COURSE STRUCTURE & CURRICULLUM

BACHELOR OF TECHNOLOGY

CHEMICAL ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING

FACULTY OF TECHNOLOGY

DHARAMSINH DESAI UNIVERSITY

NADIAD – 387 001, GJ, INDIA

www.ddu.ac.in

TEACHING SCHEME FOR THE COURSE
B.TECH. CHEMICAL ENGINEERING
ADMISSION YEAR – 2017 - 2020

L – Lecture T – Tutorial P – Practical
Th. – Theory S – Sessional TW – Term Work
Teaching Scheme – hr/week

SEMESTER – I

Subject Code	Subject Name	Teaching Scheme			Exam Scheme					Credit
		L	T	P	Th.	S	P	TW	Total	
AF111	Mathematics - I	3	1	0	60	40	-	-	100	4
AF117	Engineering Mechanics	3	1	3	60	40	25	25	150	3.5
AF115	Engineering Graphics	3	1	3	60	40	-	50	150	5.5
AF136	Work Shop-I	-	-	2	0	-	-	50	50	1
AF122	Basic Electrical & Electronic Engineering	3	1	2	60	40	25	25	150	5
AX123	Programming In 'C'	3	1	2	60	40	25	25	150	5
AM110	Engineering Economics & Principles of Management	3	-	-	60	-	40	-	100	3
		14	**5**	**11**					**850**	**27**

SEMESTER – II

Subject Code	Subject Name	Teaching Scheme			Exam Scheme					Credit
		L	T	P	Th.	S	P	TW	Total	
AF201	Mathematics - II	3	1	-	60	40	-	-	100	4
AF214	Mechanics Of Solids	3	1	2	60	40	25	25	150	5
AF217	Work Shop - II	-	-	2	-	-	-	50	50	1
AF212	Electronics Principles	3	1	2	60	40	25	25	150	5
AF215	Heat Power	3	1	2	60	40	25	25	150	5
AX223	Advanced C Programming	3	1	2	60	40	25	25	150	5
ES210	Environmental Science	3	-	-	60	-	40	-	100	3
		15	**5**	**10**					**850**	**28**

SEMESTER – III

Subject Code	Subject Name	Teaching Scheme			Exam Scheme					Credit
		L	T	P	Th.	S	P	TW	Total	
AF301	Mathematics - III	4	-	-	60	40	-	-	100	4
CH302	General Chemical Tech.-I	4	-	-	60	40	-	-	100	4
CH305	Theory Of Machines & Machine Design	4	-	3	60	40	25	25	150	5.5
CH306	Chemistry-I	3	-	3	60	40	25	25	150	4.5
CH307	Chemistry-II	3	-	3	60	40	25	25	150	4.5
CH311	Introduction To Chemical Engineering	4	-	2	60	40	25	25	150	5
AF310	Financial & Managerial Accounting	3	-	-	60	40	-	-	100	3
		22		**11**					**900**	**30.5**

SEMESTER – IV

Subject Code	Subject Name	Teaching Scheme			Exam Scheme					Credit
		L	T	P	Th.	S	P	TW	Total	
AF411	Mathematics - IV	4	-	-	60	40	-	-	100	4
CH404	Chemistry-III	3	-	3	60	40	25	25	150	4.5
CH414	General Chemical Tech.-II	4	-	3	60	40	25	25	150	5.5
CH415	Chemistry-IV	3	-	3	60	40	25	25	150	4.5
CH416	Chemical Engineering Thermodynamics-I	4	-	-	60	40	-	-	100	4
IN401	Engineering Materials	3	-	-	60	40	-	-	100	3
CH417	Chemical Process Calculations	4	-	-	60	40	-	-	100	4
		25		**9**					**850**	**29.5**

SEMESTER – V

Subject Code	Subject Name	Teaching Scheme			Exam Scheme					Credit
		L	T	P	Th.	S	P	TW	Total	
CH501	Fluid Flow Operations	4	-	3	60	40	25	25	150	5.5
CH502	Mechanical Operations	4	-	3	60	40	25	25	150	5.5
CH513	Chemical Engineering Thermodynamics-II	4	-	-	60	40	-	-	100	4
CH504	Mass Transfer-I	4	-	-	60	40	-	-	100	4
CH505	Heat Transfer	4	-	3	60	40	25	25	150	5.5
CH507	Energy Technology(E)	4	-	-	60	40	-	-	100	4
AF501	Professional Communication-I	1	-	2	50	-	-	-	50	2
		25		**11**					**800**	**30.5**

SEMESTER – VI

Subject Code	Subject Name	Teaching Scheme			Exam Scheme (Max. Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
CH601	Chemical Reaction Engineering-I	4	-	3	60	40	25	25	150	5.5
CH602	Chemical System Modelling	4	-	-	60	40	-	-	100	4
CH604	Mass Transfer-II	4	-	3	60	40	25	25	150	5.5
CH605	Instrumentation & Process Control	4	-	3	60	40	25	25	150	5.5
CH612	Numerical Techniques (E)	4	-	-	60	40	-	-	100	4
CH611	Environmental Engineering	4	-	-	60	40	-	-	100	4
AF601	Professional Communication-II	1	-	2	50	-	-	-	50	2
		25		**11**					**800**	**30.5**

SEMESTER – VII

Subject Code	Subject Name	Teaching Scheme			Exam Scheme					Credit
		L	T	P	Th.	S	P	TW	Total	
CH701	Chemical Reaction Engineering-II	4	-	3	60	40	25	25	150	5.5
CH702	Transport Phenomena	4	-	3	60	40	25	25	150	5.5
CH703	Process Equipment Design & Drawing	4	-	3	60	40	25	25	150	5.5
CH704	Chemical Engineering Plant Design & Economics	4	-	-	60	40	-	-	100	4
CHXXX	Chemical Process Safety	4	-	-	60	40	-	-	100	4
CH713	Computer Aided Design (E)	4	-	-	60	40	-	-	100	4
CH714	Optimization Techniques(E)	4	-	-	60	40	-	-	100	4
		28		**9**					**850**	**32.5**

SEMESTER – VIII

Subject Code	Subject Name	Teaching Scheme			Exam Scheme					Credit
		L	T	P	Th.	S	P	TW	Total	
AF801	Project/Industrial Training	-	-	28	-	-	300	100	400	14
AF802	Seminar	-	-	8	-	100	-	-	100	4
		25		**11**					**500**	**18**

SEMESTER – I

Subject Code	Subject Name	Teaching Scheme			Exam Scheme					Credit
		L	T	P	Th.	S	P	TW	Total	
AF111	Mathematics - I	3	1	0	60	40	-	-	100	4
AF117	Engineering Mechanics	3	1	3	60	40	25	25	150	3.5
AF115	Engineering Graphics	3	1	3	60	40	-	50	150	5.5
AF136	Work Shop-I	-	-	2	0	-	-	50	50	1
AF122	Basic Electrical & Electronic Engineering	3	1	2	60	40	25	25	150	5
AX123	Programming In 'C'	3	1	2	60	40	25	25	150	5
AM110	Engineering Economics & Principles of Management	3	-	-	60	-	40	-	100	3
		14	**5**	**11**					**850**	**27**

MATHEMATICS –I (AF111)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	1	0	60	40	0	0	100	3	1	0	4

A. OBJECTIVES OF THE COURSE

- Ability to analyse and solve problems in both familiar and unfamiliar situations including those in real-life contexts with better accuracy.
- Able to apply knowledge of key theories, concepts, tools and techniques of Mathematics to solve structured and unstructured Engineering problems.
- Understand and be able to use the language, symbols and notation of mathematics
- Use different forms of mathematical representation (formulae, diagrams, tables, charts, graphs and models)
- Generate and/or analyze information, find relationships and patterns, describe these mathematically as general rules, and justify or prove them.

B. DETAILED SYLLABUS

1. **Differential Calculus**
   Pedal equation, radius of curvature of plane curves in cartesian, polar and parametric equations, radius of curvature at origin by Newton's method and by method of expansion
2. **Successive Differentiation**
   Leibnitz's theorem, Maclaurin's theorem, Taylor's theorem, Applications to obtain expansion of functions, Indeterminates forms.
3. **Beta and Gamma Function**
   Definition, properties, relation between Beta and Gamma functions, use in evaluation of definite integrals. Error and Elliptic functions.
4. **Ordinary Differential Equations**
   Variables, separable, homogeneous, uon-homogeneous. linear equations, exact equation and reducible to these forms. Application to geometrical and physical problem.
5. **Integral Calculus**
   Applications for finding area, length of arc, volume and surface area of solids of revolutions.
6. **Reduction Formula for**
   $\int_0^{\frac{\pi}{2}} \sin^n x\, dx$ $\int_0^{\frac{\pi}{2}} \cos^n x\, dx$ $\int_0^{\frac{\pi}{2}} \sin^m x\, \cos^n x\, dx$ $\int_0^{\frac{\pi}{4}} \tan^n x\, dx$ $\int_0^{\frac{\pi}{4}} \cot^n x\, dx$ etc…
7. **Beta and Gamma Functions**
   Definition, properties, relation between Beta and Gamma functions, use in evaluation of definite integrals.

C. LEARNING OUTCOMES

- To answer at least about the convergence or divergence of integral when integral is not easily evaluated using techniques known.
- Able to evaluate the volume and surface area of the solid generated by revolving the solids by Integration.
- Apply the knowledge of differential equation to solve some practical problems such as electrical circuits, Newton's Law of cooling and problem related to orthogonal trajectories.
- Apply the knowledge of differentiation to obtain the series of function.
- Able to evaluate curvature of the given function.

D. RECOMMNEDED TEXT BOOKS

1. Engineering Mathematics-II By : Shanti Narayan, S. Chand & Company (PVT.) Ltd. Ram nagar, Delhi
2. Higher Engineering Mathematics. By : Dr. B.S. Grewal, Khanna publishers, Delhi

E. REFERENCE BOOKS

1. Engineering Mathematics-I, By : Shanti Narayan, S. Chand & Company (PVT.) Ltd.
2. Applied Mathematics, By : P.N. & J.N. Wartikar,
3. Engineering Mathematics-I By : I.B. Prasad

BASIC ELECTRICAL & ELECTRONIC ENGINEERING (AF122)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	1	2	60	40	25	25	150	3	1	1	5

A. DETAILED SYLLABUS

1. **Fundamentals of current electricity and DC circuits**
   Introduction - definition, symbols and unit of quantities, multiple and sub-multiple units, computation of resistance at constant temperature, temperature dependence of resistance, computation of resistance at different temperatures, Ohm's law - statement, illustrations and limitations, unit work, power, and energy (electrical, thermal and mechanical), circuits - identifying the elements and the connected terminology, Kirchhoffs law - statement and illustrations, resistances in series and parallel and current division technique, method of solving a circuit by Kirchhofs laws
2. **Magnetic Circuits**
   Introduction, definition, magnetic circuit, leakage flux, fringing effect, comparison between magnetic and electric circuits
3. **Electromagnetic Induction**
   Introduction, magnetic effect of electric current, current carrying conductor in magnetic field, laws of electromagnetic induction, induce EMF, self inductance (L), mutual induction (M), coupling coefficient between two magnetically coupled circuits (K)
4. **AC Fundamentals**
   Introduction, generation of alternating EMF, waveform terminology, concept of 3 phase EMF generation, root mean square (RMS) to effective value, average value of AC, phasor representation of alternating quantities, analysis of AC circuit
5. **Single Phase AC Circuits**
   Introduction, I operator, complex algebra, representation of alternating quantities in rectangular and polar forms, R-L series circuit, R-C series circuit, R-L-C series circuit, admittance and its components, simple methods of solving parallel AC circuits, resonance
6. **Electrical Machines**
   Introduction, DC generator, DC motor, transformer, 3-phase motor, application of electrical machines
7. **Passive Circuit Components**
   Constructional details of resistors, capacitors & inductors

B. PRACTICAL & TERM WORK

Experiments & demonstrations based on the syllabus

C. TEXT BOOK

- Basic Electrical, Electronics and Computer Engineering by R. Muthusubramaniam, S. Salivahanan, K.A. Muraleedharan Tata McGraw Hill Publications Co. Ltd., New Delhi

COMPUTER PROGRAMMING - I (AX123)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	2	60	40	25	25	150	4	0	1	5

A. DETAILED SYLLABUS

1. Introduction to digital computer-introduction to DOS-Overview of C-Constants, Variables and data types-Operators and Expressions-scanf() and printf() functions.
2. Decision making with if statement, if-else statement, nesting of if-else statement, else-if ladder-Switch statement.
3. ?: Operator- goto statement-While ,do While-for statement-Jumping in loops- Break and continue statement-Arrays(one dimensional)

B. PRACTICAL & TERM WORK

- The laboratory and term work will be based on above topics.

C. TEXT BOOK

- Programming in ANCI C by E. Balagurusamy 2nd Edition, Tata McGraw-Hill Publishing Company Limited-New Delhi

ENGINEERING MECHANICS (AF117)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	2	60	40	25	25	150	4	0	1	5

A. DETAILED SYLLABUS

1. Statics

- Introduction, engineering and S.I. units, accuracy in engineering calculations, Vector's composition and resolution, concept of Rigid Body.
- Resultant of a force system
- Concurrent Coplanar Force System
- Non-concurrent Coplanar Force System parallel and non-parallel
- Using analytical as well as graphical methods.
- Simple cases of concurrent force system in space.
- Concept of internal force, free body diagram.
- Equilibrium of force system listed above.
- Friction: Friction on an inclined plane, ladder friction, wedge friction, screw friction, belt and rope drive.
- Centre of gravity of lines, plane figures, volumes, bodies and Pappu's Theorems.
- Principle of Virtual Work and its application.
- Types of Beams, Types of Supports, Support Reaction for statically determinate beams.
- Simplest equivalent for a general force system "Wrench'.
  Equation of Static for rigid body assemblies for general force system

2. Dynamics

- Review of Particle Kinematics
- Laws of Motion- Motion along an inclined plane and Motion of connected bodies
- D'Alemberts principle
- Impulse, Impact and Momentum, Principle of Momentum, Instantaneous centre in plane motion
- Mass Moment of Inertia in Rotational Motion
- work power and Energy
- vibrations and SDOF systems

B. PRACTICAL & TERM WORK

(1) Experiments (2) Problems based on theory

C. TEXT BOOKS

- Engineering Mechanics by A.K.Tayal
- Engineering Mechanics Vol – I and II by Beer and Johnson

D. REFERNCE BOOKS

- Engineering Mechanics by R.S. Khurmi

- Engineering Mechanics by S. Ramamrutham
- Engineering Mechanics by Russel Hibbeler

WORKSHOP PRACTICE – I (AF136)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
0	0	2	0	0	0	50	50	0	0	1	1

A. DETAILED SYLLABUS

1. Introduction to Workshop

Workshop layout, importance of various sections/shops of workshop, type of jobs done in each shop, General safety rules and work procedure of work shop

2. Tin Smithy (One Job)

Tin smithy tools like -hammers, stakes, scissors etc. sheet metal operations such as shearing, bending, joining, safety precautions, demonstration of various operations

3. Carpentry (One Practice Job and One Joint Job)

Carpentry tools like -saw, planner, chisels, hammers, pallet, making gauge, vice, tee square, rule etc., carpentry operations such as marking, sawing, planning, chiseling, grooving, boring, joining, type of woods and carpentry hardware, safety precaution, demonstration of various operations by using hardware

4. Pipe Fitting (One Job)

Pipe fitting tools, pipe fitting operations such as marking, cutting, bending, threading, assembling, dismantling etc. Types of various spanners such as flat, fix, ring box-adjustable etc, Safety precautions, demonstration of various operations

B. RECOMMENDED TEXT / REFERNCE BOOKS

1. Work shop technology, A. K. Hajrachauchari & S. K. Hajrachaudhari
2. ITB Hand book, Engineering industry training board
3. Work shop Technology Vol. I & II, Gupta & Kaushik

ENGINEERNIG ECONOMICS & PRINCIPLES OF MANAGEMENT (AM110)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	0	0	60	0	40	0	100	3	0	10	3

A. DETAILED SYLLABUS

1. Introduction to Workshop

Workshop layout, importance of various sections/shops of workshop, type of jobs done in each shop, General safety rules and work procedure of work shop

2. Tin Smithy (One Job)

Tin smithy tools like -hammers, stakes, scissors etc. sheet metal operations such as shearing, bending, joining, safety precautions, demonstration of various operations

3. Carpentry (One Practice Job and One Joint Job)

Carpentry tools like -saw, planner, chisels, hammers, pallet, making gauge, vice, tee square, rule etc., carpentry operations such as marking, sawing, planning, chiseling, grooving, boring, joining, type of woods and carpentry hardware, safety precaution, demonstration of various operations by using hardware

4. Pipe Fitting (One Job)

Pipe fitting tools, pipe fitting operations such as marking, cutting, bending, threading, assembling, dismantling etc. Types of various spanners such as flat, fix, ring box-adjustable etc, Safety precautions, demonstration of various operations

