natural and synthetic polymers, thermoplastic (polyethylene, polypropylene, polyvinylchloride, polystyrene, and co, polymers: PMMA, polycarbonates) and thermosetting polymers (phenol formaldehyde, urea formaldehyde, polyester and epoxy resins, polyurethane), their preparation and applications, analysis of plastic materials, solubility test, copper wire test, specific gravity test, identification of plastic materials. Properties of polymers, rheology, viscous flow, rubber like elasticity, viscoelasticity, hookean elasticity, stress-strain relationship for simple models, Maxwell element, Voigt element, stress relaxation and creep, Burger model, melt flow index, capillary rheometer.

Module 3 (9 hours)

Molecular weight of polymers , number average, weight average, viscosity average molecular weights, experimental methods for molecular weight determination: cryoscopy, ebulliometry, membrane osmometry, light scattering method, viscometry, intrinsic viscosity measurement, gel permeation chromatography.

Module 4 (10 hours)

Processing methods , effect of additives used, plasticizers, colourants, heat stabilizers, antioxidants, ultraviolet absorbers, antistatic agents, flame retardants, blowing agents, fillers etc. Molding techniques for plastics , injection molding, compression molding, calendaring, blow moulding, extrusion, thermoforming, spinning methods for fibres, compounding methods for elastomers, general study of elastomer processing methods.

Reference

1. Fried, J.R., Polymer Science and Technology, Prentice Hall of India Pvt. Ltd., New Delhi, Eastern Economy Edition, 2000.
2. Billmeyer, F.W., Textbook of Polymer Science, Wiley Interscience, 1984.
3. Gowarikar, V.R., Viswanathan, M.V. &Jayadev Sridhar, Polymer Science, Wiley Eastern Ltd., 1988.
4. PremamoyGhosh, Polymer Science & Technology, Tata Mc. Graw Hill Publishing Company, New Delhi, 2002.
5. Newness, Butterworths and Brydson, J.A., Plastics Materials, London, 1975.
6. Sinha, R., Outlines of Polymer Technology: Manufacture of Polymers, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.

CH4026 FOOD TECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Able to understand the general aspects of food industry.
- CO2. Understand the constituents, quality and nutritive aspects of food and analyze food additives
- CO3. Understand the standards, deteriorating factors and controls of the food additives.
- CO4. Know about the fundamentals of food canning technology.
- CO5. Evaluate heat sterilization kinetics of canned food, containers, metal, glass, flexible packaging.
- CO6. Aware of canning procedures for fruits, vegetables meats, poultry, marine products
- CO7. Learn about preservation by heat and cold, dehydration, concentration, frying, irradiation, microwave heating, fermentation and pickling.
- CO8. Gain knowledge on packing methods, production and utilization of food products, soft and alcoholic beverages, dairy products, meat, poultry and fish products.
- CO9. Aware of treatment and disposal of food processing wastes.

Module 1 (10 hours)

Introduction, general aspects of food industry, world food requirement and Indian situation, constituents of food, quality and nutritive aspects, food additives, standards, deteriorative factors and their control, preliminary processing methods, conversion and preservation operation.

Module 2 (10 hours)

Food canning technology, fundamentals of food canning technology, heat sterilization of canned food, containers , metal, glass and flexible packaging, canning procedures for fruits, vegetables, meats, poultry marine products.

Module 3 (11 hours)

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

Module 4 (11 hours)

Production and utilization of food products, soft and alcoholic beverages, dairy products, meat, poultry and fish products, treatment and disposal of food processing wastes.

Reference

1. Heid, J.L. and Joslyn, M.A., Fundamentals of Food Processing Operation, The AVI Publishing Co., Westport, 1967.
2. Heldman, D.R., Food Process Engineering, The AVI Publishing Co., Westport, 1975.
3. Hall, C.W., Farall, A.W. &Rippen, A.L., Encyclopedia of Food Engineering, Van Nostrand, Reinhold, 1972.

CH4027 ELECTROCHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Understand the basics of electrochemistry and the laws associated with it
CO2. Study the role of electrical double layer in electrochemical process
CO3. Describe the mass transfer phenomena in electrochemical systems
CO4. Understand the fundamentals of corrosion and study the theories of corrosion.
CO5. Illustrate the different methods of corrosion control and protection.
CO6. Study the classification and understanding the principles of electrochemistry process
CO7. Know the types of electrodes and its use in industry
CO8. Understanding the fundamentals of electrochemical reactors and knowing its applications.

Module 1 (9 hours)

Review basics of electrochemistry, Faraday's law, Nernst potential galvanic cells, polarography. The electrical double layer, it's role in electrochemical processes, electro capillary curve, Helmoltz layer, Guoy, Stern layer, fields at the interface.

Module 2 (10 hours)

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

Module 3 (11 hours)

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

Module 4 (12 hours)

Electro deposition, electro refining, electroforming, electro polishing, anodizing, selective solar coatings, primary and secondary batteries, types of batteries, fuel cells, electrodes used in different electrochemical industries: Metals, Graphite, Lead dioxide, titanium substrate insoluble electrodes – iron oxide, semi conducting type etc. Metal finishing, cell design- types of electrochemical reactors, merits of different type of electrochemical reactors.

Reference

1. Picket, Electrochemical Engineering, Prentice Hall, 1977.
2. Newman, J.S., Electrochemical systems, Prentice Hall, 1973.
3. Barak, M. and Stevenge, U.K., Electrochemical Power Sources – Primary and Secondary Batteries, 1980.
4. Mantell, C., Electrochemical Engineering, McGraw Hill, 1972.

CH 4028 CERAMIC TECHNOLOGY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Understand the need of ceramic materials and its applications in the modern era
CO2. Study the process of synthesizing and fabrication of ceramic materials with superior properties.
CO3. Describe the techniques of preparation of ultra pure, fine powders of oxides, carbides, etc
CO4. Know the various physical processing techniques for preparation of composites with special properties
CO5. Illustrate the chemical reaction methods of processing ceramics

Module 1 (10 hours)

Synthesis and fabrication of advanced and future materials with emphasis on ceramic, semi, conducting and super, conducting materials with superior structural, optical and electrical properties comparison of properties of such advanced materials, with conventional materials such as metal ad polymers.

Module 2 (11 hours)

Techniques for preparation of ultra, pure- ultra fine powders of oxides, nitrides, carbides etc. with very well defined characteristics and superior properties.

Module 3 (11 hours)

Processing techniques such as sintering- hot pressing, hot isostatic pressing, tape, casting sol, gel processing for the formation of monolithic ceramics composites (ceramic, ceramic metal, as well as metal matrix) SiO_2, glasses from above powders, synthesis and processing of mixed ceramic oxides with high temperature super conducting properties.

