

**Course Structure & Syllabus**  
**of**  
**B.Tech Programme**  
**in**  
**Chemical Engineering**



**(From the Session 2015-16)**

**VSSUT, BURLA**

**COURSE STRUCTURE**  
**FIRST YEAR**  
**(COMMON TO ALL BRANCHES)**

FIRST SEMESTER				SECOND SEMESTER			
Theory		Contact Hrs.	CR	Theory		Contact Hrs.	CR
Course Code	Subject	L . T . P		Course Code	Subject	L. T. P	
	Mathematics - I	3 - 1 - 0	4		Mathematics - II	3 - 1 - 0	4
	Physics/Chemistry	3 - 1 - 0	4		Chemistry/ Physics	3 - 1 - 0	4
	Engineering Mechanics/ Computer Programming	3 - 1 - 0	4		Computer Programming/ Engineering Mechanics	3 - 1 - 0	4
	Basic Electrical Engineering/ Basic Electronics	3 - 1 - 0	4		Basic Electronics/ Basic Electrical Engineering	3 - 1 - 0	4
	English for Communication/ Environmental Science	3 - 1 - 0	4		Environmental Science/ English	3 - 1 - 0	4
<b>Sessionals</b>				<b>Sessionals</b>			
	Applied Physics Laboratory/Chemistry Lab	0 - 0 - 3	2		Chemistry Lab/Applied Physics Laboratory	0 - 0 - 3	2
	Workshop-I/ Engineering Drawing	0 - 0 - 3	2		Engineering Drawing/ Workshop-I	0 - 0 - 3	2
	Basic Electrical Engg. Lab/ Basic Electronics Lab	0 - 0 - 3	2		Basic Electronics Lab/ Basic Electrical Engg. Lab	0 - 0 - 3	2
	Business Communication Skill/ Programming Lab	0 - 0 - 3	2		Programming Lab/ Business Communication Skill	0 - 0 - 3	2
<b>Total</b>		<b>15-5-15</b>	<b>28</b>	<b>Total</b>		<b>15-5-15</b>	<b>28</b>

**SECOND YEAR**

THIRD SEMESTER				FOURTH SEMESTER			
Theory		Contact Hrs.	CR	Theory		Contact Hrs.	CR
Course Code	Subject	L . T . P		Course Code	Subject	L. T. P	
	Mathematics-III	3 - 1 - 0	4		Mathematics-IV	3 - 1 - 0	4
	Object Oriented Programming	3 - 1 - 0	4	CM15-006	Process & Handling of Materials	3 - 1 - 0	4
CM15-001	Fluid Dynamics	3 - 1 - 0	4	CM15-007	Chemical Process Calculation	3 - 1 - 0	4
CM15-002	Chemical Process Technology	3 - 1 - 0	4	CM15-008	Fuel & combustion	3 - 1 - 0	4
	Engineering Economics	3 - 1 - 0	4		Organisation Behaviour	3 - 1 - 0	4

Sessionals				Sessionals			
CM15-003	Fluid Dynamics Lab-I	0 - 0 - 3	2	CM15-009	Fluid Dynamics Lab-II	0 - 0 - 3	2
	OOP Lab	0 - 0 - 3	2	CM15-010	Material Handling Lab	0 - 0 - 3	2
CM15-004	Environmental Engg.Lab	0 - 0 - 3	2	CM15-011	Fuel Technology Lab-I	0 - 0 - 3	2
CM15-005	Process Technology Lab	0 - 0 - 3	2	CM15-012	Fuel Technology Lab-II	0 - 0 - 3	2
	<b>Total</b>	<b>15-5-15</b>	<b>28</b>		<b>Total</b>	<b>15-5-15</b>	<b>28</b>