B. RECOMMENDED TEXT / REFERNCE BOOKS

1. Work shop technology, A. K. Hajrachauchari & S. K. Hajrachaudhari
2. ITB Hand book, Engineering industry training board
3. Work shop Technology Vol. I & II, Gupta & Kaushik

ENGINEERNIG ECONOMICS & PRINCIPLES OF MANAGEMENT (AM110)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	0	0	60	0	40	0	100	3	0	0	3

A. DETAILED SYLLABUS

1. Basic Concepts and Definition

Marshall, Robbins and Samuelson's definition of economics, positive and normative economics, micro and macroeconomics, Utility, goods and services, Money and wealth, Consumer and Producer surplus

2. Demand Analysis and Consumer Behavior

Demand function, law of demand, elasticity of demand and its types, Price, income and cross-elasticity, measures of demand elasticity, factors of production, advertising elasticity, law of supply equilibrium between demand and supply

3. Markets, Product Pricing and Factor Pricing

Concepts of perfect competition, monopoly and monopolistic competition (meaning and characteristics), control of monopoly, Price discrimination and dumping, Concept of Duopoly and Oligopoly, Kinky demand curve (price leadership model with reference to oligopoly)

4. Production Cost and Revenue Analysis

Production and production function, short run & long run production function, cost analysis, various concepts of cost, Total fixed cost, Total variable cost, total cost, average fixed cost, average variable cost, average cost & marginal cost, opportunity cost, basic concepts of revenue, relationship between average revenue and marginal revenue, breakeven analysis; meaning and explanations

5. Money

Meaning, functions, types, monetary policy; meaning objectives, tools, fiscal policy; meaning, objectives, tools, Banking; meaning, types, functions, central bank- RBI, it's function, concepts, Cash reserve ratio, bank rate, repo rate, reverse repo rate, statutory liquidity ratio, functions of central & commercial banks, inflation, deflation, stagflation, monetary cycles, new economic policy, liberalization, globalization, privatization, fiscal policy of the government

B. TEXT BOOKS

1. Modern economics- H.L. Ahuja
2. Modern economics theory- K.K.Dewett
3. Monetary economics- M.L. Seth

C. REFERENCE BOOKS

1. Engineering economics, PHI publication, R. Paneerselvam
2. Fundamentals of Management: Essential concepts and applications, Pearson education, Robbins S. & Decenzo David A.
3. Economics: Principles of economics, S. Chand Publication, Dr. K. K. Dewett & M. H. Navalur
4. Introduction to economics and managerial economics by Caisenross Jean

ENGINEERING GRAPHICS (AF115)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	3	60	40	50	0	150	4	0	1.5	5.5

A. DETAILED SYLLABUS

1. Engineering Curves

Constructions of curves used in engineering such as Conics (Ellipse, Parabola, Hyperbola), Cycloidal curves (Cycloid, Epi-Cycloid, Hypo- Cycloid), Involutes, Archemedian spirals

2. Projection of Points and Straight Line

Projections of points, Projections of Lines, construction for H.T. & V.T. Simple applications of projection of points and lines

3. Projection of Planes

Projections of regular planes such as square, rectangle, triangle, circle, pentagon, hexagon, rhombus etc

4. Projection of Solids

Projections of Right & Regular Solids (Prisms, Pyramids, Cylinder and Cone)

5. Orthographic Projections

First angle projection method and third angle projection method. Dimensioning techniques and methods, Conversion of pictorial views into Orthographic Projections with dimensions, Sectional orthographic projection, Orthographic vies with full and half section, special sections.

6. Isometric Projections

Conversion of Orthographic views into Isometric Projections and views

7. Development of Surfaces

Introduction, methods of development, Development of lateral surfaces of right regular solids (Prism, Cylinder, Pyramid and Cone)

8. Computer Graphics

Introduction to Computer Graphics

B. RECOMMENDED TEXT BOOKS

1. Engineering Drawing, N. D. Bhatt
2. Engineering Drawing Vol. I & II by P. J. Shah

C. REFERENCE BOOKS

1. Fundamentals of Engineering Drawing, Luzadder
2. A Text Book of Geometrical Drawing, P. S. Gill
3. A Text Book of Machine Drawing, P. S. Gill

(Term work shall be based on the above syllabus)

SEMESTER – II

Subject Code	Subject Name	Teaching Scheme			Exam Scheme					Credit
		L	T	P	Th.	S	P	TW	Total	
AF201	Mathematics - II	3	1	-	60	40	-	-	100	4
AF214	Mechanics Of Solids	3	1	2	60	40	25	25	150	5
AF217	Work Shop - II	-	-	2	-	-	-	50	50	1
AF212	Electronics Principles	3	1	2	60	40	25	25	150	5
AF215	Heat Power	3	1	2	60	40	25	25	150	5
AX223	Advanced C Programming	3	1	2	60	40	25	25	150	5
ES210	Environmental Science	3	-	-	60	-	40	-	100	3
		15	**5**	**10**					**850**	**28**

MATHEMATICS – II (AF201)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	3	60	40	50	0	150	4	0	1.5	5.5

A. OBJECTIVES OF THE COURSE

- Ability to analyse and solve problems in both familiar and unfamiliar situations including those in real-life contexts with better accuracy.
- Able to apply knowledge of key theories, concepts, tools and techniques of Mathematics to solve structured and unstructured Engineering problems.
- Understand and be able to use the language, symbols and notation of mathematics
- Use different forms of mathematical representation (formulae, diagrams, tables, charts, graphs and models)
- Generate and/or analyze information, find relationships and patterns, describe these mathematically as general rules and justify or prove them

B. DETAILED SYLLABUS

1. Partial Differentiation & Its Applications

Partial derivatives, Homogenous functions Euler's theorem, Total derivatives-Differentiation of implicit functions, Change of variables, errors and approximations, Maxima & Minima of functions of two variables, Lagrange's method of undetermined multipliers

2. Multiple Integrals and Their Applications

Double integrals, definition evaluation, change of order of integration, double integrals in polar co-ordinates, area enclosed by plane curves, Triple integrals, change of variables, volume of solids

3. Infinite Series

Introduction, Definitions, Convergence, divergence and Oscillation of a series, P-test, Comparison test, Ratio test, Root test, Higher ratio test, Rabbe's test, Log test, Alternating series, Leibnitz's rule

4. Complex Number

Definition, elementary operations, Argan's diagram, De-Moivre's theorem, and its applications to expand Sinne, Cosne in powers of sine, cose respectively, To expand sinne, Cosn and Sinme. Cosne in a series of Sines or Cosines of multiples of e, Hyperbolic functions, Formulae of hyperbolic functions, inverse hyperbolic functions, Logarithm of complex quantities. Separation of real and imaginary parts. C + iS method

5. Laplace Transforms

Introduction, Definition Transforms of elementary functions, properties of Laplace transforms, Inverse transforms, Note on partial fractions, Transforms of derivatives, Transforms of integrals. Multiplication and division by t, convolution theorem.

C. LEARNING OUTCOMES

At the end of the course student should be able to

- Obtain Laplace transform of standard Mathematical functions.
- Evaluate Partial Derivatives and apply the knowledge to solve some practical problems such has constrained optimization problems and other problems involving Partial Differentiation.
- Understand the concept of Multiple Integration and its applications viz. Area and Volume.
- Obtain the bahaviour of Infinite series.
- Evaluate Exponential, Trigonometric and Hyperbolic Functions of a complex number

C. RECOMMENDED TEXT BOOK

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, Delhi

D. REFERENCE BOOKS

1. Applied Mathematics for Engineers and Physicists. By: Pipes & Harvill, Mc-Graw Hill Kogakusha Ltd.
2. Applied Mathematics By: P.N. & J.N. Wartikar

ELECTRONICS PRINCIPLES (AF212)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	2	60	40	50	0	150	4	0	1	5

A. DETAILED SYLLABUS

1. **Diode Theory**
   semiconductor theory, conduction in crystals, doping source, the unbiased diode, forward bias, reverse bias, linear devices, the diode graph, load lines, diode approximations, D. C. resistance of a diode
2. **Diode Circuits**
   the Sine wave, the transformer, the half wave rectifier, the full wave rectifier, the bridge rectifier, the capacitor input filter
3. **Special Purpose Diodes**
   the zener diode, the zener regulator, optoelectric devices
4. **Bipolar Transistor**
   some basic ideas, forward-reverse bias, the CE connection, transistor characteristics, DC load lines, the transistor switch
5. **Transistor Biasing Circuits**
   base bias, emitter - feedback bias, collector - feedback, voltage divide bias, emitter bias, moving ground around, PNP circuits
6. **CE Amplifiers**
   coupling & bypass capacitors, the superposition theorem for amplifiers, AC resistance of the emitter diode, AC beta, the grounded emitter amplifier, the AC mode of a CE stage
7. **CC & CB Amplifiers**
   the CC amplifier, the AC model of an emitter follower, types of coupling, direct coupling
8. **Class A & B Power Amplifiers**
   the AC load line of a CE amplifier, AC load lines of other amplifiers, class A operation
9. **OP-AMP Circuits**
   non-inverting voltage amplifiers, the inverting voltage amplifiers, the summing amplifier, comparators
10. **Oscillators and Trimers**
    theory of sinusoidal oscillation, the Wean-bridge oscillator
11. **Thyristors**
    the ideal latch, the four layer diode, the silicon controlled rectifier
12. **Frequency Domain**
    the Fourier series, the spectrum of a signal.
13. **Frequency Mixing**
    nonlinearity, medium signal operation with one sine wave, medium signal operation with two sine waves
14. **Amplitude Modulation**
    basic idea, percent modulation, AM spectrum, the envelope detector, the Superhetrodyne receiver

15. Digital IC

number system, Boolean algebra, logic gates

B. PRACTICAL & TERM WORK

The practical & term work shall be based on the above syllabus

C. TEXT BOOKS

1. Electronic Principles (Third Edition) by Albert Paul Malvino Tata McGraw Hill Publications Co. Ltd., New Delhi
2. Basic Electrical, Electronics and Computer Engineering by R. Muthusubramaniam, S. Salivahanan, K.A. Muraleedharan Tata McGraw Hill Publications Co. Ltd., New Delhi

ADVANCED C PROGRAMMING (AX223)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	2	60	40	25	25	150	4	0	1	5

A. DETAILED SYLLABUS

1. Arrays

Introduction and Initialization of two-dimensional arrays, Multidimensional arrays

2. Handling of Character Strings

Introduction, Declaring and initializing string variables, reading strings form terminal, writing strings on screen, Arithmetic operations on characters, Putting strings together, Comparison of strings, String handling functions, Table of strings.

3. User Defined Functions

Introduction, need for user defined functions, A multi-function program, Forms of C functions, Return values and their types, Calling a function, Category of functions, No arguments and no return values, Arguments and no return values, Arguments and return values, Handling of non-integer functions, Nesting of functions, Recursion, Functions with arrays, The scope and life time of variables in functions, ANSI C functions.

4. Structure and Unions

Introduction, Structure definition, Giving values to members, Structure initialization, Comparison of structure variables, Arrays of structures, Arrays within structures, Structures within structures, structures and functions, Unions, Size of structures, Bit-fields.

5. Pointers

Introduction, understanding pointers, Accessing the address of a variable, Declaring and initializing pointer, Pointer expressions, Pointer increments and scale factor, Pointer and arrays, Pointer and character strings, Pointer and functions, Pointers and structure

6. File Management in C

Introduction, Defining and opening a file, Closing a file, Input/Output operations on files, Error handling during I/O operations, Random access to files, Command line arguments

7. Dynamic Memory Allocation and Linked Lists

Introduction, Dynamic memory allocation, Concepts of linked lists, Advantages of linked lists, Types of linked lists, Pointers revisited, Basic list operations, Application of linked lists

8. The Preprocessors

Introduction, Macro substitution, File inclusion, Compiler control directives, ANSI additions.

B. PRACTICAL & TERM WORK

The laboratory and term work will be based on above topics

C. TEXT BOOK

- Programming in ANCI C by E. Balagurusamy 2nd Edition, Tata McGraw-Hill Publishing Company Limited-New Delhi.

MECHANICS OF SOLID (AF214)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	0	2	60	40	25	25	150	3	0	1	4

A. DETAILED SYLLABUS

1. Simple Stresses and Strains

Introduction, stress, strain, tensile, compressive and shear stresses, Elastic limit, Hooke's law, Poisson's Ratio, Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus, Bars of Varying sections, Extension of tapering rods, Bars of uniform strength, temperature stresses, Hoop stress, stress on oblique sections, State of simple shear, Relation between Elastic constants

2. Mechanical Properties of Materials

Ductility, Brittleness, Toughness, Malleability, Behaviour of ferrous and nonferrous metals in tension and compression, shear and bending tests, Standard test pieces, Influence of various parameters on test results, True and nominal stress, Modes of failure, Characteristic stress-strain curves, Strain hardening, Hardness, Different methods of measurement, Izod, Charpy and tension impact tests, Fatigue, Creep, Correlation between different mechanical properties, Effect of temperature. Testing machines and special features, Different types of extensometers and compressometers, Measurement of strain by electrical resistance strain gauges

3. Bending Moment and Shear Force

Bending moment, shear force in statically determinate beams subjected to uniformly distributed, concentrated and varying loads. Relation between bending moment, shear force and rate of loading.

4. Moment of Inertia

Concept of moment if Inertia, Moment of Inertia of plane areas, polar moment of Inertia, Radius of gyration of an area, Parallel Axis theorem, Moment of Inertia of composite Areas, product of Inertia, Principal axes and principal Moments of Inertia.

5. Stresses in Beams

Theory of simple bending, bending stresses, moment of resistance, modules of section, built up and composite beam section, Beams of uniform strength, Distribution of shear stress in different sections

6. Torsion

Torsion of circular. solid and hollow section shafts, shear stress angle of twist, torsional moment of resistance, power transmitted by a shaft, keys and couplings, combined bending and torsion, close coiled helical springs

7. Stresses in cylindrical and spherical shells under fluid pressure
8. Inelastic bending of beams
9. Principal Stresses and strain

B. TERM WORK

This will consist of experiments and solution of problems based on syllabus

C. RECOMMENDED TEXT BOOKS

- Strength of Materials by S. Ramamruthum
- Strength of Materials by Sadhu Singh

D. REFERENCE BOOKS

- Mechanics of Solid by R.S. Khurmi
- Strength of Materials by Timoshenko

HEAT POWER (AF215)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	2	60	40	25	25	150	4	0	1	5

A. DETAILED SYLLABUS

1. Introduction

Systems of units, Pure and working substance, properties of substance, energy, thermodynamic system, surroundings and system boundary, Path and point functions, Thermodynamic equilibrium, law of conservation of energy, Specific heat capacity, thermodynamic process and cycle

2. Properties pf Steam

Distinction between gas and vapour, Steam formation, Sensible heat, Latent heat, Total heat and super heat of steam, Condition of steam, Dryness fraction, Properties of steam i.e. Enthalpy, Internal energy, Density and Specific volume, Critical pressure and temperature of steam, External work of evaporation and internal latent heat. Combined separating and throttling calorimeter

3. Properties of Gases

Zeroth, first and second laws of thermodynamics, laws of perfect gases (Boyle's law, Charle's law, Regnault's law, Joule's law), Characteristic equation of gas, gas constants, internal energy, specific heat at constant pressure and specific heat at constant volume, relationship between specific heats, thermodynamic processes of perfect gases (constant volume, constant pressure, constant temperature, isentropic and polytropic)

4. Fuels and Combustions

Introduction, Classification of Solid fuels, Liquid Fuels, Gaseous fuels, LPG, CNG and bio fuels, Calorific values, Combustion of fuels, Minimum air required for combustion of fuels

5. Registration and Air Conditioning

Introduction, Evaporation, Refrigerating effect, Unit of refrigeration and COP, Important refrigerants, Refrigerating systems i.e. Air refrigerating system, Ammonia absorption refrigerating system and Vapour compression refrigerating system, Analysis of vapour compression refrigeration system, i.e. COP, mass flow rate, heat rejected from condenser, power consumption etc. Window and split air conditioners: principles and working

6. Boilers

Introduction, Classification, Cochran & Babcock-Wilcox boiler, Evaporation in boiler, Equivalent evaporation, Boiler efficiency, Functioning of boiler mountings and accessories. Boiler draught, Classification and comparison of boiler draught systems

7. I. C. Engines

Prime mover and its classification, advantages of I.C. engines over E.C. engines, classification of I.C. engines, thermodynamic air cycles i.e. Carnot cycle, Constant volume OTTO cycle and Diesel cycle, Air standard efficiency, construction and working of 2-stroke and 4-stroke cycle engines, p-v diagrams, I.C. engine performance. Calculations of Indicated power, brake power, efficiencies, specific fuel consumption