Module 4 (10 hours)

Processing techniques based on reaction methods such as chemical vapour deposition (CVD), vapour phase epitaxy, plasma, enhanced chemical vapour deposition (PECVD), chemical vapourinfilteration (CVI), self - propagating high temperature synthesis (SHS) for the preparation of monolithic ceramics, composites, coating, thin films, whiskers and fibres and semi conducting materials such as SI and Gallium arsenide.

Reference

1. Kingery, W.D., Introduction to Ceramics, John Wiley & sons, New York, 1965.
2. Chawla, K.K., Ceramic Matrix Composites, 2nd Edn., Kluwer Academic Publishers, Boston, 2003.
3. Vanvlack,L.H, Elements of Material Science and Engineering, 6th Edn., Adddison Wesley, 1989.
4. Brian S, Mittchell, An Introduction to Materials engineering and Science: for Chemical and Materials Engineers, Wiley Interscience, New York, 2004.

CH 4029 BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Understand the importance of biotechnology in the present scenario
CO2. Study the applications of recombinant DNA technology
CO3. Know the various aspects of fermentation technology.
CO4. Know the process of recovery of valuable products from fermentation system.
CO5. Explore the application of biotechnology in food and agricultural industries.
CO6. Able to analyze the role of biotechnology in waste processing and energy generation

Module 1 (8 hours)

Introduction, scope, potential and achievement, enzyme technology, biomass technology

Module 2 (12 hours)

Plant cell and tissue culture , culture techniques, plant cell fermentation's and production of secondary metabolites, production of secondary metabolites by immobilized plant cells, anther and pollen culture and androgens, genetic engineering of plants, direct gene transfer, cell culture and biotechnology of animals, serum, cell culture as sources of valuable products, genetic recombination in mammalian cells and embryos, biotechnology and domestic animals.

Module 3 (10 hours)

Fermentation technology and industrial microbiology , uses, fermenter, downstream processing, role of yeast, solid state fermentation, fermented foods, lactose utilization, single cell protein, enzymes and immobilization of enzymes, fermentation monitoring and recovery of products.

Module 4 (12 hours)

Food and agriculture , processing under exploited plants, petrocrops, aquaculture grain quality, disease resistance, monoclonal antibodies and agriculture, food and feed form wastes, fugal protein, environment and energy: biomass production, bioenergy, biogas, use of micro, organisms in pollution control, hydrogen, waste treatment, biological phosphorous removal from waste water, waste management.

Reference
1. Kumar, H.D., A Text Book on Biotechnology, Affiliated East West Press Private Ltd., 1993.
2. James E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, 2nd Edn.,McGraw Hill International, 1986.

CH4030 ENVIRONMENT IMPACT ASSESSMENT AND CLEAN TECHNOLOGY

Prerequisite : Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	0	3

Course outcomes:

- CO1. Understand the importance and regulatory requirement of EIA and strategic environmental assessment (SEA) towards sustainable development
- CO2. Classify impact assessment method and apply of projects
- CO3. Study and generate impact assessment report for developmental projects
- CO4. Know the contents of environmental management plan.
- CO5. Describe the procedure of conducting environmental audits and generating reports
- CO6. Illustrate the clean technology process and its options

Module 1 (9 hours)

Introduction and need for Impact assessment- legislation and pollution control acts and regulations, methodologies – collection of data and analysis, cost benefit analysis.

Module 2 (9 hours)

Application of impact assessment method in specific developmental projects- advantages, disadvantages of different methods, applicability of specific methods with examples.

Module 3 (12 hours)

Impact assessment report contents for developmental projects like thermal power projects-refinery project, chemical process industries, ranking of impact concepts and contents of environmental management plan.

Module 4 (12 hours)

Environmental audits-waste audits, life cycle assessment industrial symbiosis, clean technology options, clean technology and clean, up technology materials re use waste reduction at source and clean synthesis.

Reference

1. EIA , theory and practice, Unwin Hyman Ltd.,1988.
2. Enviormental Health and Safety Auditing Hand Book, McGraw Hill Inc, New York, 1994.
3. Larry W Carter, EIA , McGraw Hill Book Company, 1997.
4. Kirkwood, R.C and Longley, A.J, Clean Technology and Environment, Chapman &Hall, 1995.

CH4031 PROCESS AUTOMATION

L	T	P	C
3	0	0	3

Prerequisite : CH3007Process Dynamics & Control
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. applications of optimization in chemical industry

CO2. Able to understand generalized reduced gradient method, optimization of stage and discrete processes, dynamic programming

CO3. Able to understand the nature of problems to solve

CO4. Analyze simplex method of solving linear programming problems

CO5. Study about the unconstrained function in optimization problem

Module 1 (12 hours)

Introduction – Chemical plant- modern chemical process control engineering practice and automation, capital project management, project team considerations, principles of measurement and classification of control instruments, instrumentation symbols and diagrams

Module 2 (9 hours)

Single loop regulatory control and its enhancements, general feed-back control, PID controller and its tuning, user interface considerations, cascade control, feed forward control, ratio control, split, range control, override control, single loop model predictive control

Module 3(9 hours)

Multivariable regulatory control-multi loop control, decoupling control, singular value decomposition (SVD) analysis, multivariable model predictive control, user interface, discrete and interlock control, z, transforms

Module 4(12 hours)

Batch plant operation complexity, batch operation control, procedural control in batch processing, co, ordination and recipe control, batch data management, and statistical process control, batch user interface for setup and operation, case study

Reference

1. Kelvin T Erickson, John L. Hedrick, Plantwide Process Control, Wiley Series In Chemical Engineering, 1999.
2. Jonathan Love, Process Automation Hand Book, A Guide To Theory And Practice, Springer Publications, 2007.
3. Luyben ,M. L. and Luyben, W.L., Essentials Of Process Control, McGraw, Hill Companies, August 1, 1996.

CH4032 NEW ENTREPRISE CREATION AND MANAGEMENT

L	T	P	C
3	0	0	3

Prerequisite: Nil

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Understand the development of entrepreneurship as a field of study and as a profession
CO2. Understand the creative process of opportunity identification and screening in small scale enterprise
CO3. Aware of the importance of innovation in the creation of sustainable competitive advantage
CO4. Use business models, pro-forma statements and cash flow projections to understand venture processes
CO5. Use a number of techniques to test a business model to ensure its viability

Module 1 (10 hours)

Entrepreneur and entrepreneurship, entrepreneurship and small, scale enterprise (SSE), role in economic development, entrepreneurial competencies and institution interface for SSE.

Module 2 (12 hours)

Establishing the small scale enterprise, opportunity scanning and identification, market assessment for SSE, choice of technology and selection of site, financing the new / small enterprises, preparation of the business plan, ownership structures and organizational framework.

Module 3 (10 hours)

Operating the small, scale enterprises, financial management issues in SSE, operational management issues in SSE, marketing management issues in SSE, organizational relations in SSE.

Module 4 (10 hours)

Performance appraisal and growth strategies, management performance assessment and control, strategies for stabilization and growth, managing family enterprises.