### **THIRD YEAR**

FIFTH SEMESTER				SIXTH SEMESTER			
Theory		Contact Hrs.	CR	Theory		Contact Hrs.	CR
Course Code	Subject	L . T . P		Course Code	Subject	L. T. P	
CM15-013	Chemical Engineering Thermodynamics	3 - 1 - 0	4	CM15-022	Transport Phenomena	3 - 1 - 0	4
CM15-014	Heat Transfer	3 - 1 - 0	4	CM15-023	Process Instrumentation	3 - 1 - 0	4
CM15-015	Mass Transfer-I	3 - 1 - 0	4	CM15-024	Mass Transfer-II	3 - 1 - 0	4
CM15-016	Fundamentals of Biochemical processes	3 - 1 - 0	4	CM15-025	Reaction Kinetics & catalysis	3 - 1 - 0	4
CM15-017	Process Dynamics & Control	3 - 1 - 0	4	CM15-026	Process Equipment Design	3 - 1 - 0	4
<b>Sessionals</b>				<b>Sessionals</b>			
CM15-018	Biotech Lab	0 - 0 - 3	2	CM15-027	Mass Transfer Design Lab	0 - 0 - 3	2
CM15-019	Heat transfer Lab	0 - 0 - 3	2	CM15-028	Heat Transfer Design Lab	0 - 0 - 3	2
CM15-020	Mass Transfer Lab	0 - 0 - 3	2	CM15-029	Chemical reaction Engg Lab	0 - 0 - 3	2
CM15-021	Process Control Lab	0 - 0 - 3	2	CM15-030	Computer aided Design Lab	0 - 0 - 3	2
	<b>Total</b>	<b>15-5-15</b>	<b>28</b>		<b>Total</b>	<b>15-5-15</b>	<b>28</b>

## FOURTH YEAR

SEVENTH SEMESTER				EIGHTH SEMESTER			
Theory		Contact Hrs.	CR	Theory		Contact Hrs.	CR
Course Code	Subject	L . T .P		Course Code	Subject	L. T. P	
CM15-031	Petroleum Refinery Engg.	3 - 1 - 0	4	CM15-037	Fluidisation Engineering	3 - 1 - 0	4
CM15-032	Process Simulation & modelling	3 - 1 - 0	4	CM15-038	Modern separation process in Chemical Engineering	3 - 1 - 0	4
CM15-033	Mineral Process Engg.	3 - 1 - 0	4		Open Elective	3 - 1 - 0	4
CM15-034	Core Elective	3 - 1 - 0	4				
	Open Elective	3 - 1 - 0	4				
<b>Sessionals</b>				<b>Sessionals</b>			
CM15-035	Minor Project	0 - 0 - 3	2	CM15-039	Seminar	0 - 0 - 0	2
CM15-036	Process simulation Lab	0 - 0 - 3	2	CM15-040	Comprehensive Viva	0 - 0 - 0	2
				CM15-041	Major Project	0 - 0 - 6	8
<b>Total</b>		<b>15-5-6</b>	<b>24</b>	<b>Total</b>		<b>9-3-6</b>	<b>24</b>

## ELECTIVE SUBJECTS

<b>Elective-CM15-032</b>	<b>Elective-CM15-032</b>
<ol style="list-style-type: none"><li>1. Polymer Technology</li><li>2. Mineral Process Engineering</li><li>3. Paper &amp; Pulp Technology</li><li>4. Soft computing</li><li>5. Chemical Engineering Mathematics</li><li>6. Energy Conservation &amp; Renewable source of Energy</li><li>7. Corrosion and Degradation Of Materials</li><li>8. Colloid and Interfacial Engineering</li><li>9. Particulate Science and Technology</li><li>10. Materials Science and Engineering</li><li>11. Coal Processing Technology</li><li>12. Bio Materials</li></ol>	<ol style="list-style-type: none"><li>1. Food Biotechnology</li><li>2. Advanced Reactor Engineering &amp; Design</li><li>3. Nanotechnology in catalysis</li><li>4. Separation Technology</li><li>5. Disaster management in Chemical Industries</li><li>6. Nuclear Fuel Processing and Disposal</li><li>7. Instrumentation and process Control</li><li>8. Bioprocess Engineering</li><li>9. Bioenergy Engineering</li><li>10. Project Engineering</li><li>11. Optimization Techniques in Process Design</li><li>12. Flow of Complex Mixtures</li></ol>

# SYLLABUS

## FIRST & SECOND SEMESTER (COMMON TO ALL BRANCHES)

### PHYSICS – I (3 – 1 – 0)

#### Module I (10 Hours)

##### Interference

Superposition of waves - coherent and incoherent superposition, Intensity distribution.