8. Air Compressors

Introduction, Classification, Working of reciprocating air compressors, air compressor terminology, Work of compression, Reciprocating compressor efficiency, Introduction and

classification of rotary air compressors, Comparison between reciprocating and rotary compressor

B. RECOMMENDED TEXT BOOKS

1. Elements of Heat Engines (S.I. Units) Vol. 1, R. C. Patel & C. J. Karamchandani, Acharya Book Depot, Vadodara
2. Elements of Mechanical Engineering, A. V. Mehta, Everest publishing house, Pune
3. Elements of Mechanical Engineering, P. S. Desai & S. B. Soni, Atul Prakashan, Ahmedabad

C. REFERENCE BOOKS

1. Heat Engine, P. L. Ballaney, Khanna Publishing Company
2. A course in Thermal Engineering, Domkundwar, S and Kothandaraman, C. P., Dhanpat Rai and Sons

WORKSHOP – II (AF217)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
0	0	2	0	0	0	50	50	0	0	1	1

A. DETAILED SYLLABUS

1. Fitting (One Job)

Fitting tools like -files, vice, chisels, punch, scriber, hammers, surface plate, try square, calipers etc, fitting operations such as filling, grinding, sawing, marking, drilling, tapping, safety precaution, Demonstration of various operations, Preparation of male - female joints

2. Cold Forging (One Job)

Smithy tools like hammer, anvil, flatteners etc. Smithy operations such as upsetting, drawing down, bending, setting down, fork cutting, punching and fullering etc., Safety precautions

3. Carpentry (One Joint Job)

Carpentry tools like -saw, planner, chisels, hammers, pallet, making gauge, vice, tee square, rule etc., carpentry operations such as marking, sawing, planning, chiseling, grooving, boring, joining, type of woods and carpentry hardware, safety precaution, demonstration of various operations by using hardware

4. Welding (One Job)

Electric arc welding, welding machines, different types of electrodes, screen, fixers, hand gloves, demonstration of welding operation

B. RECOMMENDED TEXT / REFERENCE BOOKS

1. Work shop technology, A. K. Hajrachauchari & S. K. Hajrachaudhari
2. ITB Hand book, Engineering industry training board
3. Work shop Technology Vol. I & II, Gupta & Kaushik

ENVIRONMENT SCIENCE (ES210)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	0	0	60	0	40	0	100	3	0	0	3

A. DETAILED SYLLABUS

1. The Multidisciplinary Nature of Environmental Studies

Definition, scope and importance, need for public awareness

2. Natural Resources

Renewable and non-renewable resource: Natural resources and associated problems, Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams, and their effects on forests and tribal people, Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams benefit and problems, Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies, Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies, Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, 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 of sustainable lifestyles

3. Ecosystems

Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumer 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 ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries)

4. 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-spots of biodiversity, Threats to biodiversity, habitat loss, poaching of wildlife, man- wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity

5. Environmental Pollution

Definition, Causes, 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

6. Social Issues and The Environment

From unsustainable to sustainable development, urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people: its problems and concerns. Case studies, 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

7. **Human Population and the Environment**

   Population growth, variation among nations, Population explosion, Family Welfare Program, Environment and human health, Human rights, Value education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environmental and human health, Case studies

8. **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.

B. TEXT BOOKS

1. Erach Bharucha, Textbook for Environmental Studies, University Press
2. MP Poonia & SC Sharma, Environmental studies Khanna Publishing House
3. Rajagopalan, Environmental Studies, Oxford University Press

C. REFERNCE BOOKS

1. Jr. Environmental Science by Miller TG, Wadsworth Publishing CO. (TB)
2. Jr. Environmental Science by Odum EP, WB Saunders Co. USA
3. Environmental Biology by Agarwal KC, Nidhi Publishers Ltd. Bikaner
4. Environmental Encyclopedia by Cunningham WP, Cooper TH, Gorhani E & Hepworth MT, Jaico Publishing House, Mumbai
5. Environmental Protection and Laws by Jadhav H and Bhosale VM, Himalaya Publishing House, Delhi
6. Encyclopedia of Indian Natural History by Hawkins RE, Bombay Natural History Society, Bombay
7. Matter Hazardous by Mhaskar AK, Techno-Science Publications
8. Environmental Chemistry by De AK, Wiley Eastern Ltd.
9. Marine Pollution by Clark RS, Clanderson Press, Oxford (TB)
10. Hazardous Waste Incineration by Brunner RC, McGraw Hill Inc.
11. Waste Water Treatment by Rao MN and Datta AK, Oxford and IBH Publishing Co. Pvt. Ltd.
12. Environmental Science Systems and Solutions by Mckinney ML and Schoch RM, Web enhanced edition
13. Global Biodiversity Assessment by Heywood VH, and Watson RT, Cambridge University Press

SEMESTER – III

Subject Code	Subject Name	Teaching Scheme			Exam Scheme					Credit
		L	T	P	Th.	S	P	TW	Total	
AF301	Mathematics - III	4	-	-	60	40	-	-	100	4
CH302	General Chemical Tech.-I	4	-	-	60	40	-	-	100	4
CH305	Theory Of Machines & Machine Design	4	-	3	60	40	25	25	150	5.5
CH306	Chemistry-I	3	-	3	60	40	25	25	150	4.5
CH307	Chemistry-II	3	-	3	60	40	25	25	150	4.5
CH311	Introduction To Chemical Engineering	4	-	2	60	40	25	25	150	5
AF310	Financial & Managerial Accounting	3	-	-	60	40	-	-	100	3
		22		**11**					**900**	**30.5**

MATHEMAICS – III (AF301)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. Fourier Series

change of interval, odd & even functions, expansion of odd & even periodic functions, half range series, practical harmonic analysis

2. Integral Transforms

definition, Fourier integral, Fourier sine & cosine integrals, complex form of Fourier integral, Fourier transform, Fourier sine & cosine transforms, finite Fourier sine & cosine transform, Fourier transform of the derivative of a function, inverse Laplace transform by method of residues, application of transforms to boundary value problems

3. Matrices

fundamental concepts, operations, associated matrices, matrix method of solution of simultaneous equations, rank of matrix, linear dependence of vectors, consistency of a system of linear equations, characteristic equation, Eigen vectors & Eigen roots, Cayley Hamilton theorem, reduction of quadratic form to canonical form

4. Matrices

fundamental concepts, operations, associated matrices, matrix method of solution of simultaneous equations, rank of matrix, linear dependence of vectors, consistency of a system of linear equations, characteristic equation, Eigen vectors & Eigen roots, Cayley Hamilton theorem, reduction of quadratic form to canonical form

5. Ordinary Differential Equations

linear differential equations definition, rules for finding complementary function, rules for simultaneous linear equations with constant coefficients, application of linear differential equation to simple harmonic motion, oscillation of a spring, simple pendulum, oscillatory electrical circuits, electro-mechanical analogy, deflection of beam, whirling of shafts, application to simultaneous equations, series solution of differential equations of the second order with variable coefficients & special functions

6. Partial Differential Equations

introduction, formation, solution of a partial differential equation solvable by direct integration, linear equation of first order, non-linear equations of first order method, homogenous linear equations with constant coefficient, homogeneous linear equations with constant coefficients by finding complimentary function & particular integral, nonhomogeneous linear equations with constant coefficients solution of non-linear equation method of separation of variables, vibrating string problem, heat flow, etc.

7. Laplace Transforms

application to differential equations, simultaneous linear equation with constant coefficients

B. RECOMMENDED TEXT / REFERENCE BOOKS

1. Higher Engineering Mathematics by Dr. B. S. Grewal
2. A Text Book of Applied Mathematics by P. N. Wartikar & J. N. Wartikar
3. Mathematics for Engineering by Chandrika Prasad

4. A Text Book of Engineering Mathematics by Dr. K. N. Srivastva & G. K. Dhawan

GENERAL CHEMICAL TECHNOLOGY – I (CH302)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. **Water and Waste Water Treatment**
   Industrial use of water, demineralisation, deionisation, RO system, water treatment, concept of water resources management
2. **Fuels & Energy**
   Classification of fuel, Water gas, Producer Gas, Coke oven gas, coal & coal chemicals, coking of coal, various types of coal gasifiers, concept of energy conservation
3. **Chlor-Alkali Industry**
   Manufacture of soda ash by solvay and modified solvay process, Electrolytic process for caustic soda, different types of cells, manufacturing of chlorine and hydrogen, hydrochloric acid, common salt by vacuum evaporation process
4. **Cement and Glass Manufacturing**
   Lime stone beneficiation and Manufacturing of cement , types of cement, manufacturing of glass, types of glass
5. **Sulphuric Acid Manufacturing**
   Manufacturing of elemental sulfer by Frasch process, Single and double Absorption process for manufacturing of sulfuric acid
6. **Electrolytic Manufacturing of Aluminium and Magnesium**
   Purification of alumina from bauxite using Bayer process, Manufacturing of magnesium.
7. **Pulp and Paper Manufacturing**
   Kraft process and sulfite process for manufacturing of pulp, chemical recovery system, types of paper, paper manufacturing process
8. **Sugar and Starch Industry**
   Manufacturing of sugar, starch, and dextrin
9. **Oils, Fats, Soaps & Detergents**
   Vegetable oil Extraction method using Mechanical and Solvent extraction process , hydrogenation of oil, cleaning mechanism of soaps and detergents, manufacturing of soaps and glycerin, manufacturing of detergents
10. **Fertilizer Industry Nitrogenous Fertilizers**
    introduction to fertilizers, synthesis gas, Manufacturing of ammonia, nitric acid, urea, ammonium nitrate & ammonium sulphate Phosphatic Fertilizers: Production of elemental phosphorus, manufacture of phosphoric acid by wet process and electric furnace process, single & triple super phosphate, Ammonium phosphate Mixed Fertilizers: compositions & constituents, granulation, controlled release fertilizers

B. RECOMMENDED TEXT / REFERENCE BOOKS

1. Dryden's Outlines of Chemical Technology, 2 Ed. By M. Gopala Rao& Marshall Sitting, East West Press Pvt. Ltd.
2. Shreve's Chemical Process Industries, 5 Ed. By, George F. Austin McGraw Hill International Edition

3. Chemical Process Industries, 4 Ed. by R. Norris Shreve & J. A. Brink, Jr. International Student's Edition
4. Pollution Control in Chemical Process Industries, 1st Ed. By S. P. Mahajan Tata McGraw Hill Publications, New Delhi

FINANCIAL & MANAGEMENT ACCOUNTING (AF310)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. Financial Accounting

An Introduction: Introduction, Meaning of Accountancy, book-keeping and Accounting, Accounting Process, Objectives for accounting, Differences between book-keeping and accounting Users of accounting information, Limitations of Accounting, Basic terminologies

2. Accounting Concepts, Principles, Bases and Policies

Introduction, Accounting Concepts, Principles, Policies and Standards, Types of accounting concepts - Business Separate entity concept - Going concern concept - Money measurement concept - Periodicity concept - Accrual concept, Accounting Principles - Principle of Income recognition - Principle of expense - Principle of matching cost and revenue - Principle of Historical costs - Principle of full disclosure - Double aspect principle - Modifying Principle - Principle of materiality - Principle of consistency - Principle of conservatism or prudence, Accounting Policies - Changes in Accounting Policies - Disclosure in case of changes in Accounting Policies, Accounting Standards - Scope and functions of Accounting Standards Board - International Financial Reporting System

3. Double Entry Accounting

Introduction, Meaning of double entry accounting, Classification of accounts under Traditional approach, Classification of accounts under Accounting Equation approach, Comparison of traditional approach with Modern approach equal approach, Accounting Trail, Transactions and events, Meaning and roles of debit and credit, Accounting equation

4. Secondary Books

Introduction, Secondary books, Purchases Book/Purchases Day book - Cash discount, Trade discount - Difference between cash discount and trade discount, Sales Book or Sales Day book - Purchase Returns Book - Sales Returns Book, Bills receivable book - Bills payable book - Cash book, Posting to Ledger accounts Posting to Ledger

5. Trial Balance

Introduction, Meaning, Objectives of preparing a trial balance, Methods of preparing a trial balance, Preparation of Trial balance, Adjusting Entries, Errors and their rectification, Errors disclosed by Trial Balance, Errors not disclosed by Trial Balance, Steps to locate the errors

6. Final Accounts

Introduction, Adjustments before preparing final accounts, Depreciation, Bad Debts and accounting treatment of bad debts, Provision for doubtful debts, Reserves for Discount on Debtors, Reserve for Discount on Creditors, Closing Stock, Trading Account, Profit and Loss Account, Balance Sheet

7. Introduction to Management Accounting

Introduction, Meaning of Management accounting, The Role of Management Accounting, Management Accounting Framework, Functions of Management Accounting, Tools of

Management Accounting, The Balanced Scorecard, Cost Management System, Value Added Concept, Merits of Management Accounting, Demerits of Management Accounting, Distinction between Management Accounting and Financial Accounting

8. **Financial Statement Analysis**

   Introduction, Meaning of Ratio, Steps in Ratio Analysis, Classification of Ratios, Du Pont Chart, Solved Problems, Advantages of Ratio Analysis, Limitation of Ratio analysis

9. **Cash Flow Analysis**

   Introduction, Meaning of Cash Flow Statement, Purpose of Cash Flow Statement, Preparation of Cash Flow Statement, Format of Cash Flow Statement (AS3: Revised Method), Cash Flow from Operating Activities, Cash Flow Statement under Direct Method, Different between Cash Flow Analysis and Fund Flow Analysis, Uses of Cash Flow Statement

10. **Marginal Costing and Break-Even Analysis**

    Introduction, Concept of Marginal Costing, Characteristics of Marginal Costing, Difference between Absorption Costing and Marginal Costing, Marginal Cost, Contribution, Cost Volume Profit (CVP) Analysis, Break Even Chart, Break Even Point, Profit Volume ratio or MCSR, Target profit, Margin of Safety, Application of Marginal cost, Limitations of Marginal cost, Solved Problems

11. **Basics of Financial Management**

    Introduction of Financial Management, objectives of financial management, role of finance manager, functions of financial management, concept of time value of money, present value, future value, annuity concept, solved problems

B. RECOMMENDED TEXT / REFERENCE BOOKS

1. Financial Accounting for Managers – Text book & cases - Third Revised edition by
2. S.K. Bhattacharya, John Dearden Published, Vikash Publishing House Private Limited
3. Management Accounting - By Ravi M. Kishore – Publisher: Taxman
4. Text Book of Cost Accountancy, Vikas Publishing Pvt. Ltd., M.N. Arora
5. Cost Accounting: Method & Problems, Academic Publishers, B.K. Bhar
6. Cost Accounting – A Managerial Emphasis Prentice Hall Horngren, Foster & Datar Cost
7. Accounting Book Syndicate N.K. Prasad & A.K. Prasad
8. Cost Accounting World Press Bhabatosh Banerjee
9. Fundamental Managerial Accounting Concept Irwin McGraw Hill Edmonds,
10. Edmonds and Tsay Principles and Practice of Cost Sultan Chand Asish Bhattacharya
11. Accounting Management Accounting S. Chand R.S.N. Pillai & Bhagavati Cost Accounting John Wiley Moriarity and Allen Advanced
12. Cost and Management Accounting (Text) (Vol – 1 & 2) Sultan Chand & Sons V.K. Saxena & C.D. Vashist
13. Cost Accounting – Theory & Practices Sultan Chand & Sons Bhabatosh Banerjee Advanced
14. Cost & Management Accounting – Problems & Solutions Prentice Hall of India (P) Ltd. V.K. Saxena & C.D. Vashist
15. Cost Accounting S. Chand R.S.N. Pillai & Bhagavati Studies in Cost Management Sultan Chand & Sons S.N. Maheshwari
16. Cost and Management Accounting New Age International M.E. Thukaram Rao Management Accounting New Age International M.E. Thukaram Rao

INTRODUCTION TO CHEMICAL ENGINEERING (CH311)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	2	60	40	25	25	150	4	0	1	5

A. DETAILED SYLLABUS

1. Introduction

About the discipline of chemical engineering, concept of unit operations and unit processes, symbols as per Indian Standards, operations in batch, semi-batch and continuous mode, flow pattern in counter-current, co-current and cross-current fashion, systematic analysis to chemical process by flowsheet reading, drawing of PBD and PFD and overview of P&ID.