Reference

1. Holt, Entrepreneurship – New Venture Creation, Prentice Hall India Pvt. Ltd., 2001.
2. Madhulika Kaushik, Management of New & Small Enterprises, IGNOU course material.
3. Rathore, B.S. and Saini, S., Entrepreneurship Development Training Material:, TTTI, Chandigarh, 1988.
4. Jain, P.C., A Hand Book for New Entrepreneurs, Faculty and External Experts, EDII, Ahmedabad, 1986.
5. Patel, J.B. and Appampalli, D.G., A Manual on How to prepare a Project Report, ED II– Ahmedabad, 1991.
6. Patel, J.B. and Modi, S.S., A Manual on Business Opportunity Identification and Selection ED II, Ahmedabad, 1995.

CH4033 SPECIALITY POLYMERS

L	T	P	C
3	0	0	3

Prerequisite: Nil

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Identify high temperature and fire resistant polymers based on their chemical structure.
CO2. Describe the methods to improve the fire resistance of polymers
CO3. Explain the conducting, photo conducting mechanisms of polymers
CO4. Choose polymers for biomedical and polymer concrete applications
CO5. Describe the properties of high modulus fibers and polymeric binders
CO6. Explain the construction of sheathing materials used in telecommunication and optical cables.

Module 1 (11 hours)

High temperature and fire resistant polymers, improving low performance polymers for high temperature use, polymers for low fire hazards, polymers for high temperature resistance, fluoropolymers, aromatic polymers, hydrocarbon polymers, polyphenylenesulphide, polysulphones, polyamides, polyketones, heterocyclic polymers.

Module 2 (10 hours)

Polymers with electrical and electronic properties, conducting polymers, conducting mechanism, polyacetylene, polyparaphenylene, polypyrrole, photoconducting polymers, polymers in non, linear optics, polymers with piezoelectric, pyroelectric and ferroelectric properties, photoresists for semiconductor fabrication.

Module 3 (10 hours)

Polymer concrete-polymer impregnated concrete, ultra high modulus fibres, polymers for biomedical applications, polymeric binders for rocket propellants.

Module 4 (11 hours)

Polymers in telecommunications and power transmission, polymers as insulators, electrical breakdown strength, capacitance, dielectric loss, polymers in telecommunication, cable insulation, low fire risk materials, polymers in power transmission, optical fibre telecommunication cables.

Reference

1. Mark, H.F. (Ed.), Encyclopedia of Polymer Science & Engineering, John Wiley & Sons, New York, 1989.
2. Martin T Goosey, Plastics for Electronics, Elsevier Applied Science, 1985.

CH4034 PROCESS MODELING AND SIMULATION

L	T	P	C
3	0	0	3

Prerequisite: CH 3003 Chemical Reaction Engineering
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Understand the important physical phenomena from the problem statement
CO2. Formulate a mathematical model equations for the given system
CO3. Demonstrate the model solving ability for various processes/unit operations
CO4. Demonstrate the ability to use a process simulation

Module 1 (11 hours)

Mathematical models of chemical engineering systems, introduction, use of mathematical models, scope, principles of formulation, fundamental laws, continuity equation, energy equation, equations of motion, transport equations, equations of state, equilibrium, chemical kinetics

Module 2 (10 hours)

Classification of models, modeling of complex system in chemical engineering through lumped parameter models, continuum models, population balance models, stochastic models, Monte Carlo methods, network models, percolation concepts, and fractal analysis of complex geometries.

Module 3 (10 hours)

Linear system analysis, nonlinear dynamics and bifurcation, introduction to nonlinear analysis, examination of multiple steady states, stability, oscillations, saddle point, phase plane approach, linearization of nonlinear systems;

Module 4 (11 hours)

Examples and simulation of mathematical models of chemical engineering systems , introduction, isothermal, constant hold up CSTRs, CSTRs with variable hold, ups, two heated tanks, gas phase pressurized CSTR, non, isothermal CSTR, single component vaporizer, multi, component flash drum, batch reactor, reactor with mass transfer, ideal binary distillation column, batch distillation with hold up, pH systems.

Reference

1. Bequette, B.W., Process Dynamics: Modeling, Analysis and Simulation, Prentice Hall, 1998.
2. Hangos K.M and Cameron M.T., Process Modeling And Model Analysis, Academic Press, 2001.
3. Chapra S.C. and Canale R.P , Numerical Methods for Engineers, McGraw Hill, 2001.
4. Ogunnaike B. and W. Harmon Ray, Process Dynamics, Modeling, and Control, Oxford University Press, 1995.

CH 4035 FERTILIZER TECHNOLOGY

L	T	P	C
3	0	0	3

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Ability to know the use of fertilizers to improve soil productivity and crop yield
- CO2. Learn different types of the nitrogenous, phosphatic and potash fertilizers and different organic fertilizer production methods.
- CO3. Develop skills to Formulate and compound fertilizers and Produce fertilizers at the desired rates.
- CO4. Ability to determine the fertilizer requirement for crops in a farm land
- CO5. Ability to Investigate to ascertain the fertilizer requirement of crops and engineering problems in fertilizer manufacturing.

Module 1 (10 hours)

Chemical fertilizers and organic manures-types of chemical fertilizers, nitrogenous fertilizers, methods of production of ammonia and urea

Module 2 (10 hours)

Nitrogen sources, nitric acid, ammonium sulphate, ammonium sulphate nitrate, ammonium nitrate, ammonium chloride – their methods of production, characteristics and storage and handling specifications.

Module 3 (11 hours)

Phosphatic fertilizers, raw materials, phosphate rock, sulphur pyrites, process for the production of sulphuric and phosphoric acids, ground phosphate rock, bone, single super phosphate, triple super phosphate – methods of production, characteristics and specifications.

Module 4 (11 hours)
Potash fertilizers, potassium chloride, potassium sulphate, potassium schoenite – methods of production, specification, characteristics, complex fertilizers, NPK fertilizers, mono, ammonium phosphate, di, ammonium phosphate, nitro phosphate – methods of production.

Reference

1. Collings, G.H., Commercial Fertilizers, 5th Edn.,Mcgraw Hill, New York, 1955.
2. Handbook of Fertilizer Technology, The Fertilizer Association Of India, New Delhi, 1977.
3. Slacks, A.V., Chemistry and Technology of Fertilizers, Interscience, New York, 1966.

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CH4036 MEMBRANE TECHNOLOGY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Understand the principles of different membrane manufacturing methods.
- CO2. Ability to know which materials are most suitable for membrane separation/purification of various liquid streams, depending on the liquid composition and selected process parameters such as temperature and pressure.
- CO3. Able to design a suitable membrane separation process for the liquid stream.
- CO4. Gain knowledge of membrane capabilities and constraints in the aspects of engineering.
- CO5. Develop skills to choose appropriate membrane process for a specific application
- CO6. Understand the principles and application of reverse osmosis, microfiltration, and ultra filtration

Module 1 (10 hours)

Introduction, classification, membrane processes, principle, theory, membranes and materials, membrane selectivity, modules, concentration polarization, membrane fouling and cleaning, applications.