Two source interference theory, Interference in thin films. Newton's Rings, Determination of wavelength of light and refractive index of liquid.

##### Diffraction

Diffraction: Introduction, Types of diffraction, Fraunhofer diffraction at a single slit, Plane Diffraction grating, Diffraction spectra, Determination of wavelength of light, angular dispersion, resolving power of grating.

##### Polarization

Polarization: Introduction, Types of Polarization, Production of polarized light (elementary idea) Brewster's law, Malu's law, Double refraction (only statement, explanation), Construction and working of Nicol prism, Half wave plate and Quarter wave plate, Application of polarization (Polarimeter: Construction, Principle, Working).

#### Module II (10 Hours)

##### Electromagnetism

Vector Calculus : Gradient, Divergence, Curl of vector field, Gauss divergence theorem. Stoke's theorem, Green's theorem, Maxwell's electromagnetic equation in differential form and integral form, Electromagnetic wave equation: in vacuum and conducting medium. Poynting vector, Poynting theorem, preliminary ideas about waveguides.

#### Module III (10 Hours)

##### Quantum mechanics

Need for Quantum Physics, wave particle duality, Davisson Germer experiment, Schroedinger wave equation (time dependent and time independent), properties of wave function, Operators, eigen value, eigen function, expectation value, probability density, Simple applications: particle in a box, finite well, step potential and tunneling

#### Module IV (10 Hours)

##### Lasers

Introduction, Characteristics of lasers, Einstein's coefficients & Relation between them, Lasing action, Population inversion, Different types of Lasers (Ruby Laser, He-Ne Laser), Three and Four level pumping schemes, Applications of LASER (elementary ideas)

##### Fiber optics

Introduction, Principle of wave propagation in Optical Fiber, Structure of Optical Fiber, Types of Optical Fibers, Acceptance angle and acceptance cone, Numerical aperture, Applications of optical fibers in communications

##### Nanomaterials

Introduction, Classification, Physical characteristics and applications (fundamentals)

##### Text books:

1. Optics – A.K. Ghatak
2. Concepts of Modern Physics – A. Beiser

##### Reference Books:

1. Electricity & Magnetism – D. Griffiths
2. Quantum Mechanics – Gasiorowicz
3. Lasers, theory and applications - K. Thyagarajan and A.K. Ghatak, New York : Plenum Press.
4. Quantum Mechanics – M. Das and P.K Jena
5. An Introduction to Fiber Optics - A. Ghatak, K. Thyagarajan: Cambridge University Press.
6. Nano Materials by B. Viswanathan, Narosa Book Distributer

## **List of Experiments**

1. To Determine the Young's Modulus (Y) of the material of a Wire by Searle's Method.
2. Determination of Surface Tension of water by Capillary rise method.
3. Determination of Acceleration due to gravity by using a Bar Pendulum.
4. To determine thermal conductivity of a bad conductor by using Lee's Apparatus.
5. Determination of Wavelength of monochromatic light with the help of a Newton's Ring Apparatus.
6. Determination of Grating element of a Diffraction grating using spectrometer.
7. To verify the laws of transverse vibration of string by using sonometer.
8. To determine the Rigidity modulus of the material of a wire by using Barton's apparatus.
9. To draw the characteristics of a Bipolar Junction Transistor.
10. To draw the V-I characteristics of a P. N Junction diode.

## **CHEMISTRY – I (3 – 1 – 0)**

### **Module–I 10 Hours**

Failure of Classical Mechanics, Schrodinger's Wave Equation (Need not be Derived), Energy for 1-D Potential Box, Interaction of Wave with Matter  
Fundamental of Microwave, IR, UV-Vis Spectroscopy:  
Basic Concept of Spectroscopy, Selection Rule, Numericals, Frank-Condon Principle,

### **Module – II 10 Hours**

Thermodynamics of Chemical Processes: 05 Hours  
Concept of Entropy, Chemical Potential, Equilibrium Conditions for Closed Systems, Phase and Reaction Equilibria, Maxwell Relations  
Definition of Terms: Phase, Components, Degree of Freedom, Phase Rule Equation. Phase Diagrams: One Component Systems – Water and Sulphur, Two Component System – Lead-Silver, Cooling Curves, Iron-Carbon Phase Diagram