2. Overview of Chemical Process Industry and Role of Chemical Engineer

Satisfactory definition of CPI/GCT, important chemical process industries, its typical raw materials, products and end usages. role of chemical engineer in various aspects such as research, process development, process design & evaluation, plant design, construction (EPC firms), process supervision, plant technical service, product sales, general aspects of chemical engineering such as communication, human relations, professional activities & technical reading

3. Useful Mathematical Methods

Presentation & correlation of data, curve fitting using graphical method and method of least squares, graphical addition & subtraction (inverse lever arm rule), graphical and numerical methods for integration, differentiation and to find the root of an equation, trial & error solution, mean values, Lagrangian method of interpolation, dimensions, units and conversion of units, dimensional analysis by Buckingham method and Rayleigh ‘s method

4. Physical and Chemical Principles

Process variables – temperature, pressure, density, composition & flow rate, physical states, phase equilibria, fundamentals of reaction rates, illustrative problems on the listed topics

5. Mass Balance

Overall mass balance, material balance without chemical reactions and with chemical reactions, basic concept of by-pass, recycle, purge and differential mass balances. Concept of yield, conversion and selectivity

6. Energy Balance

Various forms of energy, flow process and non-flow process, state and path function, total energy balance, energy balance in non-flow systems, illustrative problems on the listed topics

B. RECOMMENDED TEXT / REFERENCE BOOKS

1. Introduction to Chemical Engineering by L. B. Andersen& L. A. Wenzel McGraw – Hill Book Company, 1961.
2. Basic Principles & Calculations in Chemical Engineering by D.M. Himmelblau Prentice Hall (India)
3. Introduction to Chemical Engineering by Salil K Ghosal, Siddhartha Datta, Shyamal K Sanyal, Tata McGraw - Hill Education, 2004.

4. 4. Introduction to Chemical Engineering by E. V. Thompson & W. H. Cekler McGraw – Hill Kogakusha Company Ltd.
5. Introduction to Chemical Engineering by Walter L Badger and Julius T Banchero, McGraw – Hill Book Company Ltd, 1955.

THEORY OF MACHINES & MACHINE DESIGN (CH305)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	3	60	40	25	25	150	4	0	1.5	5.5

A. DETAILED SYLLABUS

THEORY OF MACHINES 40% WEIGHTAGE

1. **CAM**

   types of cam, types of followers, nomenclature of cam mechanism, types of motions of follower – uniform velocity, simple harmonic, uniform equal acceleration & retardation, design of cam profile, applications of cam

2. **Friction**

   screw friction, bearing friction in – journal bearing, flat pivot thrust bearing, collar pivot thrust bearing & conical pivot thrust bearing, friction clutches – plate or disc clutches & cone clutches, ball & roller bearing

3. **Belt Drive**

   types of flat belt drive, velocity ratio of simple & compound belt drive, slip and creep of belt, length of belt, power transmitted by belt, ratio of driving tension for flat belt drive, centrifugal tension, condition for transmission of maximum power, V-belt drive, advantages & disadvantages of V-belt drive, ratio of driving tension for V-belt drive

4. **Toothed Gearing**

   nomenclature & classification of toothed gears, types of gear trains – simple & compound, reverted & epicyclical spur gear trains

5. **Brakes**

   types of brakes – simple block or shoe brake & band brake

MACHINES DESIGN 60% WEIGHTAGE

1. **Design of Operational Joints**

   cotter joints, sleeve type cotter joint, gib & cotter joint, knuckle joints, pinned joints, threaded fasteners, design load for fasteners, turn buckle, bolt of uniform strength

2. **Welded Connections**

   types of welded joints, weld symbols, strength & design of welds, direct loading, asymmetric loading, designation and representation, design procedure

3. **Pressure Vessels and Pipes**

   classification of pressure vessels, stresses in thin cylinder due to internal pressure, circumferential stresses, longitudinal stresses, thin spherical shells, thick cylinders, thickness of cylinder heads & cover plates, design of pipes, pipe joints, design of circular flanged pipe joints, design of oval flanged pipe joints, design of square flanged pipe joints, standard pipe flanges, hydraulic pipe joint for high pressure

4. **Shafts, Keys & Couplings**

   design of shafts on basis of strength & rigidity, shaft subjected - to torque, bending moment & combined bending moment & torque, types of keys, design of shank key, design of shear pins, design of shaft coupling, design of flange coupling, design of bush pin type flexible coupling

5. **Levers**
   types of levers, design of levers – hand lever, foot lever, bell crank lever & lever of safety valve
6. **Design of Springs**
   types of springs, materials, allowable working stress, design of closely coiled spring subjected to axial load
7. **Belt and Pulley Drive**
   design of belt & pulley drive
8. **Eccentric Loading**
   eccentric loading on rivets & bolts
9. **Columns and Struts**
   types of end conditions of column, slenderness ratio, Euler's formula, Rankine's formula, design of simple column, design of piston rod & connecting rod

B. PRACTICAL & TERM WORK

The term work shall be based on the above syllabus which involves designing & preparation of detailed drawings.

C. RECOMMENDED TEXT / REFERENCE BOOKS

1. Theory of Machines by R. S. Khurmi & J. K. Gupta
2. Machine Design by R. S. Khurmi & J. K. Gupta
3. Theory of Machines by P. L. Ballaney
4. Theory of Machines by N. C. Pandya & C. S. Shah
5. Thenical Dynamics by L. B. Shah, R. C. Patel & B. M. Patel
6. Machine Design Vol. 1 by R. C. Patel, A. D. Pandya, H. J. Rajput & S. S. Shikh

CHEMISTRY – I (CH306)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	0	3	60	40	25	25	150	3	0	1.5	4.5

A. DETAILED SYLLABUS

1. Physical Properties and Chemical Constitution

additive & constitutive properties, molar volume, surface tension & parachor, viscosity, refractivity & molar refractivity, dipole moments, spectroscopy - the visible & invisible spectrum, spectrum analysis, different types of spectra

2. Phase Equilibria

definition, statement of phase rule, application to one & two component system, distribution law, Henry's law, critical solution temperature, solvent extraction, phase rule & applications

3. Chemical Kinetics

rate of a reaction, rate constant, order & molecularity, first & second order reaction, determination of order of reaction, theories of reaction rates, effect of temperature

4. Photochemistry

Lambert & Bear's law, law of photochemistry, quantum yield, high & low quantum yield, method of determination of quantum efficiency, types of photochemical reaction, luminescence

5. Surface Chemistry and Colloids

absorption & adsorption, Freundlich adsorption isotherms, Langmuir adsorption isotherms, partition & adsorption, chromatography, classification of colloids, preparation of colloids, purification of colloids, properties of colloids, industrial application of colloidal chemistry, emulsions & gels, catalysis, types of catalysis, theory of catalysis

6. Thermodynamics

first & second law of thermodynamics, spontaneous process, entropy, efficiency of reversible cycle, free energy & maximum work, Clapeyron equation, Clausius – Clapeyron equation, Gibb's – Helmholtz equation, Van't hoff isotherm & iscochore, thermo chemistry – heat of reaction, heat of combustion, heat of formation, heat of neutralisation, Hess's law of constant heat summation, heat of reaction at constant volume & at constant pressure

7. Acids and Bases

modern concept of acids & bases, hydrolysis, relative strength of acids &bases, theory of indicator

B. PRACTICAL & TERM WORK

Experiments based on theory are performed in the laboratory class

C. RECOMMENDED TEXT / REFERENCE BOOKS

1. Essentials of Physical Chemistry by B. S. Bhal & G. D. Tuli S. Chand & Co., New Delhi
2. Elements of physical Chemistry by S. Glassstone Macmillan & Co. Ltd., London

CHEMISTRY – II (CH307)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	0	3	60	40	25	25	150	3	0	1.5	4.5

A. DETAILED SYLLABUS

1. **Purification of Organic Compounds**
   by crystalisation, fractional crystalisation, sublimation & different types of distillation.
2. **Detection and Estimation of Elements**
   detection of elements (C, H, N, S, P & halogens), estimation of elements (C, H, S, P & halogens) by combustion estimation of nitrogen by Dumas method & Kjeldahl's method, Carius method, chemical reactions involved in the methods of detection & determination of elements
3. **Nomenclature of Organic Compounds**
   IUPAC nomenclature of organic compounds including heterocyclic & alicyclic compounds.
4. **Stereochemistry**
   isomerism – structural & stereoisomerism, optical isomers of lactic acid & tartaric acid, geometrical isomerism
5. **Organic Reactions**
   general nature of Organic reactions – substitution, addition, elimination, rearrangement, nucleophilic & electrophillic reactions with their mechanism
6. **Aliphatic Compounds**
   general methods of preparation & important chemical properties, general methods of preparation & important chemical properties with their uses of the following compounds – chloroform, carbon tetrachloride, iodoform, ethanol, ethylene glycol, glycerine, formaldehyde, acetaldehyde, acetone, lactic acid, oxalic acid, citric acid, succinic acid, diethyl ether, acetoacetic ether, malonic ester
7. **Organometallic Compounds**
   preparation & industrial uses of organolead compounds, organozinc compounds, organolithium compounds, organomagnesium compounds
8. **Aromatic Compounds**
   general nature of aromatic reaction with their mechanism, halogenation, sulphonation, nitration, alkylation, acylation & addition reaction
9. **Arylhalides**
   study of chlorobenzene, bromobenzene, benzylchloride, D.D.T & B.H.C
10. **Amines and Amino Compounds**
    study of aniline, acetanilide, sulphanilic acid, aulphanilamide, diphenylamine, dimethylamine, distinguishing tests for different amines
11. **Phenols and Aromatic Alcohols**
    preparation & important chemical properties of phenol, catechol, resorcinol, quinol & phloroglucinol
12. **Aromatic Aldehydes and Ketones**
    study of benzaldehyde, salicylaldehyde, cinnamaldehyde, acetophenone & benzophenone
13. **Aromatic Acids**
    study of benzoic acid, salicylic acid, pthalic acid, cinnamic acid

Note: Study term include discussion of important methods of preparation & chemical properties with industrial & commercial uses.

B. PRACTICAL & TERM WORK

Practical – Laboratory experiments may be given relating to theory as:

1. Quantitative analysis of organic compounds
2. Preparation of nitrobenzene, m-dinitrobenzene, acetanilide, sulphonic acid, saccharine, phenol & its derivatives, aniline, diazo derivatives, etc
3. Purification of impure organic solids & liquids
4. Measurement of melting & boiling points

C. RECOMMENDED TEXT / REFERENCE BOOKS

1. A Text Book of Organic chemistry by P. L. Soni
2. Advance Organic Chemistry by Fischer & Fischer
3. Advance Organic Chemistry by Robert & Cassero

SEMESTER – IV

Subject Code	Subject Name	Teaching Scheme			Exam Scheme					Credit
		L	T	P	Th.	S	P	TW	Total	
AF411	Mathematics - IV	4	-	-	60	40	-	-	100	4
CH404	Chemistry-III	3	-	3	60	40	25	25	150	4.5
CH414	General Chemical Tech.-II	4	-	3	60	40	25	25	150	5.5
CH415	Chemistry-IV	3	-	3	60	40	25	25	150	4.5
CH416	Chemical Engineering Thermodynamics-I	4	-	-	60	40	-	-	100	4
IN401	Engineering Materials	3	-	-	60	40	-	-	100	3
CH417	Chemical Process Calculations	4	-	-	60	40	-	-	100	4
		25		**9**					**850**	**29.5**

MATHEMATICS – IV (CH411)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. Functions and Complex Variables

analytic functions, Cauchy – Reimann equations, harmonic functions, orthogonal system, complex potential, determination of conjugate function, conformal transformation, some standard transformations – translation, magnification & rotation, inversion & reflection & bilinear transformations, line integral, properties of complex integration, Cauchy's theorem, Cauchy's integral formula

2. Numerical Methods

solution of algebraic and transcendental equations by Newton – Raphson method, direct iteration method & false position method, solution of linear simultaneous equations by Gauss elimination method, Gauss – Jordan method & Gauss – Siedel, numerical methods to solve first order & first degree ordinary differential equations by Picard's method, Taylor's series method, modified Euler's method, Milne's method, Runge's method, Runge – Kutta method

3. Finite Differences and Difference Equations

finite difference, interpolation, Newton's forward, backward & central difference, Lagrange's formula, Stirling & Bessel's formula, numerical differentiation, numerical integration – trapezoidal rule, Simpson's rules, difference equations with constant coefficient, Z-transform

4. Vector Calculus

vector function of a single scalar variable, differentiation of vectors, simple applications to plane, motion, scalar & vector point functions, del applied to scalar point function (gradient), divergence of a vector point function, curl of a vector, second order expressions, line integrals, surface integrals, Gauss theorem, Stoke's theorem

5. Statistical Methods

binomial distribution, Poisson's distribution, normal distribution, calculation of errors, probable errors, standard error, coefficient of correlation, lines of regression

B. RECOMMENDED TEXT / REFERENCE BOOKS

1. Higher Engineering Mathematics by Dr. B. S. Grewal
2. A Text Book of Applied Mathematics by P. N. Wartikar & J. N. Wartikar
3. Mathematics for Engineering by Chandrika Prasad
4. A Text Book of Engineering Mathematics by Dr. K. N. Srivastva & G. K. Dhawan

CHEMICAL PROCESS CALCULATIONS (CH418)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. Dimensions & Units

Dimensions & system of units, fundamental & derived units, dimensional consistency, dimensional equations & empirical equations, different ways of expressing units of quantities & physical constants. Conversion of empirical formula from one unit system to another.

2. Basic Chemical Calculations

Composition of gaseous mixtures, liquid mixtures, solutions. Determination of hardness, elements present in compound, acidity-alkalinity and concentration based numerical. Behaviour of real gas and determination of Van-der-waals constants, humidity & saturation based numerical etc.

3. Material Balance without Chemical Reactions

Schematic representation of process, selection of key component, degree of freedom analysis, material balance with & without recycle, bypass, purge stream, material balance around equipments related to unit operations like absorber, stripper, distillation tower, extractors, dryers, evaporators, crystallisers, humidification & dehumidification towers, material balance of unsteady state operations like mixing etc.

4. Material Balance with Chemical Reactions

Concept of limiting & excess reactants, percent conversion, yield, etc., material balance involving reactions with special reference to fertilizers, electrochemical industries, petrochemicals, dyestuffs etc.

5. Energy Balance

Heat capacity of gases & gaseous mixtures, heat capacity of liquids & solids, sensible heat change in liquids & gases, enthalpy changes during phase change transformation, enthalpy changes accompanied by chemical reactions, thermo chemistry of mixing process, dissolution of liquids and solids etc.

6. Fuels & Combustion

Types of fuels, calorific value of fuels as gross and net, problems on combustion of coal, liquid fuels, gaseous fuels, sulphur & sulphur pyrites, etc., proximate & ultimate analysis etc.

B. RECOMMENDED TEXT / REFERENCE BOOKS

1. Stoichiometry Vth Ed. By B. I. Bhatt & S. B. Thakore, Tata McGraw Hill Education Pvt. Ltd.
2. Chemical Process Principles by Hougen, Watson & Ragatz Asia Publishing House
3. Stoichiometry for Chemical Engineers by E. Williams & C. Johnson, Mc-Graw Hill Book Company.
4. Basic Principles & Calculations in Chemical Engineering, VIIth Ed., by D. M. Himmelblau, PHI Learning Pvt. Ltd.
5. Elementary Principles of Chemical Processes, IIIrd Ed by Richard Felder and Ronald Rousseau, John Wiley & Sons, Inc.

CHEMICAL ENGINEERING THERMODYNAMICS – I (CH416)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. Introduction

conservation of energy & first law of thermodynamics, application to steady state flow process, enthalpy, internal energy, equilibrium state, phase rule, irreversible & reversible processes, heat capacity & specific heat

2. Properties of Pure Substances

PVT behaviour of pure substance, ideal & non-ideal gases, different equations of state for real gases like Viral equation, Vander wall's equation, Redlich – Kwong equation, etc., calculation of constants in terms of P, V, & T conditions to be satisfied, corresponding states theory, Pitzer's modification to law of corresponding states

3. Heat Effects

heat capacity of gases as a function of temperature, heat capacities of gases, liquids & solids, concept of C, heat of vaporisation, heat of fusion, heat of sublimation, heat of formation, heat of combustion, calculation of heat of formation from heat of combustion, calculation heat of reaction from heat of formation, etc.

4. Second Law of Thermodynamics

second law of thermodynamics, thermodynamics temperature scale, ideal gas temperature scale, concept of entropy, change & irreversibility, introduction to third law of thermodynamics

5. Thermodynamic Properties of Fluids

network of thermodynamic equations, mathematical relations among thermodynamic functions, Maxwell's relations, interrelation between H, S, U, G, CP, CV, etc. in terms of PVT relations, thermodynamic properties of single phase & two phase systems, types of thermodynamic diagrams, generalised correlation of thermodynamic properties

6. Thermodynamics of Flow Processes

fundamental equations & relationships for flow in pipes, maximum velocity in pipe flow, throttling process, flow through nozzles, single stage multistage compressors

7. Conversion of Heat into Work by Heat Power Cycle

Steam power plant, internal combustion engine, Auto engine, Diesel Engine, Gas Turbine power plant, Jet engine, Rocket Engine.