Module 2 (10 hours)

Mechanism of membrane transport , RO/UF transport, solution diffusion model, dual sorption model, free volume theory, pore flow model, resistance model, boundary layer film model, membrane modules , flat, cartridge, spiral wound, tubular, hollow fiber, design equations, applications.

Module 3 (12 hours)

Membrane preparation techniques-isotropic membranes, anisotropic membranes, metal membranes, ceramic membranes, liquid membranes and biomembranes.
pervaporation andgas separation, principle, theory, process design, applications, complete mixing model (binary and multi component) for gas separation, cross flow model, counter current flow model

Module 4 (10 hours)

Engineering aspects of membranes, cascade operation, examples of cascade operation, design of gaseous & liquid diffusion membrane module. Hybrid membrane techniques, membrane reactor, membrane distillation, membrane extraction and osmotic distillation, design equations, applications.

Reference

1. Christie J. Geankoplis, Transport Processes and Unit Operations, 3rd Edn., Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
2. Sun, Tak, Hwang and Karl Kammermayer, Membranes in Separations, John Wiley and Sons, New York, 1975.
3. Richard W. Baker, Membrane Technology and Applications, John Wiley & Sons Inc., 2004
4. Separation Process Principles by J. D. Seader and Ernest J. Henley, John Wiley & Sons, 2006.
5. Coulson J.M. and Richardson, Chemical Engineering:– Particle Technology and Separation Processes Vol. 2, 4thEdn., Asian Books Pvt. Ltd., New Delhi, 1998.
6. Warren L. McCabe, Julian Smith and Peter Harriot, Unit Operations of Chemical Engineering, 6th Edn., 2004.
7. C. Judson King, Separation Processes, McGraw Hill Inc, 1980.
8. E. J. Hoffman, Membrane separations Technology: single, stage, Multistage, and Differential Permeation, Gulf Professional Publishing, 2003.

CH4037 MATHEMATICAL METHODS IN CHEMICAL ENGINEERING

L	T	P	C
3	0	0	3

Prerequisites: CH 2006 Heat Transfer
CH 3006 Mass Transfer II
CH 3003 Chemical Reaction Engineering
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Understand the basic algorithms for solution of and be able to solve non-linear equations.
- CO2. Understand the basic algorithms for solution of and be able to solve linear algebraic equation
- CO3. Acquire knowledge in manipulation of logarithmic, exponential, and other non-linear functions in order to linearize and to regress non-linear expressions.
- CO4. Familiar with a variety of numerical methods for solving partial differential equations
- CO5. Develop skilla in the use of programming language such as C or FORTRAN and use of software such as Excel Spreadsheets, Polymath, Matlab or Scilab, etc. to solve the types of problems listed above.
- CO6. Ability to apply the techniques learnt in this subject to the solution of a comprehensive design problem related to chemical engineering.

Module 1 (7 hours)

Mathematical formulation of the physical problems, application of the law of conservation of mass, salt accumulation in stirred tank, starting equilibrium still, solvent extraction in two stages, diffusion with chemical reaction, application of the law of conservation of energy, radial heat transfer through cylindrical conductors, heating a closed kettle, flow of heat from a fin.

Module 2 (12 hours)

Linear algebraic equations, existence and uniqueness of solutions, Gauss elimination, LU decomposition, Eigen values, eigenvectors, symmetric and non, symmetric matraces, similarity transformations, Jordan forms, application to linear ODEs computing eigenvalues, power, inverse power, householder, QL and QR algorithms, non, linear equations, Picard iteration, Newton, Raphson, contraction mapping theorem; Sturm, Liouville problems, separation of variables in rectangular and cylindrical coordinates;

Module 3 (12 hours)

Analytical (explicit) solution of ordinary differential equations encountered in chemical engineering problems , first order differential equations, method of separation of variables, equations solved by integration factors, certain examples involving mass and energy balances and reaction kinetics, second order differential equations, non, linear equations, linear equations, simultaneous diffusions and chemical reaction in a tubular reactor, continuous hydrolysis of tallow in a spray column, formulation of partial differential equations, unsteady state heat conduction in one dimension, mass transfer with axial symmetry, continuity equations, boundary conditions, function specified, derivative specified and mixed conditions, iterative solution of algebraic equations , Jacobi's method, Gauss, Siedel method and successive order – relaxation (S.O.R) method.

Module 4 (11 hours)

Numerical solution of initial value problems; time, integration methods, Runge, Kutta predictor, corrector methods, stability, finite differences for partial differential equations orthogonal collocation and finite element methods

Reference

1. S. Pushpavanam, Mathematical Methods in Chemical Engineering, Prentice Hall of India, 2001.
2. Bender C M, Orszag S A Advanced mathematical Methods for Scientists and Engineers, Springer, Verlag 1999
3. Mickley, H.S., Thomas. K. Sherwood and Road, C.E., Applied Mathematics in Chemical Engineering, Tata McGraw, Hill Publications, 1957.

CH 4038 COMPUTATIONAL FLUID DYNAMICS

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks
Course outcomes:

CO1. Develop skills to use CFD in industrial settings and get a solid foundation in both fluid mechanics and numerical analysis.
CO2. Learn how to formulate and solve computational problems arising in the flow of fluids.
CO3. Familiar with the differential equations for flow phenomena and numerical methods for their solution.
CO4. Able to use and develop flow simulation software for the most important classes of flows in engineering and science.
CO5. Able to critically analyze different mathematical models and computational methods for flow simulations.

Module 1 (11 hours)

Conservation laws of fluid motion and boundary conditions: governing equations of fluid flow and heat transfer-equations of state, Navier, Stokes equations for a Newtonian fluid, classification of physical behavior, classification of fluid flow equations, auxiliary conditions for viscous fluid flow equations

Module 2 (10 hours)

Turbulence and its Modeling: Transition from laminar to turbulent flow, Effect of turbulence on time, averaged Navier, Stokes equations, characteristics of simple turbulent flows, free turbulent flows, flat plate boundary layer and pipe flow, turbulence models, mixing length model, the K, E model, Reynolds stress equation models, algebraic stress equation models the finite volume method for diffusion problems, introduction, one, dimensional steady state diffusion, two, dimensional diffusion problems, three, dimensional diffusion problems, discretized equations for diffusion problems

Module 3 (10 hours)

The finite volume method for convection, diffusion problems: steady one, dimensional convection and diffusion, the central differencing scheme, properties of discretisation schemes, conservativeness, boundedness, transportiveness, assessment of the central differencing scheme for convection, diffusion problems, the upwind differencing scheme, the hybrid differencing scheme, the power, law scheme, higher order differencing schemes for convection, diffusion, quadratic upwind differencing scheme.