### **Module–III 10 Hours**

Electrode Potentials and its Relevance to Oxidation and Reduction, Measurement of EMF, Determination of pH, Hydrogen, Glass, Quinhydrone Electrodes, Dry Cells, Fuel Cells and Corrosion: Concept, Galvanic Corrosion

### **Module–IV 10 Hours**

Kinetics of Chemical Reactions: 05 Hours  
Reversible, Consecutive and Parallel Reactions, Steady State Approximation, Chain Engineering application of materials: 05 Hours  
Organometallics and Nanomaterials

- 1) P. W. Atkins, Elements of Physical Chemistry, 4th Edition, Oxford University Press
- 2) C. N. Banwell and E. M. MacCash, Fundamentals of Molecular Spectroscopy, 5th Edition,
- 3) P. K. Kar, S. Dash and B. Mishra, B.Tech. Chemistry Vol. I, Kalyani Publications

# Chemistry Laboratory

(Any ten Experiments)

1. Determination of amount of sodium hydroxide and sodium carbonate in a Mixture.
2. Determination of Total hardness of water by EDTA method.
3. Estimation of calcium present in the limestone.
4. Preparation of aspirin.
5. Standardization of  $\text{KMnO}_4$  using sodium oxalate.
6. Determination of ferrous iron in Mohr's salt by potassium permanganate.
7. Determination of Rate constant of acid catalyzed hydrolysis of ester.
8. Determination of dissolved oxygen in a sample of water.
9. Determination of Viscosity of lubricating oil by red wood Viscometer.
10. Determination of Flash point of given oil by Pensky Marten's Flash point Apparatus.
11. Determination of available chlorine in bleaching powder.

**Reference Book:** B.Tech practical Chemistry-Kalyani publisher

## MATHEMATICS - I

### Subject – Mathematics I (Calculus, Linear Algebra and Numerical Method) (3-1-0)

#### *Module 1: (10 Lectures)*

Open sets, Closed sets, Limit points of a set, Limits, Continuous functions, Functions continuous on closed intervals, The derivative, Increasing and decreasing functions, Statement and applications of Darboux's theorem, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Extremum values; Riemann integral: Definition and existence of the integral, Integral as a limit of sums, some integrable functions, Fundamental theorem of calculus, Mean value theorems for integral calculus.

#### *Module 2: (10 Lectures)*

Matrices, Vectors: Addition and Scalar Multiplication, Matrix Multiplication, Linear Systems of Equations, Gauss Elimination, Linear Independence, Rank of a Matrix, Vector Space, Solutions of Linear Systems: Existence, Uniqueness, Determinants, Cramer's Rule, Gauss-Jordan Elimination, Vector Spaces, Inner Product Spaces,

#### *Module 3: (10 Lectures)*

Eigenvalues, Eigenvectors, Some Applications of Eigenvalue Problems, Symmetric, Skew-Symmetric, and Orthogonal Matrices, Eigenbases, Diagonalization, Quadratic Forms, Complex Matrices and Forms, Inclusion of Matrix Eigenvalues, Power Method for Eigenvalues

#### *Module 4: (10 Lectures)*

Numerical methods in general, Introduction, Solution of Equations by Iteration, Interpolation, Numerical Integration and Differentiation

#### **Text Books:**

- 1) S.C. Malik and S. Arora, Mathematical Analysis, New Age International
- 2) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd

Chapters: S.C. Malik - 2(2.1- 2.3), 5(5.1-5.3), 6(6.1, 6.3-6.7), 7(7.1), 9(9.1, 9.6, 9.7, 9.9,9.10)

E. Kreyszig - 7(7.1-7.5, 7.7, 7.8,7.9), 8, 20 (20.7, 20.8), 19(19.1, 19.2, 19.3, 19.5) 9<sup>th</sup> Edition

#### **Reference Books:**

- 1) George B. Thomas , Jr. and Ross L. Finney, Calculus and Analytic Geometry, Addison Wesley Publishing Company
- 2) R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Taylor & Francis
- 3) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press



# MATHEMATICS - II

## Differential Equations (3-1-0)

### **Module 1: (10 Lectures)**

Basic Concepts, Modeling, Separable ODEs, Modeling, Exact ODEs, Integrating Factors, Linear ODEs, Bernoulli Equation, Population Dynamics, Existence and Uniqueness of Solutions. Homogeneous Linear ODEs of Second Order, Homogeneous Linear ODEs with Constant Coefficients, Euler-Cauchy Equations, Existence and Uniqueness of Solutions, Wronskian, Nonhomogeneous ODEs, Solution by Variation of Parameters.