8. Refrigeration & Liquefaction

Carnot refrigeration cycle, air refrigeration cycle, vapour compression cycle, absorption refrigeration, choice of refrigerant, heat pump, liquefaction processes

B. RECOMMENDED TEXT / REFERENCE BOOKS

1. Introduction to Chemical Engineering Thermodynamics 4th Ed. by J. M. Smith & H. C. Van Ness McGraw Hill Book Company
2. Chemical Engineering Thermodynamics by B. F. Dodge McGraw Hill Book Company

ENGINEERING MATERIALS (CH416)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	0	0	60	40	0	0	100	3	0	0	3

A. DETAILED SYLLABUS

1. Basic Concepts of Material Science

Introduction to Material science, Classes of engineering materials. Mechanical properties: Isotropy and anisotropy, Stress and strain relation, Hooke's law, Modulus of material, Poisson's ratio. Fundamental Properties: Elasticity, Plasticity, Strength, Stiffness, Resilience, ductility, Malleability, Toughness, Hardness etc. Deformation of metals elastic & plastic deformations, failure of metals, creep, fracture & fatigue with illustrative examples.

2. Ferrous & Non-Ferrous Materials

Ferrous metals: Cast iron and its types, Steel, stainless steel, Classification of steel, manufacturing process of steel, alloy steels and its classification, effect of alloying elements on mechanical properties of steel Nonferrous metals: Aluminum & its alloys, titanium, zirconium, copper & its alloys, lead & its alloys, Zinc and its alloys, Nickel & its alloys. Effects of acids & alkali on metals & alloys, Heat treatment to metals – Annealing, Normalizing, Quenching, Tempering, Case hardening- carburizing, cyaniding, nitriding, Surface hardening.

3. Inorganic, Organic & Other Materials

Glass, vitreous, silicon, concrete & ceramic materials, high polymers, rubbers, wood, graphite, insulating & cementing materials.

4. Corrosion & its Prevention

Mechanism of corrosion, dry & wet corrosion, other forms of corrosion, Passivity, factors influencing corrosion, atmospheric corrosion, Control & prevention of corrosion – cathodic& anodic control, inhibitors & other protective measures. Protective coatings, metallic coating & metal cladding, physio-chemical principles involved, chemical conversion coating, organic coating, enamels, ceramic protective materials.

5. Fabrication Methods

Forming, Forging, Rolling, Extrusion, Various type of Casting, joining, welding and weld checking methods.

B. RECOMMENDED TEXT / REFERENCE BOOKS

1. Material science and Processes, by S. K. HajraChaudhry
2. Material Science, by M.S.Vijya and G. Rangrajan
3. Nature & Properties of engineering Materials, by D. ZasterZebski
4. Chemical Engineering Materials by F. Rumford
5. Engineering Physical Metallurgy & Heat Treatment by Lakhtin
6. Elements of Material Science by Van Valk

GENERAL CHEMICAL TECHNOLOGY – II (CH414)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	3	60	40	25	25	150	4	0	1.5	5.5

A. DETAILED SYLLABUS

1. Petroleum Refining

Origin of petroleum, important refining operations such as dehydration and desalting, atmospheric and vacuum distillation. Treatment of LPG, Gasoline, kerosene, diesel and lube oil. Desulfurization, dewaxing and deasaphalting of crude using recent technique. Chemical processes like thermal cracking, fluid bed catalytic cracking, catalytic reforming, hydro-treating and coking. Characterization of crude and testing of various important fractions such as gasoline, kerosene, lube oil and asphalt.

2. Petrochemical Industry

Production of important C1, C2, C3 and C4 chemicals. Production of important aromatic and other petrochemicals using recent technology.

3. Polymer Industry

polymerisation basics, manufacture of phenol & urea formaldehyde resins, manufacture of PVC, polyethylene, etc, manufacture of synthetic rubber

4. Synthetic Fiber Industry

nylon, polyester, acrylic, rayon, etc.

5. Fine Chemicals and Drugs

classification of pharmaceuticals, manufacture of important drugs and pharmaceuticals – salicylic acid, methyl salicylate, aspirin, antibiotics, & vitamins

6. Intermediates & Dyes

classification of dyes, representative azo dyes, reactive dyes, disperse dyes

7. Biochemical Engineering

fundamentals, micro-organisms, strains, culture, etc., kinetics of biochemical reactions, fermentation and enzyme engineering

8. Environmental Aspects of Various Industries

B. PRACTICAL & TERM WORK

Experiments to determine pour point, flash point, etc, estimation of ammonia, carbonate etc., in given compounds, estimation of casein present in milk etc.

C. RECOMMENDED TEXT / REFERENCE BOOKS

1. Chemical Process Industries, 4th Ed. by R. Norris Shreve & J. A. Brink, Jr.
2. Shreve‘s Chemical Process Industries, 5th Ed. By, George F. Austin McGraw Hill International Edition
3. Dryden‘s Outlines of Chemical Technology, 2nd Ed. By M. Gopala Rao & Marshall Sitting East West Press Pvt. Ltd., New Delhi
4. Biochemical Engineering Fundamental 2nd Ed. by Bailey & Ollis International Student Edition
5. Petroleum Refinery Processes by Nelson McGraw Hill Publication.

CHEMISTRY – III (CH404)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	0	3	60	40	25	25	150	3	0	1.5	4.5

A. DETAILED SYLLABUS

1. Inorganic

general metallurgy, chemistry of the following metals beryllium, lithium, thorium, tungsten, uranium, molybdenum, rare earth metals

2. Electrochemistry

r\theory of electrolytic dissociation, Arrhenius theory, buffer solution, buffer capacity, theory of ionic interaction, activity & activity coefficient, Debye – Huckel model of electrolytic solution.

3. Electrical Conductance

specific & equivalent conductance its measurement & applications, Kohlrausch's law, transport number & its determination, Debye – Onsager theory, thermodynamic expression for equilibrium electrode potential, classification of electrodes, types of electrochemical systems (electrochemical cells), Faraday's laws, current efficiency, types of over potential & hydrogen over voltage, instrumental analytical techniques – potentiometry, pH-metry, conductometry, voltametry, polarography, colorimetry, spectrophotometry, flame photometry, nephelometry & turbidimetry, principles & applications of thermogravimetry, differential thermal analysis

B. PRACTICAL & TERM WORK

Experiments based on topics 2 & 3.

C. RECOMMENDED TEXT / REFERENCE BOOKS

1. Text book of Inorganic Chemistry by P. L. Soni S. Chand & Sons
2. Theoretical Electrochemistry by L. Antropov, Mir Publishers
3. Instrumental Method of Analysis by Willard, Merritt & Dean EWP
4. Instrumental Method of Analysis by B. K. Sharma

CHEMISTRY – IV (CH415)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	0	3	60	40	25	25	150	3	0	1.5	4.5

A. DETAILED SYLLABUS

1. Naphthalene & its Derivatives

nomenclature and isomerism of naphthalene & its derivatives, manufacture of naphthalene, chemical properties – orientation, derivatives of naphthalene, nitro, halo, sulphonic acid, naphthalamines, naphthols & naphthaquinones

2. Anthracene & its Derivatives

nomenclature & isomerism of anthracene & its derivatives, preparation of anthracene, properties of anthracene, uses of anthracene, structure of anthracene, derivatives of anthracene – anthraquinone, alizarin, phenanthrene

3. Aromatic Heterocyclic Compounds

introduction, furan, furfural, thiophene, pyrrole, pyridine

4. Carbohydrates

introduction, classification, glucose, constitution of glucose, reactions of glucose, mutarotation, fructose, constitution of fructose, reactions of fructose, some typical conversions in monosaccharides, disaccharides, sucrose, manufacturing of sucrose, properties & uses of sucrose, starch & cellulose

5. Proteins

introduction, composition of proteins, classification of proteins according to composition & functions, isolation of proteins, general characteristics of proteins, physical characteristics of proteins, analytical tests, properties & uses of proteins

6. Alkaloids

introduction, occurrence & extraction of alkaloids, general properties, determination of chemical constitution of alkaloids, Hofmann exhaustive methylation, some individual members – coniine, piperine & nicotine

7. Synthetic Drugs

introduction, chemotherapy, sulpha drugs – sulphappyridine, sulphathiazole, sulphadizine, sulphanilamide, mode of action of sulpha drugs, chemotherapy in malaria, antimalarial drugs, synthetic antimalarial drugs, aminoacridine, 4-aminoquinol, mode of action, derivatives of 8-aminoquinolines, antipyretics & analgesics, tranquillizers, sedatives, antidepressants, anaesthetics

8. Polymers

introduction, classification of polymers, types of polymerisation reactions, the process of addition polymerisation, free radical polymerisation, chain transfer agents, ionic polymerisation, thermoplastic & thermosetting plastics, plasticizers, classification of resins & plastics, synthetic & natural rubbers – polychloroprene, buna-S and buna-N

9. Colours & Dyes

colour sensation, dyes & dyeing, colour & constitution, chromophore – auxochrome theory, chromogen, valence bond theory of colour, classification of dyes, direct dies, mordant dyes, vat dyes, classification based on chemical structure, nitro & nitroso dyes, triphenyl dyes

10. Oils, Fats & Waxes

occurrence, classification of oils, chemical properties, soaps, detergents

B. PRACTICAL & TERM WORK

Experiments involving estimation of various inorganic & organic elements

C. RECOMMENDED TEXT / REFERENCE BOOKS

1. A Text Book of Organic Chemistry by P. L. Soni S. Chand & Co., New Delhi
2. Synthetic Organic Chemistry by O. P. Agarwal
3. Natural Products Vol. 1 by O. P. Agarwal

SEMESTER – V

Subject Code	Subject Name	Teaching Scheme			Exam Scheme					Credit
		L	T	P	Th.	S	P	TW	Total	
CH501	Fluid Flow Operations	4	-	3	60	40	25	25	150	5.5
CH502	Mechanical Operations	4	-	3	60	40	25	25	150	5.5
CH513	Chemical Engineering Thermodynamics-II	4	-	-	60	40	-	-	100	4
CH504	Mass Transfer-I	4	-	-	60	40	-	-	100	4
CH505	Heat Transfer	4	-	3	60	40	25	25	150	5.5
CH507	Energy Technology(E)	4	-	-	60	40	-	-	100	4
AF501	Professional Communication-I	1	-	2	50	-	-	-	50	2
		25		**11**					**800**	**30.5**

FLUID FLOW OPERATIONS (CH501)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	3	60	40	25	25	150	4	0	1.5	5.5

A. DETAILED SYLLABUS

1. Fluid Properties & Dimensional Analysis

Definition of a fluid, types of fluids, perfect or ideal fluid, properties of fluids – viscosity, density, specific volume, specific weigh, specific gravity, pressure, bulk modulus of elasticity, vapour pressure & surface tension, systems of unit, dimensional analysis & its applications to fluid flow problems

2. Fluid Statics & its Applications

Pressure concept & types of pressure, hydrostatic equilibrium & its applications – barometric equation, hydrostatic equilibrium in a centrifugal field, design of continuous gravity decanter & continuous centrifugal decanters, pressure measuring devices – static pressure & its measurement, types of manometers – open U tube & open gauge type, the differential U tube, closed U tube, mercury barometer, tube size estimation of manometers, multiplying gauges, change of manometric fluids, inclined U tube, draft gauge & two fluid U tube, mechanical pressure gauges – bourdon tube gauge, diaphragm gauge, pressure signal transmission – the differential pressure cell

3. Fluid Flow Phenomena

Types of flow – potential flow, steady flow, one dimensional flow, laminar flow & turbulent flow, Reynolds number, transition from laminar to turbulent flow, Reynolds number for non- Newtonian fluids, nature of turbulence, eddy viscosity & eddy diffusivity of momentum, flow in boundary layers, laminar & turbulent flow in boundary layer, calculation of boundary layer thickness & friction factor in streamline portion of boundary layer, turbulent portion of boundary layer, laminar sub layer portion of boundary layer, boundary layer formation in straight tubes, transition length for laminar & turbulent flow, boundary layer separation & wake formation

4. Basic Equations of Fluid Flow

Continuity equation, average velocity, mass velocity, momentum balance, momentum correction factor, momentum balance in potential flow – Bernoulli equation without friction, mechanical energy equation, kinetic energy & its correction factor, Bernoulli equation with friction & pump work.

5. Frictions in Pipes & Channels

Shear stress distribution in fluid, resistance to flow in pipes, friction factor charts, calculation of pressure drop along a pipe, roughness of pipe surface, velocity distribution for streamline flow for pipes of circular cross section, volumetric flow rates & average velocity calculations, kinetic energy of fluid, flow between two parallel plates, flow through an annulus, velocity distribution for turbulent flow in non-circular ducts, flow through curved pipes, miscellaneous friction loses for incompressible fluids – sudden enlargement, sudden contraction, pipe fittings & flow over banks of tubes, flow in open channels – uniform flow

6. Flow of Compressible Fluids & Two-Phase Flows

Continuity equation, total energy balance, mechanical energy balance, velocity of sound, ideal gas equations, acoustic velocity & Mach number of ideal gas, stagnation

temperature, process of incompressible flow – flow through variable area conduits (i.e. converging – diverging nozzle), equations for isentropic flow, change in gas properties during flow, velocity in nozzle, effect of cross section area in nozzle flow, adiabatic frictional flow – friction parameter, equation for adiabatic frictional flow, property equations, maximum conduit length & mass velocity, isothermal frictional flow, heat transfer in isothermal, two phase flow pattern, hold up, pressure, momentum & energy relations & erosion

7. **Flow Past Immersed Bodies**

   Drag, drag coefficient, stagnation point, stagnation pressure, friction in flow through beds of solids, motion of particles through fluids – mechanics of particle motion, types of settling, fluidization, conditions for fluidization, minimum fluidization velocity & types of fluidizations.

8. **Fluid Flow Measurement**

   Pitot tube, orifice meter, nozzle, venturi meter, pressure recovery in orifice type meter, variable area meters- rota-meter, notches & weirs, other methods of measuring flow rates – hot wire anemometer, magnetic meter, quantity meter & liquid meters

9. **Pumping of Fluids**

   Pumping equipment for liquids – reciprocating pumps, positive displacement rotary pumps, centrifugal pumps, use of compressed air for pumping air lift pumps, pumping equipment for gases – reciprocating compressor, rotary blowers & compressors, centrifugal blowers & compressors including turbo compressor, vacuum producing equipment, power required for compression of gases – clearance volume, multistage compressors, compressor efficiencies, power required for pumping through pipelines, types of turbines

10. **Agitation & Mixing**

    Agitation of liquids – purpose of agitation, agitation equipment, impellers, flow patterns in agitated vessels, standard turbine design, circulation velocities & power consumption in agitated vessels, blending & mixing – mixing of miscible liquids, suspension of solid particles, blending of miscible liquids, motionless mixers, mixer selection, scale up of agitator design, dispersion operations – characteristics of dispersed phase, mean diameter, gas dispersion – bubble diameter, gas dispersion in agitated vessels, gas handling capacity & loading of turbine impellers, power input to turbine dispensers, dispersion of liquids in liquids

B. PRACTICAL & TERM WORK

1. Experiments based on metering devices such as venturi meter, orifice meter, pitot tube, rotameter & notched weirs
2. Experiments based on characteristics of pumps, blowers, compressors, vacuum jet ejectors, etc.
3. Experiments based on measurement of pressure drop like flow through various pipes, flow through packed beds, flow through pipe fittings & valves, etc.
4. Experiments based on practical applications of theory like Bernoulli‘s theorem, Ergun equation, Reynold‘s experiment, etc.

C. RECOMMENDED TEXT BOOKS

1. Unit Operation of Chemical Engineering by Warren L. McCabe, Julian C. Smith & Peter Harriott 4th Ed, McGraw Hill Publications

2. Chemical Engineering Vol. 1 3rd Ed. by J. M. Coulson & J. F. Richardson Pergamon International, 1984, Great Britain

C. RECOMMENDED REFERENCE BOOKS

1. Fluid Mechanics by Victor L. Streeter, E. Benjamin Wylie, 7th Ed. McGraw Hill Publications
2. Fluid Dynamics & Heat Transfer by J. G. Knudson & Donald L. Kala McGraw Hill Publications
3. Perry‘s Chemical Engineer‘s Handbook by Robert H. Perry, Don W. Green McGraw Hill Publications

MECHANICAL OPERATIONS (CH404)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	3	60	40	25	25	150	4	0	1.5	5.5

A. DETAILED SYLLABUS

1. Solids

Characteristics of solid particles, Concept of Sphericity, Properties of mixture

2. Size Reduction and Enlargement

Principle of communition, types of crushers, grinders & disintegrators for coarse, intermediate & fine grinding, energy & power requirement, laws of crushers & work index, close & open circuit grinding, feed control, mill discharge, removal & supply of heat in wet grinding, size enlargement – objectives, methods and equipments used in industries.