Module 4 (11 hours)

The finite volume method for unsteady flows and implementation of boundary conditions: one, dimensional unsteady heat conduction, discretisation of transient convection, diffusion equation, solution procedures for unsteady flow calculations, implementation of inlet, outlet and wall boundary conditions, constant pressure boundary condition.

Reference

1. H. K. Versteeg and W. Malalasekera, An introduction to computational fluid dynamics: the finite volume method, Longman scientific & technical publishers, 2007
2. John D. Anderson, Computational fluid dynamics: The Basics with Applications McGraw, Hill, New York, 1995
3. Vivek V. Ranade, Computational flow modeling for chemical reactor engineeringAcademic Press, San Diego, 2002

CH4039 CATALYSIS

Prerequisite: CH 3003 Chemical Reaction Engineering
Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	0	3

Course outcomes:

CO1. Understanding of various catalysts and the role of catalyst in chemical reactions.
CO2. Knowledge of heterogeneous catalyst preparation and characterization methods.
CO3. Knowledge of heat and mass transfer effects on catalytic reactions.
CO4. Ability to design different types of reactors for conducting catalytic reactions.
CO5. Develop skills to use enzyme catalyst for biochemical reaction and its application

Module 1 (9 hours)

Introduction to catalysis , scope and importance, basic concepts, rate determining steps, reaction kinetics, Langmuir, Hinshelwood kinetics, Michaelis, Menten kinetics, catalyst deactivation, sintering, thermal degradation, inhibition, poisoning.

Module 2 (12 hours)

Homogeneous catalysis – metal complex catalysis in the liquid phase- elementary steps, ligand exchange, oxidative addition, reductive elimination, structure/activity relationship, stearic effects, Industrial examples

Module 3 (9 hours)

Heterogeneous catalysis, adsorption - chemisorption, active sites, promoters, modifiers, poisons; preparation of solid catalysts, selection of right support.

Module 4 (12 hours)

Catalyst characterization – traditional surface characterization techniques, temperature programmed studies, spectroscopy and microscopy, introduction to biocatalysis, binding models, enzymatic catalysis and application of enzyme catalysis

Reference

1. Rothenberg G, Catalysis: Concepts and green applications, Wiley Publications, 2008.
2. J. M. Thomas, W. M. Thomas, Principles and practice heterogeneous catalysis, Wiley VCH, 1997.
3. J. M. Smith, Chemical Engineering Kinetics, Mc, Graw Hill, 1981

CH4040 PROFESSIONAL ETHICS AND HUMAN VALUES

L	T	P	C
3	0	0	3

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Familiar with the legal requirements, ethical issues, and professional issues in the engineering profession.
CO2. Understand the social impact of decisions and actions of participants
CO3. Learn writing short essays and papers related to legal, ethical and professional issues.
CO4. Understand the core values that shape the ethical behaviour of an engineer
CO5. Know about the engineer role and value of engineer in technological development
CO6. Understand social responsibility of an engineer.
CO7. Understand ethical dilemma while discharging duties in professional life.

Module 1 (9hours)

Human values : morals, values and ethics, integrity, work ethic, service learning, civic virtue, respect for others, living peacefully, caring, honesty, courage, valuing time, co-operation, commitment, empathy, self, confidence, character, spirituality.

Module 2 (14 hours)

Engineering ethics : sense of 'engineering ethics', variety of moral issued, types of inquiry, moral dilemmas, moral autonomy, Kohiberg's theory, Gilligans theory, consensus and controversy, models of professional roles, theories about right action, self interest, customs and region, uses of ethical theories, engineering as experimentation, engineers for responsible experiments, code of ethics, a balanced outlook on law, the Challenger case studies.

Module 3 (10hours)

Safety-responsibilities and rights, safety and risk, assessment of safety and risk benefit analysis and reducing risk, the Three Miles Island and Chernobyl case studies. Collegiality and loyalty-respect for authority, collective bargaining, confidentiality, conflicts of interest, occupational crime professional rights employee right, intellectual property rights (IPR) discrimination.

Module 4 (9 hours)

Global issues, multinational corporations- environmental ethics, computer ethics weapons development, engineers as managers, consulting engineers as expert witnesses and advisers, moral leadership, sample code of ethics (specific to a particular engineering discipline)

Reference

1. Martin, M &Schinzimger, R "Ethics in Engineering", McGraw Hill, New York, 1996.
2. Govidarakam, M.,Nadarajan, S &Senthil Kumar V.S, " Engineering Ethics", Prentice Hall of India, New Delhi, 2004.
3. Fledermann, C.D, Engineering Ethics, Prentice Hall, New Jersey, 2004.
4. Harris, C.E., Pritchard,M.S. and Rabins, M.J, Engineering Ethics – Concept and Cases, Wadsworth Thompson Learning, 2000.

CH4041 MICRO ELECTRONICS PROCESSING

L	T	P	C
3	0	0	3

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Able to design, simulate, built and debug complex combinational and sequential circuits based on an abstract functional specification.
- CO2. Able to know semiconductor processing, device design, device operation, and circuit integration.
- CO3. Develop skills in manufacturing practices of novel semiconductor devices, MEMS, photonics, and nanoscale devices
- CO4. Understand the carrier concentrations for semiconductor materials under a variety of conditions.

Module 1 (10 hours)

Integrated circuits – semiconductors and charge carriers- basic relationships and conductivity, basic units of integrated circuits, broad view of microelectronics processing, silicon refining and other raw materials, metallurgical grade and electronic grade silicon, metal organic compounds.

Module 2 (10 hours)

Bulk crystal growth, crystal structures and defects, crystal growth and impurity distribution, oxygen precipitation, chemical rate processes in the fabrication of ICs , growth processes of films of crystalline structure, heterogeneous reactions and deposition kinetics.

Module 3 (11 hours)

Chemical vapour deposition reactors, regimes of fluid flow, intrinsic kinetics and transport effects, reactor design, isothermal, non isothermal and molecular flow reactors, incorporation and transportation of dopants – dopant incorporation, radiation damage and annealing, dopant redistribution and auto doping.

Module 4 (11 hours)

Lithography – illumination and pattern transfer, resists and resist development, yield and ultimate limits, physical and physicochemical rate processes , evaporation and physical vapour deposition, plasma, physical sputtering, plasma deposition and gas, solid reaction, plasma etching, physical vapour deposition apparatuses, plasma reactors.

Reference

1. Lee H.H., Microelectronics Processing, McGraw Hill, 1990.

CH4042 RISK ANALYSIS AND HAZOP

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	0	3

Course outcomes:

CO1. Aquire knowledge to ensure safety and manage risk in chemical industries.
CO2. Understand the risk analysis, targets and contingencies, and risk mitigation strategies.
CO3. Ability to Identify hazards and affects in chemical industries
CO4. Develop skills to estimate risks and apply a control measure hierarchy to control risks
CO5. Know about the Safe Working Procedures
CO6. Able to Conduct assessment and produce Safe operational Working Procedure in industries and research laboratories

Module 1 (10 hours)

Risk Analysis: Introduction, quantitative risk assessment, rapid risk analysis, comprehensive risk analysis, emission and dispersion, leak rate calculation, single and two, phase flow dispersion model for dense gas, flash fire, plume dispersion, toxic dispersion model and evaluation of risk.