### **Module 2: (10 Lectures)**

General linear differential equations of order  $n$ , Differential Operators, Homogeneous Linear ODEs, Homogeneous Linear ODEs with Constant Coefficients, Nonhomogeneous Linear ODEs, Conversion of an  $n$ th-Order ODE to a System, Basic Theory of Systems of ODEs.

Power Series Method, Theory of the Power Series Method, Frobenius Method, Sturm-Liouville Problems, Orthogonal Functions.

### **Module 3: (10 Lectures)**

Laplace Transforms, Laplace Transform, Inverse Transform, Linearity.  $s$ -Shifting, Transforms of Derivatives and Integrals, ODEs, Unit Step Function,  $t$ -Shifting, Short Impulses, Dirac's Delta Function, Partial Fractions, Convolution, Integral Equations, Differentiation and Integration of Transforms.

### **Module 4: (10 Lectures)**

Partial differential equations, Basic Concepts, Modeling: Vibrating String, Wave Equation Solution by Separating Variables, Use of Fourier Series, D' Alembert's Solution of the Wave Equation. Characteristics, Heat Equation: Solution by Fourier Series, Solution of PDEs by Laplace Transforms.

### **Text Book:**

- 1) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd, 9<sup>th</sup> edition.

Chapters: 1(1.1-1.5, 1.7), 2(except 2.4, 2.8, 2.9), 3, 4(4.1, 4.2), 5(5.1, 5.2, 5.4), 6(6.1-6.5), 12(12.1-12.5, 12.11)

### **Reference Books:**

- 1) R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Taylor & Francis
- 2) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press
- 3) J. Sinha Roy and S. Padhy, Ordinary and Partial Differential Equation, Kalyani Publisher.
- 4) Richard Bronsan and Gabriel Costa, Scahum's Outline of Differential Equations, McGraw Hill
- 5) Paul Duchateau and D.W. Zachmann, Scahum's Outline of Partial Differential Equations, McGraw Hill
- 6) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill

# English for Communication

(Credit: 4-0-0)

Objective- For developing the ability to communicate effectively in professional environment by enhancing their skills in communication.

## Module 1: Fundamentals of Communication (10 Hours)

- ❖ Communication: Process, pattern and stages of communication, channels and types of communication and Barriers to Communication.
- ❖ Functions of language: Descriptive, Expressive and Social Functions.
- ❖ Formal and Informal English
- ❖ Plain English ( Cross cultural communication)
- ❖ Bias free language

## Module 2: Communicative Grammar (10 Hours)

- ❖ Time, Tense and Aspects
- ❖ Verbs of State and Events
- ❖ Use of Modal Verbs
- ❖ Passive and Active Voice
- ❖ Conditionals

## Module 3: Sounds of English (10 Hours)

- ❖ The Speech Mechanism and Organs of Speech
- ❖ Consonant Sounds of English
- ❖ Vowel Sounds of English
- ❖ Stress Pattern: Syllable, Stress and Intonation.
- ❖ Problem sounds for Indian Speakers

## Module 4: Business and Official Writing (10 Hours)

- ❖ Paragraph writing and Sentence Linker
- ❖ Business and Official Letters
- ❖ Report and Proposal writing,
- ❖ Notice, Circular and Memo writing
- ❖ Résumé (CV) Writing.