3. Screening & Other Separation Methods

Screen Terminology and various screen series, Differential and cumulative method of screen analysis, types of Industrial screen, comparison of ideal & actual screens, capacity & effectiveness of screens, principle of elutriation, floatation, jigging, electrostatic & magnetic separation processes

4. Screening & Other Separation Methods

Concept of sedimentation, terminal settling velocities , batch settling test ,free & hindered settling, flocculation, types of thickener & thickener area calculation, batch & continuous settling chambers, sorting classifiers, centrifugal settling process, cyclone, principle of centrifugal sedimentation

5. Filtration

Types of filtration, requirements of filter media, filter aids, principle of cake filtration, constant pressure filtration, batch & continuous filtration equipments – filter press, leaf filter, cartridge filter, rotary drum filter, theories of filtration, washing of cake, principle of centrifugal filtration, suspended basket centrifuge, etc.

6. Mixing & Agitation

fundamentals of mixing & agitation, purpose of agitation and standard agitated vessel, types of impellers, vortex formation in agitated vessel, power consumption in agitated vessels, scale of agitated vessel and power consumption, characteristics of mixing equipments, mixing of pastes & paste masses, pony mixers, beater mixer, mixing of dry powder, ribbon blender, tumbler mixer, etc.

7. Storage & Conveying

Storage of solid, liquid and gases, types of storage vessels, types of flow in solid discharge and various problems, types of Mechanical & pneumatic conveying system.

B. PRACTICAL & TERM WORK

Experiments based on screening, screen efficiency, sedimentation, filtration, fluidisation, etc.

C. RECOMMENDED TEXT / REFERENCE BOOKS

1. Unit Operations in Chemical Engineering by Warren L. McCabe, Julian C. Smith & Peter Harriot 4th Ed. McGraw Hill Publications

2. Introduction to Chemical Engineering by Badger & Banchero McGraw Hill Publications
3. Chemical Engineering Vol. 2 by J. M. Coulson & J. F. Richardson Pergamon International, 1984, Great Britain
4. Unit Operations by Brown & Associates John Wiley & Sons

CHEMICAL ENGINEERING THERMODYNAMICS – II (CH513)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. Thermodynamic Properties of Fluids

Partial molar properties, chemical potential, ideal & non-ideal solution, fugacity & fugacity coefficient, evaluation of fugacity coefficient – for a pure component, for a mixture of gases & for liquids, effect of temperature & pressure on fugacity & fugacity coefficient of a pure component as well as a gaseous mixture, Lewis – Randall rule & Henry's law, excess properties, activity & activity coefficient

2. Phase Equilibrium

Criterion of phase equilibrium, phase rule, Duhem's theorem, vapour – liquid equilibrium calculations, phase diagrams for miscible systems, phase diagrams for immiscible systems, phase diagrams for partially miscible systems, testing of vapour – liquid equilibrium data, Gibb's – Duhem equation, Van Laar equation, Margule's equation, evaluation of constants in these equations, Redlich – Kister equation, P-x,y& T-x,y& x-y diagrams, vapour – liquid equilibrium of ideal & non-ideal solutions, Raoult's law & Henry's law, positive & negative deviations from Raoult's law

3. Chemical Equilibrium

Criteria for chemical equilibrium, equilibrium conversion (x), equilibrium constant (k), effect of temperature & pressure on k, evaluation of equilibrium constants by various methods, evaluation of equilibrium conversion for gas phase reactions, liquid phase reaction, heterogeneous reactions etc., phase rule for chemically reacting systems

4. Introduction to Statistical Thermodynamics

different thermodynamic distributions like Boltzmann distribution, Bose – Einstein distribution, Fermi – Dirac distribution, corrected Boltzmann statistics, partition function, evaluation of properties for monoatomic gases using partition function, group contribution methods

B. RECOMMENDED TEXT / REFERENCE BOOKS

1. Introduction to Chemical Engineering Thermodynamics 4th Ed. by J. M. Smith & H. Van Ness, McGraw Hill Book Company
2. Chemical Engineering Thermodynamics by Y.V.C. Rao Universities press
3. Fundamentals of Statistical Thermodynamics by Sonntag & Van Wylen John Wiley & sons

HEAT TRANSFER (CH505)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	3	60	40	25	25	150	4	0	1.5	5.5

A. DETAILED SYLLABUS

1. Introduction

Modes of heat transfer & basic equations, classification of heat flow processes, Fourier's law, steady state heat conduction through composite wall, cylinder & sphere, stead & unsteady state processes, partial differential equation for one dimensional heat flow, flow of heat through solid slab

2. Convection

Heat transfer by convection, fluid with & without phase change, free & forced convection, laminar & turbulent flow, heat transfer inside & outside tubes, concepts of thermal boundary layer, individual and overall heat transfer coefficients, LMTD, fouling factor, transfer units, laminar flow over flat plate, heat transfer in turbulent flow, Re, Pr& other dimensionless numbers, dimensional analysis, empirical correlations, heat transfer in packed &fluidized beds

3. Natural Convection

Gr, analogies, heat transfer to molten metals

4. Boiling

definition, phenomena of boiling, regimes of boiling, heat transfer to boiling liquids

5. Condensation

Definition, film type & drop wise condensation, condensation on horizontal & vertical tubes

6. Evaporation

Definition, basic principles, single effect evaporators, boiling point elevation, multi effect evaporation, forward & backward feed systems, different types of evaporators

7. Heat Exchanger

Basic types of heat exchangers, performance, design parameter of heat exchangers, parallel, counter current & cross flow heat exchangers, shell & tube type heat exchanges, double pipe heat exchanger.

8. Radiation

Definition, emission of radiation, laws of radiation, black body, radiation between surfaces, radiation shield, radiation through gases

9. Extended Surfaces

Different types of fins, fin efficiency, applications of extended surfaces.

B. PRACTICAL & TERM WORK

Experiments to measure heat transfer coefficients, boiling, heat transfer in agitated vessel, condensation, radiation, etc.

C. RECOMMENDED TEXT BOOKS

1. Unit Operations in Chemical Engineering by Warren L. McCabe, Julian C. Smith & Peter Harriot 4th Ed. McGraw Hill Publications

2. Chemical Engineering Vol. 1 by J. M. Coulson & J. F. Richardson Pergamon International, 1984, Great Britain
3. Heat Transfer by Holman J. P. McGraw Hill Publications

D. RECOMMENDED REFERENCE BOOKS

1. Heat Transfer - Basic Approach by Ozisic M. N. Tata McGraw Hill
2. Heat Transfer by Gebhart B. Tata McGraw Hill
3. Engineering Heat Transfer by Wiley John Wiley & Sons.

MASS TRANSFER – I (CH504)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. Introduction to Mass Transfer Operations (MTO)

Classification, methods of conducting MTO

2. Molecular Diffusion in Fluids

Steady state molecular diffusion in fluids (both liquids & gases), diffusivity of liquids & gases

3. Mass Transfer Coefficients

MT coefficients in laminar flow & turbulent flow, theories of MT, heat, mass & momentum transfer in laminar & turbulent flow & their analogies, simultaneous heat & mass transfer

4. Diffusion in Solids

Fick's law, unsteady state diffusion, types of solid diffusion

5. Inter Phase Mass Transfer

Equilibrium, diffusion between phases, local & overall diffusion, various processes & material balance for each of them

6. Equipment for Gas-Liquid Operations

Gas dispersion, liquid dispersion equipments

7. Distillation

VLE data, flash distillation, simple distillation, continuous rectification, McCabe Thiele & Ponchon-Sovarit methods, distillation in packed columns & vacuum distillation

B. RECOMMENDED TEXT / REFERENCE BOOKS

1. Mass Transfer Operations 3rd Ed. by R. E. Treybal McGraw Hill Publications
2. Unit Operations in Chemical Engineering by Warren L. McCabe, Julian C. Smith & Peter Harriot 4th Ed. McGraw Hill Publications

ENERGY TECHNOLOGY (CH507)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. An Introduction to Energy Sources

Energy sources (conventional & non-conventional), renewable energy resources, primary & secondary energy sources, energy chain, energy demand, national energy strategy & plan, energy management, energy audit & conservation

2. Definitions, Units & Measures

Proximate & ultimate analysis, calorific values, rank of coal, coking & caking, gasification, basis for reporting results of analysis, units & conversion factors

3. Solid Fuels

Wood & charcoal, peat, lignite, sub-bituminous & bituminous coals, semi-anthracite and anthracite coals, cannel & boghead coal, origin of coal, composition of coal, analysis & properties of coal, problems

4. Processing Solid Fuels

Coal preparation, washability curve, dry & wet washing methods of coal, washer efficiency, gasification & liquefaction of solid fuels, problems

5. Solar Energy

Solar constant, solar radiation & related terms, measurement of solar radiation, solar energy collectors – flat plate collector, air collector, collectors with porous absorbers, concentrating collectors, applications & advantages of various collectors, selective absorber coatings, solar energy storage systems (thermal, electrical, chemical & mechanical), solar pond, applications of solar energy

6. Wind Energy

Basic principles, power in wind, force on blades & turbines, wind energy conversion, site selection, basic components of wind energy conversion systems (WECS), classification of WECS, wind energy collectors, applications of wind energy

7. Energy from Biomass

Introduction, energy plantation, biomass conversion technologies, photosynthesis, biogas generation, factors affecting biogas generation, classification of biogas plants & their comparisons, types of biogas plants (including those used in India), biogas from plant wastes, community plants & site selection, digester design considerations, design calculations, methods of maintaining & starting biogas plants, properties & utilisation of biogas, thermal gasification of biomass, pyrolysis, alternative liquid fuels.

8. Geothermal Energy

Geothermal resources, hydrothermal resources, liquid dominated systems, geopressured resources, petrothermal systems, magma resources, energy conservation & comparison with other resources, applications of geothermal energy

9. Energy From Oceans

OTEC, methods (open cycle & close cycle) energy from tides, components of tidal power plants, operation, methods of utilisation of tidal energy, storage, ocean waves, wave energy conversion devices

10. Fuel Cell

Introduction, hydrogen – oxygen fuel cell, ion exchange membrane cell, fossil fuel cell, molten carbonate cell, advantages & disadvantages, conversion efficiency, polarisation, type of electrodes, applications of fuel cells

11. Hydrogen & Methanol

Properties of Hydrogen, production of hydrogen, thermochemical methods, fossil fuel methods, solar methods, storage & transportation, safety & management

12. Magneto Hydro-dynamic (MHD) Power Generation

Principle, MHD system, open cycle system, closed cycle system, design problems & developments, advantages, materials for MHD generators, magnetic field & super conductivity

13. Nuclear Energy

Fission, fusion, fuel for nuclear fission reactor (exploration, mining, milling, concentrating, refining, enrichment, fuel fabrication, fuel use, reprocessing, waste disposal), storage & transportation, fast & slow neutrons, multiplication factors & reactor control, uranium enrichment process, nuclear reactor power plant, fast breeder reactor, boiling water reactor, pressurised heavy & light water reactor

B. RECOMMENDED TEXT / REFERENCE BOOKS

1. Energy Sources 2nd Ed. by G. D. Rai Khanna Publications, New Delhi
2. Fuels & combustion by Samir Sarkar Orient Longmans (1974)
3. Solar Energy by Sukatame Tata McGraw Hill, New Delhi
4. Energy Technology by Rao & Parulaker

PROFESSIONAL COMMUNICATION – I (AF501)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
1	0	2	50	0	0	50	100	1	0	1	2

A. DETAILED SYLLABUS

1. Professional Communication

i. Introduction
ii. Methods & Manners
iii. Objectives

2. Communication

i. Communication Process
ii. Barriers and their solutions to communication
iii. Main problems in Communication
iv. Verbal Communication:
- Effective Communication
- Listening Process

v. Nonverbal Communication:
- Body Language
- Paralanguage

3. Language Proficiency

i. Grammar
ii. Vocabulary
iii. Usages of Language

4. Communication: LSRW

i. Listening: Listening criticism
ii. Speaking: Elements of Speaking Skills: Vowels & Consonants, Pronunciation, Speech Art
iii. Reading: Skimming, Scanning, Intensive Reading, Levels of Comprehension (Literal and Inferential)
iv. Writing: Developing Basic writing skill, letter & e-mail writing

B. RECOMMENDED TEXT BOOKS

1. Provided by the Language Lab Software
2. Will be specially designed for the target students

C. RECOMMENDED REFERENCE BOOKS

1. Effective Technical Communication, M Ashraf Rizvi, Tata McGraw-Hill Education, 2005
2. Effective Business Communication, Asha Kaul, 2ed, PHI Learning Pvt. Ltd., 2014

D. METHODOLOGY

Academic brilliance and technical expertise along with effective communication and polished soft skills make a student employable. The observation says that in the technical and professional courses, the core subject teachers opine and behave that _the English language

learning and English Communication Skills will automatically take place while learning the core subjects.‘ It rarely happens in our classrooms because the objective of teaching is to make the students have a clear understanding of the _technical concepts‘ for which the teachers use local language so that the students understand the _concepts.‘ Even the time constraint of completing the syllabus before examination does not allow these teachers to focus and attend the language and communication skills development in their classes.
So, to develop the desired competency of English Communication, the TBLT (Task-Based Language Teaching) and OCT (Oral Communicative Tasks) are intensively planned with the support of Motivational Strategies. TBLT approach focuses on communication and conveying a message, it encourages the students to use the English language fluently‘ and effectively.‘ In TBLT classes students perform in the English Language using _pre-decided communicative tasks. The language, being a human element, any language learning is more effective if carried out with encouragement and motivations to the students. The belief behind this method and approach is task-based learning is most effective when encourage by motivating the students.

OUTCOMES

Engineering students are enabled to acquire spoken English proficiency and effective communication skills for their academic purposes and better employability so that they can have better scope and growth in their professional career.

SEMESTER – VI

Subject Code	Subject Name	Teaching Scheme			Exam Scheme (Max. Marks)					Credit
		L	T	P	Th.	S	P	TW	Total	
CH601	Chemical Reaction Engineering-I	4	-	3	60	40	25	25	150	5.5
CH602	Chemical System Modelling	4	-	-	60	40	-	-	100	4
CH604	Mass Transfer-II	4	-	3	60	40	25	25	150	5.5
CH605	Instrumentation & Process Control	4	-	3	60	40	25	25	150	5.5
CH612	Numerical Techniques (E)	4	-	-	60	40	-	-	100	4
CH611	Environmental Engineering	4	-	-	60	40	-	-	100	4
AF601	Professional Communication-II	1	-	2	50	-	-	-	50	2
		25		**11**					**800**	**30.5**

CHEMICAL REACTION ENGINEERING – I (CH601)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	3	60	40	25	25	150	4	0	1.5	5.5

A. DETAILED SYLLABUS

1. Introduction

Classification of reactions, Chemical kinetics, Role of Thermodynamics, Rate of reaction, Rate expression for various types of reactions, variables affecting the rate of reaction

2. Kinetics of Homogeneous Reactions

Rate law equation – Effect of concentration on rate of reaction. Terminology in calculation of rate of reaction – Elementary, non-elementary, Molecularity, order, rate constant, equilibrium constant etc. Reaction rate theory – Effect of temperature on rate of reaction. (Arrhenius theory, collision theory & transition state theory, comparisons of the theories) Kinetic models for nonelementary reactions - matching reaction -mechanism with rate law equation

3. Interpretation of Batch Reactor Data of Homogeneous Reactions

Constant volume reaction Integral method of analysis – irreversible, reversible, series, parallel, catalytic reactions etc. Differential method of analysis – partial analysis of rate of reaction Concept of variable volume reaction – integral and differential method of analysis Reactions with shifting order – Higher to lower and lower to higher

4. Introduction to Reactor Design

Introduction to concept of macro and micro mixing, concept of ideal mixing in reactors, Selection of Batch or continuous mode of reactor operation

5. Single Ideal Reactors

Overall material balance of reactor geometry. Introduction and characteristics of Ideal batch reactor, Ideal Continuous stirred tank reactor, Ideal Plug flow reactor. Reactor terminology - space time, space velocity, steady state condition, local conversion, global conversion etc. Design equations of Ideal reactors and application to various systems.

6. Design for Single Reactions

Comparison of various type of reactors for same order, comparison of same type of reactors for various feed ratios, comparison of MFR with that of PFR for same order for constant volume and variable volume reactors. Graphical method and analytical method of comparison. Multiple reactor system, plug flow reactors in series and/or in parallel, Equal sized mixed reactors in series, mixed flow reactors of different sizes is series, Reactors of different types in series. Introduction to recycle reactor, Design of recycle reactor, Solution using graphical method

B. PRACTICAL & TERM WORK

Experiment pertaining to determination of order and rate constant of reaction using integral & differential methods of analysis, effect of temperature on rate of reaction, study of pilot scale reactor Application of computer by solving ordinary differential equation using numerical methods to compare the result predicted by numerical method with that of experimental data.