Module 2 (9 hours)

Radiation tank on fire flame length, radiation intensity calculation and its effect on plant, people and property, radiation VCVCE, explosion due to over pressure, effects of explosion, risk contour , effects, explosion, BLEVE, jet fire, fire ball.

Module 3 (10 hours)

Overall risk analysis, generation of meteorological data, ignition data, population data, consequence analysis and total risk analysis, overall risk analysis, overall risk contours for different failure scenarios, disaster management plan, emergency planning, onsite and off, site emergency planning, risk management, ISO 14000, EMS models case studies, marketing terminal, gas processing complex, refinery.

Module 4 (13 hours)

Hazard identification safety audits, checklist, 'what if' analysis, vulnerability models event tree analysis, fault tree analysis, hazard past accident analysis, Fixborough, Mexico, Madras, Vizag, Bhopal analysis, hazop guidewords, parameters, derivation, cause, consequences, recommendation, coarse hazop study, case studies, pumping system, reactor, mass transfer system.

Reference

1. K.V. Raghavan and A.A. Khan, Methodologies in Hazard identification and assessment, Manual, CLRI publication 1990.
2. V.C. Marcel, Major Chemical Hazard, Ellis Hawood Ltd., Chi Chester, UK, 1987.
3. B. Skeleton, Process Safety Analysis, Institution of Chemical Engineers, U.K., 1997.
4. Daniel A. Crowl and J.F. Louvar, Chemical Process Safety: Fundamentals with Applications, Prentice Hall, NJ 1990.

CH4043 OPERATIONS RESEARCH

L	T	P	C
3	0	0	3

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

- CO1. Able to understand the characteristics of different types of decision-making environments and the appropriate decision-making approaches and tools to be used in each type.
- CO2. Able to build and solve Transportation Models and Assignment Models.
- CO3. Able to design new simple models, like CPM, MSPT to improve decision –making and develop critical thinking and objective analysis of decision problems.
- CO4. Able to understand production and personnel management, finance, budgeting and marketing

Module 1 (12 hours)
Linear programming , formulation and graphical solution of LPP's, the general L.PP, stack, surplus and artificial variables, reduction of a LPP to the standard form, Simplex computational procedure, Big M method, two, phase method, solution in case of unrestricted variables, dual linear programming problem, solution of the primal from the solution of the dual problems.

Module 2 (10 hours)

Transportation problems , balanced and unbalanced transportation problems, initial basic feasible solution using NW corner rule, row minimum method, column minimum, least cost entry method and Vogel's approximation method, optimal solutions, degeneracy in transportation problems.

Module 3 (10 hours)

Queuing theory, Poisson process and exponential distribution- Poisson queues, model (M/M/D/Infinite/FIFO) and its characteristics.

Module 4 (10 hours)

Network representation of projects, critical path calculation-construction of the time, chart and resource leveling, probability and cost consideration in project scheduling, project control, graphical evaluation and review techniques.

Reference
1. KantiSwarup, Man Mohan and Gupta, P.K., Introduction to Operations Research, S. Chand and sons, 2005.
2. Pant, J.C., Introduction to Operations Research, Jain Brothers, 2008.
3. Kambo, N.S., Mathematical Programming Techniques, Affiliated East West Press Pvt. Ltd., 2000.

CH 4044 NOVEL SEPARATION TECHNIQUES

L	T	P	C
3	0	0	3

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Knowledge of various chemical engineering modern separation techniques in various processes
CO2. Ability to analyze and design novel membranes for intended application
CO3. Ability to analyze and design pervaporation, chromatography and dialysis based separation processes
CO4. Ability to analyze the separation system for multi-component mixtures
CO5. Ability to Select and design separation system for the effective solution of intended problem.

Module 1 (9 hours)

Absorptive separations, review of fundamentals, mathematical modeling of column factors, pressure swing adsorption, ion-exchange, affinity chromatography, gradient chromatography & counter current separations etc.

Module 2 (9 hours)

Membrane separation processes, classification, structure & characteristics of membranes, thermodynamic considerations, mass transfer considerations, design of R.O.U.F, per-evaporation, gaseous separations.

Module 3 (12 hours)

Surfactant based separations, fundamentals of surfactants at surfaces & in solutions, liquid membrane permeation, foam separations, micellar separations, external field induced separations electric & magnetic field separations, centrifugal separations.

Module 4 (12 hours)

Super critical fluid extraction, physicochemical principles, thermodynamics, process synthesis and energy analysis, separation by thermal diffusion and electrophoresis.

Reference

1. Wankat, P.C., Large Scale Adsorption Chromatography, CRC press, 1986.
2. Rousseu, R.W., Handbook of Separation Process Technology, John Wiley & Sons, 1987.
3. Sourirajan, S. &Matsura, T., Reverse Osmosis and Ultra Filtration Process Principle, NRC publication Ottawa, 1985.
4. Hatton, T.A., Surfactant Based Separation Process, Vol.23, 1989.
5. Mchugh, M.A. &Krukonis, V.J., Supercritical Fluid Extraction, Butterworth, 1985.

CH4045 HUMAN RESOURCE MANAGEMENT

L	T	P	C
3	0	0	3

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Gain an understanding of key terms, theories/concepts and practices within the field of human resource management.
CO2. Develop employability skills for the personnel management environment in workplace.
CO3. Develop an ability to undertake qualitative and quantitative research and apply this knowledge in the context of an independently constructed piece of work (i.e. dissertation).
CO4. Show evidence of the ability to analyze, manage and problem solve to deal with the challenges and complexities of the practice of collective bargaining.
CO5. Problem-solve human resource challenges and industrial conflict resolution.

Module 1 (11 hours)

Planning personnel functions – human resource development systems, personnel management environment in India, functions and operations of a personnel office, manpower planning, employee selection and development – recruitment, selection and induction, staff training and development, career planning.

Module 2 (12 hours)

Motivation- job design and appraisal , motivation and productivity, job description, analysis and evaluation, employee motivation and job enrichment, performance monitoring and appraisal, compensation planning – economic background and employee compensation, laws and rules governing employee benefits and welfare, compensation and salary administration.

Module 3 (10 hours)

Managing industrial relations – regulatory mechanisms guiding industrial relations- employee discipline, suspension, retrenchment and dismissal, employee grievance handling.

Module 4 (9 hours)

Unions and management- trade unionism, employees' associations, collective bargaining, industrial conflict resolution, industrial democracy and workers participation in management.