### Text Books:

1. Effective Technical Communication by M Ashraf Rizvi (Tata McGraw Hill)
2. Better English Pronunciations By J. D.O Conner ( Cambridge University Press)
3. A Communicative Grammar of English by G.N. Leech and Jan Svartik (OUP)

**Reference Books:** “Business communication” by Ramachandran, Lakshmi and Krishna (Macmillan)

## **ENGLISH COMMUNICATION SKILLS (Credit: 0-0-2)**

**Objective: For enhancing corporate readiness among students by inculcating several skills of communication through activities.**

### **Laboratory Activities:**

1. **Giving Introduction ( Self and others)**
2. **Group Discussion**
3. **Interviews**
4. **Role Play**
5. **Listening skill Development**
6. **Reading skill Development**
7. **Writing skill Development**
8. **Speaking skill Development**
9. **Meeting**
10. **Presentation**

### **Books Recommended:**

1. **Soft Skills – By Dr K Alex ( S Chand)**

# ENGINEERING MECHANICS

## Module – I (10 Hours)

1. **Concurrent forces on a plane:** Composition, resolution and equilibrium of concurrent coplanar forces, method of moment, friction (chapter 1). (7)
2. **Parallel forces on a plane:** General case of parallel forces, center of parallel forces and center of gravity, centroid of composite plane figure and curves(chapter 2.1 to 2.4) (4)

## Module - II (10 Hours)

3. **General case of forces on a plane:** Composition and equilibrium of forces in a plane, plane trusses, method of joints and method of sections, plane frame, principle of virtual work, equilibrium of ideal systems.(8)
4. **Moments of inertia:** Plane figure with respect to an axis in its plane and perpendicular to the plane, parallel axis theorem(chapter 3.1 to3.4, 5.1, appendix A.1 to A.3) (3)

## Module - III (10 Hours)

5. **Rectilinear translation:** Kinematics, principle of dynamics, D'Alembert's Principle, momentum and impulse, work and energy, impact (chapter 6). (11)

## Module – IV (10 Hours)

6. **Curvilinear translation:** Kinematics, equation of motion, projectile, D'Alembert's principle of curvilinear motion. (4)
7. **Kinematics** of rotation of rigid body (Chapter 9.1) (3)

## Text book:

1. Engineering Mechanics: S Timoshenko & Young; 4<sup>th</sup> Edition (International Edition) Mc Graw Hill.

## Reference books:

1. Fundamental of Engineering mechanics (2<sup>nd</sup> Edition):  
S Rajesekharan & G Shankara Subramaniam; Vikas Pub. House Pvt ltd.
2. Engineering mechanics: K.L. Kumar; Tata MC Graw Hill.

## SESSIONAL

### Workshop -I

(Consists of 3 sections) :

1. Carpentry Section: Wooden rack/bench/chair/stool (any one)
2. Fitting Section: Paper Wt., Square or Rectangular joint (male and female joint) (any one)
3. Black Smith Section : Weeding hook/Hexagonal headed bolt blank (any one )

## COMPUTER PROGRAMMING

**L-T-P: 3-1-0**

**Cr.-4**

**Module I: (10 Hours)**

Introduction to computing- Block architecture of a computer, bit, bytes, memory, representation of numbers in memory. Introduction to problem solving- Basic concepts of an algorithm, program design methods, flowcharts.C Language Fundamentals- Character set, Identifiers, Keywords, Data Types, Constant and Variables, Statements. Input &Output - Input & Output Assignments, Formatted Outputs. Operatorsand Expressions-Operators, Precedence of operators.

**Module II: (10 Hours)**

Decision Control Structure, Loop Control Structure and Case Control Structure.Functions- Monolithic vs Modular programs, User defined vs standard functions, formal vs Actualarguments, Functions category, function prototypes, parameter passing, Recursion.Arrays- 1D Array, 2D Array & Multi-Dimensional Array. Strings- Declaration &Initialization,String Handling Functions.

**Module III: (10 Hours)**

Pointers- Pointer variable and its importance, Pointer Arithmetic, Passing parameters, pointer to pointer, pointer to function.Dynamic Memory Allocation.Structure- Nested Structure, Array of Structures, Pointer to Structure, Structure & Functions, typedef, Enumerated Data Type, Bit Fields. Union- Array of Union Variables, Union inside Structure.Storage Class.

**Module IV: (10 Hours)**

Preprocessor Directives- Types, Pragma Directives, Conditional Directives.Files- Reading data from Files, Reading data from Files, Writing data to Files, Error Handling during File Operations.Advanced Issues in Input & Output – using *argc&argv*.Operation on Bits.

**Text Books:**

1. C: The Complete Reference: Herbert Schildt
2. Computer Fundamentals &Programming in C: ReemaThareja, Oxford University Press.