C. TEXT BOOK

1. Chemical Reaction Engineering 3rd Ed. by Octave Levenspiel John Wiley & Sons

REFERENCE BOOKS

1. Elements of Chemical Reaction Engineering 4th Ed., by H. Scott Fogler, Prentice Hall Publication
2. Chemical Engineering Kinetics 3rd Ed. by J. M. Smith McGraw Hill Publishing
3. Reaction Kinetics for Chemical Engineers by S. M. Nalas McGraw Hill Publishing

CHEMICAL SYSTEM MODELING (CH602)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. Introduction

Physical modelling, mathematical modelling, principles of similarity in physical modelling, definitions of independent variables, dependent variables & boundary conditions

2. Mathematical modeling of Chemical Systems

single stage, 2 stage & N stage extraction of steady state mass transfer process, unsteady state formulation of single stage extraction, steady state heat conduction through hollow cylindrical pipe using various boundary conditions, unsteady state process of steam heating of liquid, heat transfer through extended surfaces (triangle & rectangle), steady state counter current cooling of tanks, unsteady state heat loss through maturing tank, diffusion with chemical reaction in a tubular reactor, gas pre-heater, heat loss through circular flanges

3. Partial Differential Equations and Finite Difference

unsteady state continuity equation, unsteady state heat conduction, unsteady state mass transfer (Fick‘s second law), gas absorption accompanied by chemical reaction (mathematical model formulation), finite difference – solvent extraction in N stage process, gas absorption in N stages (Kremser – Brown), N stirred tanks reactors in series, etc.

4. Numerical Methods

Simpson‘s rules, Gauss‘s method, trapezoidal rule, solving differential equations by Taylor‘s series method, modified Euler‘s method, Runge – Kutta Method

5. Treatment of Experimental Results

errors, method of averages, linear least squares method

6. Optimisation

simplex method, method of steepest descent, method of Lagrange‘s multiplier

7. Introduction to Computers

analog & digital computers, linear computers involving summer, integrators, potentiometer, multiplication, examples of solving the differential equations

B. RECOMMENDED TEXT / REFERENCE BOOKS

1. Mathematical Methods in Chemical Engineering by V. G. Jensen & G. V. Jeffreys Academic Press, New York
2. Applied Mathematics in Chemical Engineering 2nd Ed. by H. S. Mickley, T. S. Sherwood & C. E. Reed Tata McGraw Hill Publishing Co. Ltd., New Delhi
3. Cybernetic Methods in Chemistry & Chemical Engineering by V. Kafarov Mir Publishers

MASS TRANSFER – II (CH604)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	3	60	40	25	25	150	4	0	1.5	5.5

A. DETAILED SYLLABUS

1. **Absorption**
   Equilibrium, material balance for single component transfer, multistage & packed tower operation
2. **Humidification**
   Equilibrium, vapor – gas mixture, gas liquid contact operations, adiabatic & non-adiabatic operations
3. **Liquid Extraction**
   Equilibrium, stage wise contact, single stage type contactor, continuous contact extractor
4. **Adsorption & Ion-Exchange**
   Equilibrium, stage wise operation, continuous contact operation.
5. **Drying**
   Equilibrium, batch drying, mechanism of batch drying, continuous drying
6. **Leeching**
   Equilibrium, steady state & unsteady state operations, methods of calculations
7. **Crystalisation**
   Equilibrium, operations, equipments.
8. **Introduction to Recent Separation Techniques Using Mass Transfer**
   Thermal diffusion, reverse osmosis, membrane processes, etc.

B. PRACTICAL & TERM WORK

Experiments on diffusion in liquids, diffusion through solids, distillation, leeching, liquid-liquid extraction, crystallisation, drying, adsorption, humidification, etc.

C. RECOMMENDED TEXT / REFERENCE BOOKS

1. Mass Transfer Operations 3rd Ed. by R. E. Treybal McGraw Hill Publications
2. Unit Operations in Chemical Engineering by Warren L. McCabe, Julian C. Smith & Peter Harriot 4th Ed. , McGraw Hill Publications

INSTRUMENTAION & PROCESS CONTROL (CH605)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	3	60	40	25	25	150	4	0	1.5	5.5

A. DETAILED SYLLABUS

1. Process Control

introduction, steady state & unsteady state design equation for an agitated heated tank, introduction to P, PI & PID controls, dynamics of first order systems subjected to various disturbance like step, ramp, impulse & sinusoidal, examples of the above systems viz. liquid level tanks, mixing process, thermometer, etc., response of the first order system in series, dynamics of the second order systems subjected to various disturbances like step, impulse & sinusoidal, transportation lag, linear closed loop system – servo & regulator problem, closed loop transfer function, block diagram for various simple systems, transient response of a control system, stability of control system, Routh test criterion, frequency analysis for simple order systems, Bode diagrams, advanced controls like feed forward, cascade & ratio control, controller & control element, control values

2. Instrumentation

measuring instruments for temperature, pressure, level & flow

B. PRACTICAL & TERM WORK

Experiments to study the response of first order systems and second order system to various inputs.

C. RECOMMENDED TEXT / REFERENCE BOOKS

1. Process System Analysis & Control by D. R. Coughanowr McGraw Hill Publishing Co.
2. Instrumentation by Eckman
3. Introduction to Control Systems by Stephenopolous

ENVIRONMENTAL ENGINEERING (CH611)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	1	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. Introduction

Types of pollution & their impact on the environment

AIR POLLUTION

2. Sources and Effects

measuring instruments for temperature, pressure, level & flow

3. Meteorological Aspects of Air Pollution

Pollutant dispersion, temperature lapse rate & stability, wind velocity & turbulence, plume behaviour, dispersion of air pollutants – atmospheric dispersion model & the Gaussian plume model, estimation of plume rise

4. Air Pollution Sampling & Measurement

Ambient air sampling & stack sampling, analysis of air pollutants

5. Air Pollution Control Methods & Equipment

Source correction methods, particulate emission control methods & gaseous emission control methods

6. Control of Specific Gaseous Pollutants

Control of sulphur oxides, nitrogen oxides, carbon monoxide & hydrocarbon emissions

WATER POLLUTION

7. Origin of Waste Water (W.W.) & W.W. Flow Rates

8. W.W. Characteristics

W. W. composition & physical, chemical & biological characteristics of W. W.

9. W.W. Sampling

Methods of sampling, methods of analysis & water quality standards

10. W.W. Treatment

Objectives & classification of W. W. treatment methods

11. Physical Unit Operations & Their Design

Screening, communition, grit chambers, flow equalisation, mixing, flocculation, sedimentation, floatation & filtration.

12. Chemical Unit Processes

Chemical precipitation, gas transfer, adsorption, disinfection with chlorine & ozone, dechlorination

13. Biological Unit Processes

Fundamentals of microbiology, bacterial growth & biological oxidation, kinetics of growth, aerobic suspended growth, treatment processes, activated sludge process & its design, aerobic aerated lagoons, aerobic digestion, aerobic stabilisation ponds, aerobic attached growth treatment processes – trickling filters & its design, rotating biological contactors, anaerobic suspended growth, treatment processes – anaerobic digestion, anaerobic attached growth treatment process – anaerobic filter & anaerobic ponds, combined aerobic/anoxic or anaerobic treatment processes – facultative lagoons (ponds),

sludge treatment & disposal

14. Solid Waste Management

Sources & classification, methods of collection & disposal

15. Noise Pollution

Sources of noise pollution & their control methods

16. Environmental Legislation

Water and air act, hazardous waste handling & management act, environmental impact assessment, environmental audit

C. TEXT BOOKS

1. Environmental Pollution Control Engineering by C. S. Rao Wiley Eastern Ltd.
2. Waste Water Engineering – Treatment, Disposal & Reuse by Metcalf & Eddy Inc. Tata McGraw Hill Publications

REFERENCE BOOKS

1. Introduction to Environmental Engineering by Mackenzie L. Davis & David A. Cornwell McGraw Hill International Publications
2. Environmental Engineering by Raw, Peavy & Tchobanoglous
3. Chemistry for Environmental Engineering 3rd Ed. by Sawyer & McCarty McGraw Hill Publications

NUMERICAL TECHNIQUES (CH612)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. Error Analysis

Significant figures, accuracy and precision, error definitions and round of errors, truncation errors, error propagation, Taylor series, total numerical errors, formulation errors and data uncertainty.

2. Solution of Polynomial Equation

Roots of equations, bracketing methods – graphical, bi section and false position methods, Open methods – Newton Raphson, secant methods, Roots of polynomials – computing methods like Mular method and Bair Stows methods

3. Linear Algebraic Equations

Gauss elimination, gauss Jordan, non-linaer system of equations, gauss seidel method

4. Matrices & Eigen Value Identification

Matrix inverse, error function and analysis, special matrices, eigen values and eigen vectors

5. Ordinary Differential Equations

Euler‘s methods, Runge-Kutta method, systems of equations, multistep methods, boundary value problem, eigen value problem

6. Partial Differential Equation

Finite difference method, elliptic equations, parabolic equations, finite element method

7. MATLAB Introduction and Hands-on Practice

Introduction to mathematical equation solutions, programming, use of different tool boxes.

8. Introduction to Optimization

One dimensional unconstrained optimization – golden section search and Newton‘s methods, multidimensional unconstrained optimization – direct and gradient methods, constrained optimization – linear programming

B. RECOMMENDED TEXT / REFERENCE BOOKS

1. Numerical methods for engineers by steven C. Chapra, Raymond P. Canale (Tata McGraw Hill 4th Ed.)
2. Applied mathematical methods for chemical engineers by Norman W. Loney (CR press 2nd Ed)
3. Problem solving in chemical engineering with numerical methods by M.B. Cutlip and Mordechai Shacham (Prentice Hall international series)
4. Applied mathematics and modeling for chemical engineers by Rice and Do (Jhon Wiley publication)

PROFESSIONAL COMMUNICATIONS – II (AF601)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
1	0	2	50	0	0	50	100	1	0	1	2

A. DETAILED SYLLABUS

1. Communication Skills

1. Inter and Intrapersonal communication
2. Developing Positive Attitude
3. Importance of empathy in communication
4. Psychological dealings in communication

2. Team Spirit

1. Skills and Qualities
2. Techniques to be a team member

3. Effective Self Presentation Through LSRW

1. Listening: Active Listening
2. Reading: Speed Reading, Reading Practice, Levels of Comprehension (Evaluative and Applied), Comprehension Practice
3. Writing: minutes, notice, proposal, report writing
4. Speaking: Indianisms, Presentation

B. TEXT BOOKS

1. Provided by the Language Lab Software
2. Will be specially designed for the target students

REFERENCE BOOKS

1. Title: Effective Technical Communication, Author - M Ashraf Rizvi, Publisher Tata McGraw-Hill Education, 2005, ISBN 1259082512, 9781259082511, Length 545 pages
2. Title: Effective Business Communication, Author - Asha Kaul, Edition 2, illustrated Publisher PHI Learning Pvt. Ltd., 2014, ISBN 8120350723, 9788120350724 Length 248 pages

C. METHODOLOGY

Academic brilliance and technical expertise along with effective communication and polished soft skills make a student employable. The observation says that in the technical and professional courses, the core subject teachers opine and behave that _the English language learning and English Communication Skills will automatically take place while learning the core subjects.‘ It rarely happens in our classrooms because the objective of teaching is to make the students have a clear understanding of the _technical concepts‘ for which the teachers use local language so that the students understand the _concepts.‘ Even the time constraint of completing the syllabus before examination does not allow these teachers to focus and attend the language and communication skills development in their classes. So, to develop the desired competency of English Communication, the TBLT (Task-Based Language Teaching) and OCT (Oral Communicative Tasks) are intensively planned with the support of Motivational Strategies. TBLT approach focuses on communication and conveying a message, it encourages the students to use the English language fluently and effectively. In TBLT

classes students perform in the English Language using _pre-decided communicative tasks. The language, being a human element, any language learning is more effective if carried out with encouragement and motivations to the students. The belief behind this method and approach is task-based learning is most effective when encourage by motivating the students.

OUTCOMES

Engineering students are enabled to acquire spoken English proficiency and effective communication skills for their academic purposes and better employability so that they can have better scope and growth in their professional career.

SEMESTER – VII

Subject Code	Subject Name	Teaching Scheme			Exam Scheme					Credit
		L	T	P	Th.	S	P	TW	Total	
CH701	Chemical Reaction Engineering-II	4	-	3	60	40	25	25	150	5.5
CH702	Transport Phenomena	4	-	3	60	40	25	25	150	5.5
CH703	Process Equipment Design & Drawing	4	-	3	60	40	25	25	150	5.5
CH704	Chemical Engineering Plant Design & Economics	4	-	-	60	40	-	-	100	4
CHXXX	Chemical Process Safety	4	-	-	60	40	-	-	100	4
CH713	Computer Aided Design (E)	4	-	-	60	40	-	-	100	4
CH714	Optimization Techniques(E)	4	-	-	60	40	-	-	100	4
		28		**9**					**850**	**32.5**

CHEMICAL REACTION ENGINEERING – II (CH701)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	1	3	60	40	25	25	150	3	1	1.5	5.5

A. DETAILED SYLLABUS

1. Residence Time Distribution of Fluid in Vessels

E, the age distribution of fluid leaving vessel, experimental methods, the F curve, the C curve, relation among E, F & C curves & mean time for closed vessel, Useful mathematical tools, the mean & variance ways of using age distribution information, linear & non-linear systems with flow models, Finding RTD by experiment, Conversion directly from tracer information, Model for non-ideal flow dispersion model, fitting the dispersion model for small extents of dispersion & large extent of dispersion, chemical reaction & dispersion, Tanks in series model, Two parameter model

2. Non-Isothermal Reactor Design

Material and Energy balances for CSTR and PFR, Design Algorithms for CSTR and PFR for specified conversion specified reactor volume, adiabatic and non-adiabatic design procedures, Unsteady-state Batch reactor design Procedures, Non-isothermal endothermic and exothermic equilibrium limited reactions and its reactor design procedures

3. Introduction to Design for Heterogeneous Reacting Systems

Material and Energy balances for CSTR and PFR, Design Algorithms for CSTR and PFR for specified conversion specified reactor volume, Adiabatic and non-adiabatic design procedures, Unsteady-state Batch reactor design Procedures, Non-isothermal endothermic and exothermic equilibrium limited reactions and its reactor design procedures

4. Fluid-Solid Reactions

Rate equation for heterogeneous reactions, Combining linear & non-linear rate expressions, The concept of rate controlling step, Linearization of a non-linear rate equation, Contacting patterns for two phase systems

5. Fluid-Fluid Reactions

Kinetic regimes for mass transfer & reaction, Detailed treatment for all the cases, Film conversion parameter M, Kinetic regime from experiment, Slurry reaction kinetics, Design of towers for fast & slow reactions

6. Solid Catalyzed reactions

Effectiveness factor for first order reaction, Experimental methods for finding rates

B. PRACTICAL & TERM WORK

Experiments to determine RTD & conversion form RTD for various geometries under laminar & turbulent flows, heterogeneous reaction system, and application of tank in series & dispersion models, RTD in a pilot scale batch reactor

C. TEXT BOOKS

- Levenspiel, O. Chemical Reaction Engineering; 3rd ed.; John Wiley & Sons (Asia) Pvt. Ltd : Singapore, 2014.

REFERENCE BOOKS

1. Scott, F. H. Elements of Chemical Reaction Engineering; 5th ed.; Prentice Hall India (p) Ltd.: New Delhi, 2016.
2. Smith, J. M. Chemical Engineering Kinetics; 3rd ed.; McGraw Hill Incorporation: New York, 2000.