Reference

1. Rao, T.V. and Pereira, D.F., Recent Experiences in Human Resources Development, Oxford and IBH publishing Co., New Delhi, 1986.
2. Davar, R.S., Personnel Management and Industrial Relations, Vikas Publishing House, New Delhi, 1981.
3. Monappa, Arun and Saiyaddain, Mirza, S., Personnel Management, Tata McGraw Hill, Bombay, 1983.
4. Dasgupta, A., Business and Management in India, Vikas Publishing House, New Delhi, 1974.
5. Yoder, Dale and Paul D. Staudohar, Personnel Management and Industrial Relations, Prentice, Hall, Englewood, Cliffs, 1982.
6. Tripathi, P.C., Personnel Management, S.Chand and Co., Delhi, 1985.
7. Heresy, P. and Blanchard, K.H., Management of Organizational Behaviour, Prentice Hall of India, New Delhi, 1983.

CH4046 PROJECT ENGINEERING

L	T	P	C
3	0	0	3

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Bridges boundaries between engineering and chemical industry management.
CO2. Provide the students with a basic understanding and importance of design of chemical plants.
CO3. Understand the responsibilities of project engineer, which includes schedule preparation, pre-planning and resource forecasting for engineering and other technical activities relating to the project.
CO4. Understand the details of engineering design and equipment selection- design calculations and process equipment.

Module 1 (11 hours)

Scope of project engineering, the role of project engineer, R&D, TEFR, plant location and site selection, preliminary data for construction projects, process engineering, flow diagrams, plot plans, engineering design and drafting.

Module 2 (10 hours)

Planning and scheduling of projects- bar chart and network techniques, procurement operations, office procedures, contracts and contractors, project financing, statutory sanctions.

Module 3 (11 hours)

Details of engineering design and equipment selection- design calculations excluded vessels, heat exchangers, process pumps, compressors and vacuum pumps, motors and turbines, other process equipment.

Module 4 (10 hours)

Piping design- thermal insulation and buildings, safety in plant design, plant constructions, start up and commissioning, design calculations excluded

Reference

1. Rase & Barrow, Project Engineering of Process Plants, John Wiley, 1974.

CH4047 DRUGS AND PHARMACEUTICAL TECHNOLOGY

Prerequisite: Nil

L	T	P	C
3	0	0	3

Assessment:
Continuous: 50 marks
End Semester: 50 marks
Course outcomes:

CO1. Understand the fabrication, design, evaluation and application of drug and its distribution in biological system.
CO2. Understand the important unit processes involved in drug manufacturing process and their applications.
CO3. Ability to know factors affecting the bioavailability of drugs and its metabolism.
CO4. Able to Know salient features of GMP, TQM applicable in pharmaceutical industry and standard hygiene and manufacturing practice of drugs.
CO5. Know about biogeneric drugs and its manufacturing methods.
CO6. Develop skills to test various drugs and pharmaceuticals analytically, packing techniques, stability calculations, shelf life calculations and accelerated stability studies- quality control

Module 1 (10 hours)

Development of drugs and pharmaceutical industry, organic therapeutic agents, uses and economics, important unit processes and their applications , chemical conversion processes, alkylation, carboxylation, condensation, cyclisation, dehydration, esterification, halogenation, oxidation, sulfonation, complex chemical conversions, fermentation.

Module 2 (12 hours)

Drug metabolism, physico chemical principles, radio activity, pharma kinetics, action of drugs on human bodies, manufacturing principles , compressed tablets, wet granulation, dry granulation, direct compression, tablet presses formulation, coating pills, capsules sustained action dosage forms, parential solutions, oral liquids, injections, ointments, standard of hygiene and manufacturing practice.

Module 3 (12 hours)

Vitamins, cold remedies, laxatives, analgesics, nonsteroidal contraceptives, external antiseptics, antacids and others, antibiotics, hormones, vitamins, preservation.

Module 4 (8 hours)

Analytical methods and tests for various drugs and pharmaceuticals, packing techniques- quality control.

Reference

1. Rawlines, E.A., Bentleys Text book of Pharmaceutics, 3rd Edn.,BailliereTindall, London, 1977.
2. Yalkonsky, S.H., Swarbick, J., Drug and Pharmaceutical Sciences, Vol. I, II, III, IV, V, VI and VII, Marcel Dekkar Inc., New York, 1975.
3. Remington’s Pharmaceutical Sciences, Mack Publishing Co., 1975.

CH4048 FUEL CELLS

Prerequisite : Nil

Assessment:

Continuous: 50 marks

End Semester: 50 marks

L	T	P	C
3	0	0	3

Course outcomes:

CO1. Knowledge about the need and promise of alternative, “clean energy”

CO2. Understand the basic principles, prevalent types, and applications of fuel cells and expose students to near-term implementations of the technology

CO3. Ability to know about the ancillary components needed for an integrated fuel cell system.

CO4. Understand societal catalysts and challenges regarding fuel cell implementation and transport in fuel cell systems.

CO5. Develop skills to formulate and define problems based on the needs of the research area.

CO6. Able to Know the applications of fuel cells in various fields especially in vehicles, utility power systems and stand, alone system.

Module 1 (9 hours)

Introduction, definition, differences between a battery and a fuel cell, advantages, historical aspects, types of fuel cells–alkaline fuel cell, phosphoric acid and molten carbonate fuel cells. Solid polymer electrolyte fuel cell. description and working of H_2, O_2 and MeOH, O_2 fuel cells.

Module 2 (11 hours)

Electrochemistry basics, double layer phenomena, electrochemical equilibrium, reaction kinetics, efficiencies, thermodynamics fuel cell systems, physical nature of thermodynamic variables, heat of formation, sensible enthalpy, and latent heat, determination of change of enthalpy for non reacting species and mixtures, thermodynamic efficiency of a fuel cell.

Module 3 (11 hours)

Transport in fuel cell systems, ion transport in an electrolyte- electron transport, gas phase mass transport, single phase flow in channels, multiphase mass transport in channels and porous media, heat generation and transport.

Module 4 (11 hours)

Modeling of fuel cells- linear and nonlinear models of fuel cell dynamics, experimental methods, equipment and methods, laboratory, fuel processing, fuels, handling and production of hydrogen. Applications of fuel cells in vehicles, utility power systems and stand, alone systems

Reference

1. Larminie, J. and Dicks, A. Fuel cell systems explained, John Wiley & Sons England, 1st Ed. 2006
2. Mench, M. M, Fuel cell engines, John Wiley & Sons New Jersey, 2008
3. Gou, B., Na, K. W., and Diong, B., Fuel cells: Modeling, Control and Applications, CRC Press, 2010

CH4049 COMPOSITE MATERIALS

L	T	P	C
3	0	0	3

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

Course outcomes:

CO1. Know the types and fundamental of composite materials.
CO2. Ability to analyze problems on macro and micromechanical behavior of lamina
CO3. Ability to analyze problems on bending, buckling, and vibration of laminated plates and beams of composite materials
CO4. Understand and know the different method of manufacturing processes of composite materials
CO5. Ability to understand the characteristics of composite materials like stiffness and strength
CO6. Ability to test the composite materials and products for quality control and application of composite of materials in various fields.