**Reference Books:**

1. Let us C- Y.Kanetkar, BPB Publications.
2. Programming with ANSI and Turbo C- Kamthane, A.N. Pearson Education
3. C How to Program- Deitel and Deitel, Pearson Education.
4. The C programming Language- Brian W. Kernighan and Dennis M. Ritchie,Prentice-Hall.

**PROGRAMMING LAB (CS15-984)**

**L-T-P: (0-0-3)**

**Cr: 2**

Introduction to OS : Linux/Unix, Dos, Windows, Vi editor, File Handling, Directory Structure, File Permissions, Creating and editing simple c programs, Compilation and Execution  
C programming on variables and expression assignment, simple arithmetic loops, If-else, Case statements, Break, Continue, Go to  
Single and Multidimensional arrays  
Functions, Recursion, File handling in C  
Pointers, address operator, Declaring pointers and operators on pointers, Address of an array, Structures, Pointer to structure, Dynamic memory allocation  
Fundamental Programs on Data Structures (Stack, Queue, Linked lists, Trees, Graphs)

## **(EL15-002) BASIC ELECTRICAL ENGINEERING (3-1-0)**

### **MODULE-I (10 HOURS)**

DC Networks: Kirchhoff's laws, node and mesh analysis, Delta-star and star-delta transformations. Superposition, Thevenin's and Norton's theorem. Transients, in R-L, R-C and R-L-C circuits with DC. Excitation.  
Single Phase AC Circuits: Single phase EMF generation, average and effective values of sinusoids, j- operations, complex representation of impedances, phasor diagrams, power factor, power in complex notation, solution of series and parallel circuits. Introduction to resonance in series RLC circuit.  
Three Phase AC Circuit: Three phase EMF generation, delta and star connection, Line and Phase quantities. Solutions of 3-phase circuits with balanced load. Power in 3-phase balanced circuits.

### **MODULE-II (10 HOURS)**

Magnetic Circuits: B-H Curve, Hysteresis, Permeability and reluctance, solution of simple magnetic circuits, Hysteresis and Eddy current losses.  
DC Generator: Different types, Principle of Operation of DC generator, EMF equation, methods of excitation. DC Motor: Back e.m.f., speed and torque of a DC Motor, Conditions for maximum Power. Speed control of DC shunt motor.  
Transformers: Construction and Principle of operation of single-phase transformer, EMF equation, Single-phase autotransformer.

### **MODULE-III (10 HOURS)**

Three phase Induction Motor: Construction and principle of operation, types; Slip-torque characteristics.  
Synchronous Machines: Construction & principle of operation of Synchronous generator and motor. EMF equation, Voltage regulation, Applications and starting of Synchronous motor.  
Introduction to single-phase induction Motor.

### **MODULE-IV (10 HOURS)**

Measuring Instruments: DC PMMC instruments, Extension of range by shunts and multipliers. Moving iron ammeters and voltmeters, Dynamometer type Watt meters, Induction type Energy Meter.  
Power supply systems: Principle of generation - thermal, hydel and nuclear. Transmission and distribution of electric energy. Introduction to Electric Heating & Welding.

### **TEXT BOOKS**

- [1]. Edward Hughes (revised by Ian McKenzie Smith), "Electrical & Electronics Technology", Pearson Education Limited. Indian Reprint 2002, 10<sup>th</sup> Edition.

[2]. D.Kulshreshtha, “ Basic Electrical Engineering” TMH, 1<sup>st</sup> Edition.

#### **REFERENCE BOOKS**

[3]. H.Cotton, “Advanced Electrical Technology”, CBS Publishers, New Delhi, 7<sup>th</sup> Edition.

[4]. C.L. Wadhwa, “Electrical Engineering”, New Age International Publishers, 2<sup>nd</sup> Edition.

[5]. S. Parker Smith, “Problems in Electrical Engineering”, Asia Publications, 10<sup>th</sup> Edition.