TRANSPORT PHENOMENA (CH702)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	1	3	60	40	25	25	150	3	1	1.5	5.5

A. DETAILED SYLLABUS

1. Transport by Molecular Motion

Review of momentum, energy & mass transport by molecular motion

2. Transport in Laminar One-Dimensional Flow

Momentum Transport: shell momentum balances, velocity profiles in cases like adjacent flow of two liquids, Energy Transport: shell energy balances, temperature profiles, heat conduction with an electrical heat source, heat conduction viscous heat source & heat conduction chemical heat source, Mass Transport: concentration distribution in solids & laminar flow, shell mass balances, diffusion with heterogeneous chemical reaction, diffusion in falling liquid film

3. Transport in Arbitrary Continuum

Momentum Transport: equation of change for isothermal system, equation of continuity & motion in rectangular, cylindrical & spherical co-ordinates, Energy Transport: non-isothermal systems, equation of energy of motion for forced & free convection in non-isothermal flow, Mass Transport: equation of continuity for binary mixtures, equation of change for multi-component systems, mass flux in terms of transport properties, use of equation of change

4. Transport with Two Independent Variables

Rate equation for heterogeneous reactions, Combining linear & non-linear rate expressions, The concept of rate controlling step, Linearization of a non-linear rate equation, Contacting patterns for two phase systems

5. Transport in Turbulent Flow

Momentum Transport: unsteady state viscous flow, two-dimensional viscous flow, boundary layer momentum transport, Energy Transport: heat conduction in viscous flow, boundary layer energy transport, Mass Transport: unsteady diffusion, diffusion in viscous flow, two-dimensional diffusion in solids, boundary layer theory

6. Transport between Two Phases

Momentum transport: friction factors for flow in tubes, flow rate & pressure drop relations, friction factor for packed beds, Energy Transport: non-isothermal system, heat transfer coefficients, dimensionless correlations for forced & free convection in tubes & around submerged objects, heat transfer coefficient for forced convection through packed bed, Mass Transport: mass transport coefficient, correlations for binary systems in one phase & at low mass transfer rates, definition & correlation for binary mass transfer coefficients in two phases at low mass transfer rates, transfer coefficients for high mass transfer rates, boundary layer theory

7. Transport in Layer Flow System

Microscopic mass balance & mechanical energy balances, estimation of friction losses, macroscopic energy balance in non-isothermal systems, use of balances to solve steady state & unsteady state problems

B. PRACTICAL & TERM WORK

Experiments on based on the above-mentioned topics

C. TEXT BOOKS

1. Bird R B; Stewart W E; Lightfoot F W, Transport Phenomena, John Wiley & Sons
2. Gupta S K, Momentum Transfer Operations, Tata McGraw Hill Corp

REFERENCE BOOKS

3. Laddha G S; Degaleesan T E , Transport Phenomenon in Liquid Extraction , McGraw Hill Publishing
4. Sherwood T K; Pigford R L, Absorption & Extraction, McGraw Hill Publishing
5. Holland D D ,Multi-component Distillation , Prentice Hall, India

PROCESS EQUIPMENT DESIGN & DRAWING (CH703)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	3	60	40	25	25	150	4	0	1.5	5.5

A. DETAILED SYLLABUS

1. Introduction

Introduction to design and drawing, Basic considerations in mechanical design of process equipments, Concept of pressure vessel, definition and type, selection of type of vessel, Methods of fabrication of vessel, economic consideration.

2. Vessel Design

Selection Criteria for vessel design, Design Preliminaries like excessive allowable stress, design stress, factor of safety, Poisson's ratio, elastic deformation, plastic instability, brittle rupture, creep, thickness of vessel wall, Introduction to vessel codes and standards.

3. Vessels Under Internal Pressure

Design of pressure vessels under internal pressure, Design of wall thickness based on Lame theorem and membrane stress theory, Types of closers for pressure vessel, design thickness of closer , Selection and Design of nozzles and reinforcement pads, Introduction to flanges and gasket, types and selection, design of flanges for pressure vessels.

4. Vessels Under External Pressure

Industrial pressure vessels under external pressure, Design of vessel wall in presence and absence of stiffeners using analytical & graphical methods, Design of circumferential stiffeners, Design of closers subjected to external pressure.

5. Reaction Vessels

Introduction to various components of reaction vessel, Selection and design of various jackets and Coil, Selection and design of Agitators based on torque, moment and critical speed.

6. Storage Vessels

Identification for storage for non-volatile & volatile liquids, storage of gases, Types & constructional features of storage vessels, Rectangular storage tank design, Design of cylindrical storage tank, course to course calculation of wall thickness, bottom design, roof design.

7. Design of Tall Column

Industrial requirement of tall vessels, Construction & features in column stress & determination of shell thickness

8. High Pressure Vessel

Types of high pressure vessel , Design of high pressure vessel, Construction features, materials for high pressure shell design, vessel closures

9. Design of Heat Exchanger

Basic introduction to heat exchanger and selection of heat exchanger, Fluid allocation in heat exchanger, process design of various components like tube, baffles, shell etc and Mechanical design of shell and tube heat exchanger based on TEMA class, Pressure drop on shell side and tube side in heat exchanger.

10. Support for Vessels

Selection and design of different types – bracket or lug support, skirt support & saddle support, design calculations

B. PRACTICAL & TERM WORK

Students are Divided in to two groups, one of the groups will go to computer center, where they will use excel to carry out design of pressure vessel and its components based on theory class, whereas second group will go to drawing hall, where they will draw the pressure vessel components they designed in computer center with dimensions. They will be judged based on both design and drawing, as the title of subject emphasis on both

C. TEXT BOOKS

1. Umarji, S. B.; Mahajani, V.V. Joshi's Process Equipment Design; 5th ed.; Trinity Press: New Delhi, 2016.
2. Brownel, L. E.; Young, E. H. Process Equipment Design & Drawing; 2nd ed.; Wiley Eastern Ltd.: New Delhi, 2005.

REFERENCE BOOKS

1. Bhattacharya, B.C. Process Equipment Design: Mechanical Aspect; 1st ed.; CBS Publisher and Distributors Pvt. Ltd.: New Delhi, 2014.
2. Bhattacharya, B.C.; Narayanan, C.M. Computer Aided Process Equipment Design; 1st ed.; New Central Book agency (p) ltd.: Kolkata, 1992.

CHEMICAL ENGINEERING PLANT DESIGN & ECONOMICS (CH704)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
3	1	0	60	40	0	0	100	3	1	0	4

A. DETAILED SYLLABUS

1. Introduction

Basic considerations in chemical engineering plant design, identification – preliminary techno-economic feasibility

2. Process Design Aspects

Selection of process, factors affecting selection, importance of laboratory development, pilot plant, scale-up methods, safety factors, type of flow diagrams

3. Selection of Process Equipments

Standard vs. special equipment, material of construction for process equipments, selection criteria, specifications sheet

4. Process Auxiliary

Piping design, layout, supports for piping, insulation, pipe fittings, types of valves, selection of valves, process control & instrumentation, control system design

5. Process Utilities

Process water, boiler feed water, water treatment, waste treatment & disposal, steam, oil heating system, chilling plant, compressed air & vacuum

6. Plant Location & Layout

Factors affecting location, factors in planning layout, principles of layout, use of scale models

7. Cost Estimation

Factors involved in project cost estimation, total capital investment, fixed capital investment, fixed capital & working capital, type & methods for estimation of total cost, investment, estimation of cost of equipment & cost of production

8. Estimation of Total Product Costs

Factors involved in total cost of production, factors affecting investment & production cost

9. Depreciation

Types & methods of determining depreciation, evaluation of depreciation methods

10. Profitability, Alternative Investment & Replacement

Methods for profitability evaluation, practical factors in alternative investment & replacement studies

11. Optimum Design

General production rates in plant operation, optimum conditions, optimum production rates in plant operation, and optimum conditions in cyclic operations

B. RECOMMENDED TEXT & REFERENCE BOOK

1. Peters M S ; Timmerhaus K D ,Plant Design & Economics for Chemical Engineers by 2nd Ed. McGraw Hill Publication
2. Vilbrant F C; Dryden C E, Chemical Engineering Plant Design McGraw Hill Publication

COMPUTER AIDED DESIGN (CH704)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. Introduction to Computer Aided Design

Motivation for using CAD in chemical engineering, Preliminaries of CAD, Tools of CAD, Onion model of process design

2. Computer Aided Design of Process Equipment

Computer aided design of pressure vessel and algorithm development, Computer aided Nozzle design, Computer aided Head design, CAD module generation for Pressure Vessel using MATLAB

3. Computer Aided Optimization in Chemical Engineeringa

Introduction of Optimization, Linear Programming, Simplex and Big M method and its variants, Application of MATLAB for solving linear programming optimization problems, Nonlinear optimization in chemical engineering, Convexity and its determination, Unconstraint and constraint nonlinear optimization methods, Newton's method, Nelder-Mead method, Steepest descent method, Nonlinear optimization using MATLAB, CAD module generation for Optimization

4. Process Synthesis & Pinch Technology

Optimal Distillation column sequencing, Direct and indirect sequencing, side-rectifier, side-stripper columns, Prefractionator with heat integration, Petluyk column, Simulation studies of column sequencing, Heat Exchanger network design, energy target, computer aided design of HENS

5. Process Flow-Sheeting & Simulation

Flow sheet simulation algorithms, sequential modular and simultaneous modular approaches, Equation Oriented approach, tearing of recycle streams, Simulation examples using process simulators.

6. Advanced Process Control

Introduction of model predictive control (MPC), Dynamic matrix control, step response model, MATLAB application for MPC

B. TEXT BOOKS

1. Bhattacharya, C. M.; Narayanan, C. M. Computer Aided Design of Chemical Equipment; New Central Book Agency (P) Ltd.: Calcutta, India, 1992.
2. Husain, A. Chemical Process Simulation, Wiley Eastern Limited: New Delhi, 1986.
3. Smith, R. Chemical Process Design and Integration, John Wiley & Sons Ltd.: England, 2005.
4. Seborg, D. E.; Edger, T. F.; Mellichamp, D. A. Process Dynamics and Control, 2nd ed.; Wiley India, New Delhi, 2004.

REFERENCE BOOK

1. Edger, T. F.; Himmelblau, D. M.; Lasdon, L. S. *Optimization of Chemical Processes*; 2 nd ed. McGraw-Hill: New York, 2001.

OPTIMIZATION TECHNIQUES (CH714)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. Introduction

Introduction, Engineering Application, Methods of Operation Research, Formulation, Graphical method of Solution

2. Linear Programming

Simplex method, Degeneracy, Big-M method, Dual Simplex Method, Revised Simplex method.

3. Transportation Model

North-West Corner rule, Row and Column Minima method, Least-cost method, Vogel's approximation method, Degeneracy in transportation problem, stepping stone method, modified distribution method, unbalanced supply and demand, profit maximization problem, trans-shipment problems

4. Assignment Model

Hungarian method for solution, Variation of the assignment problem - non-square matrix, restriction on assignments, Maximization problem, travelling salesman problem, Travelling salesman problem (shortest cyclic route models

5. Scheduling Optimization & Related Models on Sequencing

Batch Scheduling, Formulation of sequencing models and its applications. Introduction to Gantt Chart and its Application to Different types of Transfer policies.

6. Advanced Topic in Linear Programming

Duality In Linear Programming, Primal to Dual conversion, Duality Theorem and Dual Simplex method

7. Dynamic Programming

Bellman's principle of optimality, examples on the application of routing problem, inventory problem, marketing problem

8. Non-Linear Programming

Introduction, Elimination methods — Unrestricted Search, Exhaustive Search, Dichotomous search, Fibonacci method, Golden Section Method, Kuhn tucker condition

B. TEXT BOOKS

1. Gupta P.,Hira D.S., " Operation Research", S. Chand & Company Ltd
2. Rao S.S., "Engineering Optimization: Theory and Practice", Willey Publication.
3. Vohra N D, Quantitative Techniques in Management, Tata McGraw Hill, New Delhi

REFERENCE BOOKS

1. Sharma S D ; Sharma H, Operations Research: Theory, methods & applications,
2. K. Nath R. Nath Arora J.S., "Introduction to Optimum Design", Elsevier Academic Press.
3. Hiller ; Libermann, Introduction to Operations Research, Tata McGraw Hill
4. Hamdy A T, Operation Research, Pearson Education.

CHEMICAL ENGINEERING MATERIALS & PROCESS SAFETY (CH715)

Teaching Scheme (hr/week)			Marks					Credit per Semester			
L	T	P	Th.	S	TW	P	Total	L	T	P	Total
4	0	0	60	40	0	0	100	4	0	0	4

A. DETAILED SYLLABUS

1. Material Properties & Selection Strategy

Various mechanical properties like Elasticity, Plasticity, Strength, Stiffness, Resilience, ductility, Malleability, Toughness, Hardness, Isotropy and anisotropy etc., Stress and strain relation, Hooke's law, Modulus of material, Poisson's ratio. Deformation of metals elastic & plastic deformations, creep and fatigue failures. Various ferrous and non-ferrous metals, Unique Identification Numbering (UIN) for metal identification, corrosion resistant metals, high temperature alloys, and super alloys for specific applications.

2. Corrosion & its Prevention

Mechanism of corrosion, dry & wet corrosion, other forms of corrosion, Passivity, factors influencing corrosion, atmospheric corrosion, Control & prevention of corrosion – cathodic & anodic control, inhibitors & other protective measures. Protective coatings, metallic coating & metal cladding, physico-chemical principles involved, chemical conversion coating, organic coating, enamels, ceramic protective materials

3. Introduction to Process Safety

Define: safety, hazard, risk, accident, incident, likelihood, consequence, loss prevention, domino effect, first aid, incident rate, lost workdays, occupational injury and illness, frequency rate, severity rate, fatality rate and fatal accident rate. Theory of accident causation, nature of accident process.

4. Process Safety Strategies & Case Studies

Concept of Active, Passive, Inherent and Procedural Strategies. Case Studies: Analysis of mistakes made and lessons to learn from four significant chemical industry disasters: Flixborough (England), Pasadena (Texas), Seveso (Italy) and Bhopal (India)

5. Toxicological Studies

Entry routes of toxicants into biological system and appropriate control strategy, elimination of toxicants from biological system by various ways, target organ, acute and chronic toxicity and its toxicological studies, chemical and physical asphyxiates, TLV-TWA, TLV-STEL and TLV-C, LD 50 and LC 50, detection of possible hazard through senses.

6. Industrial Hygiene

Laws and regulations in Indian context and US context, role of OSHA, NIOSH, ACGIH, EPA, PSM vs. RMP, Safety work permits, Pre-start up and shut down procedures, emergency planning and response, mock drill, safety audit. Role of industrial hygienist: Identification using MSDS and NFPA diamond, Evaluation (quantification methods) and Control methods like Dyke and Enclosures, dilute and local ventilation, wet methods, good housekeeping and Personal Protective Equipment (PPE).

7. Fire & Explosion

Basic definitions like fire, combustion, explosion, fire and flash point, auto-ignition etc., concept of fire triangle, flammability limits (LFL and UFL). Classification of fires, various extinguishing medium and its selection, mobile and stationary fire-fighting methods. Explosion types like mechanical explosion, detonation and deflagration, deflagration to

detonation transition (DtoD transition), confined and unconfined explosion, dust explosions, vapor cloud explosion, BLEVE their causes and prevention, Numerical on fire & explosion

8. **Source Models**

Concept of source models, flow of liquids and vapors through various geometries, flashing liquids, liquid pool evaporation, Realistic and worst case releases.

9. **Chemical Reactivity Hazard**

Concept of chemical reactive hazard, thermal run away models and parametric sensitivity, use of calorimeters and its types like DSC, ARC, ARRST, APTAC, VSP2 etc, characterization of reactive chemical hazard using calorimeters, strategies to control reactive hazard, case study of T2 laboratory for reactive hazard.

10. **Introduction to Reliefs and Relief Devices**

Need for relief devices, few terminology like set pressure, max. allowable working pressure, operating pressure, accumulation, overpressure, backpressure, blowdown, max. allowable accumulated pressure etc., location of reliefs, various relief devices like spring loaded (relief valve, safety valve and safety relief valve), mechanical, buckling pin and rupture dick, selection criteria and combination criteria, effluent system, knock-out drum, cyclone, condenser, quench tank, scrubber, flare and incinerator. Concept of Basic process control systems (BPCS) and Safety instrumented system (SIS), sensor location criteria and redundancy of system, safety interlocks and alarm systems.

11. **Hazard Identification and Hazard Analysis**

HAZID tools like hazard checklist, job safety assessment, hazard survey (Calculation of Dow and Mond Index), Hazard Operability (HAZOP case study), safety reviews, ALARP and Risk Management (RM). HAZAN using probabilistic methods, revealed and unrevealed failures, common failure modes and reliability calculations. Use of tools like FTA, ETA and LOPA analysis.

12. **Miscellaneous topics**

Safety in laboratory of academic institute and R&D houses, safety during loading and unloading of chemicals, safety while operating positive pressure and negative pressure systems, safety in tank farm, plant lay outing for safer operations, piping and electrical color code. In addition brief discussion on coverage of factories act (1948), boiler act (1923), hazardous waste (management and handling) rules (1989), OISD guidelines and ISO-14000 (EMS), 18000 (OHSAS) and 31000 (RM).

B. TEXT BOOKS

1. Crawl, D. A.; Louvar, J. F. Chemical Process Safety (fundamentals with applications); Prentice Hall International Series, 3rd Ed, 2011.
2. Chaudhary, S.K.H. Material Science and Processes; Indian Book Distributor Company, 1978.

REFERENCE BOOK

1. Lees, F. P. Loss Prevention in the Process Industries (Hazard Identification, Assessment and Control); Butterworth-Heinemann, 2nd Ed, 1980.
2. Kletz, T. Learning from Accidents; Gulf Professional Publishing, 3rd Ed, 2001.
3. Stoessel, F. Thermal Safety of Chemical Processes (Risk Assessment and Process Design); Wiley-VCH, 2008.
4. Banerjee, S. Industrial Hazards and Plant Safety; CRC Press, 1st Ed, 2002.

PROJECT / INDUSTRIAL TRAINING & SEMINAR

Subject Code	Subject Name	Teaching Scheme			Exam Scheme					Credit
		L	T	P	Th.	S	P	TW	Total	
AF801	Project/Industrial Training	-	-	28	-	-	300	100	400	14
AF802	Seminar	-	-	8	-	100	-	-	100	4
		25		**11**					**500**	**18**