Module 1 (10 hours)

Introduction to composite materials, definitions and basic concepts, classification, type of composite materials, characteristic features and advantages of composite materials, reinforcement and matrix materials and their properties, glass, carbon, Kevlar, boron, asbestos, steel, natural fibres and whiskers, reinforcement fibres, different types and forms used in FRP, surface treatment for fibres, size and coupling agents, commonly used fibres and additives in FRP and their effects, various types of resins used, polyester resins, epoxy and phenol formaldehyde resins.

Module 2 (10 hours)

FRP processing, important methods, hand lay-up, spray up, filament winding (polar and helical), pressure bag moulding, autoclave moulding, vacuum bag moulding, centrifugal casting, pultrusion, advantages and disadvantages, manufacture and properties of moulding compounds, prepregs and performs, fabrication of products using them, Fibre Reinforced Thermoplastics (FRTP) preparation, brief description of coating process, melt compounding process and dry blending process, injection moulding, rotational moulding and cold forming of reinforced thermoplastics.

Module 3 (11 hours)

Theory of reinforcement, selection criterion of matrix and reinforcement mechanics of composite materials, mechanism of load transfer, minimum and critical fibre content, critical fibre length, law of mixture rule, unidirectional, bidirectional and random fibre composites, effect of fibre orientation on stiffness and strength, concept of unit cell, stress analysis of unit cells, toughness of fibrous composites, microscopic stress, strain curves.

Module 4 (11 hours)

Testing of composite materials and products for quality control, testing of glass fibre, resins and products, general design considerations, design values, factor of safety, working stress approach, service ability design, selection of materials ad processing methods, application of composite of materials in various fields.

Reference

1. Peters, S.T,(Ed)., Handbook of Composites, 2nd Edn., Chapman & Hall, New York, 1997.
2. Mohr. J.G. et at SPI Handbook of Technology andEngineeringof Reinforced Plastic Composites, 2nd Edn., Van Nostrand, New York,1978.
3. Richardson M.O.W., (Ed.), Polymer Engineering Composites- Applied Science Publisher, London, 1977.
4. Lubin G., Handbook of Composites, 2nd Edn., Van Nostrand, New York, 1981.

CH4050 SAFETY IN CHEMICAL INDUSTRIES

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	0	3

Course outcomes:

- CO1. Anticipate, recognize, and evaluate hazardous conditions and practices affecting people, property and the environment, develop and evaluate appropriate strategies designed to mitigate risk.
- CO2. Understand the importance of plant safety and safety regulations, different types of plant hazards and their control, personal protective equipments, principles and procedures of safety audit.
- CO3. Ability to do Hazard analysis, Risk assessment techniques (HAZOP, HAZON, Fault Tree Analysis, Consequence Analysis), Onsite and offsite emergency management, Human error Analysis and Accident Analysis.
- CO4. Recognize that the practice of safety requires ongoing learning, and undertake appropriate activities to address this need

Module 1 (10 hours)

Introduction, safety program, engineering ethics, accident and loss statistics: acceptable risk, public perception, chemical hazards , toxic chemicals, dust, gases, fumes, vapours and smoke, the concept of threshold limits, acute and chronic exposure effects, personal monitoring, biological sampling, control measures.

Module 2 (10 hours)

UN and other classification of chemicals, transportation of chemicals, receiving and storing chemicals, work permit systems, pipe lines in chemical factories, colour coding of chemical pipe lines, reactors , run away reactions, control, precaution and prevention, inherent safety.

Module 3 (10 hours)

Emergency planning, on, site and off, site emergency planning, emergency preparedness, rehearsal and exercises, Mood's toxicity index, inspection techniques for plants, reaction vessels, check list for routine checks, checklist for specific maintenance and breakdown.

Module 4 (12 hours)

Fires and explosions, fire triangle, distinction between fires and explosions, definitions, flammability characteristics of liquids and vapours, designs to prevent fires and explosions, inerting, explosion proof equipment and instruments, ventilation, sprinkler systems, risk assessment, hazard vs. risk, techniques for risk assessment, HAZOP, fault tree analysis, past accident analysis, FMEA, quantitative risk assessment.

Reference

1. Crowl, D.A. and Louva, J.F., Chemical Process Safety (Fundamentals with Applications), Prentice Hall, 2001.
2. Fawcett, H.H. and Wood, W.S., Safety and Accident Prevention in Chemical Operations, 2nd edition, John Wiley & Sons, New York, 1982.
3. Sinnot, R.K., Chemical Engineering, Volume, 6, Butterworth Coulson and Richardson's Heinnann Ltd.
4. Accident Prevention Manual for Industrial Operations, Vol I & II, NSC Chicago, 1982.
5. Irving, S.X., Dangerous Properties of Industrial Materials, 1968.
6. Lees, F.P., Loss Prevention in Process Industries, Butterworths, NewDelhi, 3rdEdn., 2005.

CH4051 COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING

Prerequisite: Nil
Assessment:
Continuous: 50 marks
End Semester: 50 marks

L	T	P	C
3	0	0	3

Course outcomes:

CO1. Understanding of fundamental mathematics and to solve problems of algebraic and differential equations, simultaneous equation, partial differential equations.
CO2. Understand the use of Artificial Intelligence in chemical engineering and develop the idea on Knowledge based applications in chemical engineering.
CO3. Ability to convert problem solving strategies to procedural algorithms and to write program structures
CO4. Ability to solve engineering problems using computational techniques
CO5. Ability to assess reasonableness of solutions, and select appropriate levels of solution sophistication.

Module 1 (10 hours)

Artificial intelligence (AI) in chemical engineering , introduction to AI programming, introduction to prolog, introduction to AI principles, prolog, expert system for separation synthesis

Module 2 (10 hours)

Knowledge based applications in chemical engineering, process fault diagnosis, process control, process planning and operation, product design and development, process modeling and simulation

Module 3 (10 hours)

Introduction to artificial neural networks (ANN) in chemical engineering, fundamentals of neural networks, application of ANN to process control, fault diagnosis, process modeling, process forecasting, limitations of ANN

Module 4 (12 hours)

Introduction to process engineering packages (Aspen Plus, Super Pro), process modeling and computer simulation, limitations and usefulness of process simulation, mathematical modeling, steady and unsteady lumped systems, solutions and programming to solve partial differential equations

Reference

1. TE Quantrille, YA Liu; Artificial Intelligence in Chemical Engineering, Academic Press, 1991
2. Ramirez WF, Computational Methods For Process Simulation, Butterworth Heinemann, 1998
3. Franks R.G., Mathematical Modeling in Chemical Engineering, Wiley Publications, 1967.
4. Gupta S. K., Numerical methods for Engineers, New Age Publishers, 1995.