#### **(EL15-003) BASIC ELECTRICAL ENGINEERING LAB (0-0-3)**

1. Preliminary: Preparation of symbol chart for various systems & components as per ISS, To study the constructional & operational features for Voltmeter, Ammeter, Wattmeter, Frequency meter, multi-meter and Rheostat, Study of safety rules as per ISS
2. Measurement of the armature & field resistance of D.C. Machine by volt-amp method. & Starting and speed control of a D.C. shunt motor
3. Study of BH Curve
4. Determination of open circuit characteristics (O.C.C) of D.C shunt generator when separately excited at different speeds.
5. Measurement of earth resistance and insulation resistance
6. Starting of Induction motor and measurement of three phase power & power factor by 2-wattmeter method.
7. Calibration of a single phase Energy Meter by directed loading & Phantom loading

### **BASIC ELECTRONICS (3-1-0)**

#### **UNIT-1**

**(10 Hours)**

Introduction to Electronics: Signals, Frequency Spectrum of Signals, Analog and Digital Signals, Linear Wave Shaping Circuits: RC LPF, Integrator, RC HPF, Differentiator.

Properties of Semiconductors: Intrinsic, Extrinsic Semiconductors, Current Flow in Semiconductors, Diodes: p-n junction theory, Current-Voltage characteristics, Analysis of Diode circuits, Rectifiers, Clippers, Clampers, Special diodes- LED, Photo diode, Zener Diode.

**UNIT-II (14 Hours)**

Bipolar junction Transistor (BJTs): Device Structure and Operation, Current-Voltage Characteristics, BJT as an Amplifier and as a Switch, Introduction to Power Amplifiers, A,B and C types.

JFET: Physical Structure, Operation and Characteristics MOSFET: Physical Structure, Operation and Characteristics, Feedback Amplifiers & Oscillators: General Feedback Structure, Properties of Negative Feedback, Four Basic Feedback Topologies (block diagram only), Basic Principles of Sinusoidal Oscillators( Crystal, Hartley & Collpit).

Operational Amplifiers (OP-AMPs): The Ideal OP-AMP, Inverting Configuration, Non-Inverting Configuration. OP-AMP Applications (Adder, Subtractor, Integrator, Differentiator).

**UNIT-III (10 Hours)**

Digital Fundamentals: Binary Numbers, Signed-binary numbers, Decimal-to-Binary & Binary-to-Decimal Conversion, Binary Addition, Subtraction, Multiplication and Division, Hexadecimal Number Systems, Logic Gates, Boolean Algebra, De Morgan's Theorems, Laws of Boolean Algebra, RS Flip flop, JK Flip flop.

**UNIT-IV (10 Hours)**

Introduction to Electronic Instruments: CRO: CRT, Waveform Display, Applications of CRO, Electronic Multimeter, Audio Signal Generator: Block diagram, Front Panel Controls.

Principles of Communication: Fundamentals of AM & FM, Block diagram of Transmitters & Receivers.

**TEXT BOOKS:**

1. Microelectronics Circuits, A.S Sedra, K.C. Smith, Oxford University Press. Selected portions from chapters 1 to 3, 5, 8, 13.
2. Electronics Fundamentals and Applications, D Chattopadhyay and P.C. Rakshit, NewAge International Publications. Selected portions from chapters 4 to 12,14, 16 to 18,20,21.

**REFERENCE BOOKS:**

1. Integrated Electronics, Millman and Halkias, TMH Publications.
2. Electronic Devices & Circuit Theory, R.L Boylestad and L. Nashelsky, Pearson Education.

**BASIC ELECTRONICS LAB**

**LIST OF EXPERIMENTS**

1. Familiarity with electronic components and devices( Testing of semiconductor diode, Transistor, IC Pins connection) Digital multimeter should be used.
2. Study and use of CRO to view waveforms and measure its Amplitude and Frequency.
3. V-I Characteristics of a Semiconductor Diode. Determining DC and AC resistance.
4. Clipper and Clamper Circuit.
5. Half Wave and Full Wave Rectifier without Capacitor filter. Record of Waveforms, Measurement of Average and RMS value.
6. V-I (Output) Characteristics of N-P-N Transistor in CE Configuration.
7. OP-AMP: Inverting and Non-Inverting Configuration. Record of Waveforms.
8. Verification of Truth table of Logic gates (AND, OR,NOT, NAND, NOR, EX-OR)

**CE 15001: ENVIRONMENTAL SCIENCE & ENGINEERING (3-1-0) CR-04**

**Module – I**

**(6 Hours)**



Components of Earth System: Lithosphere, Cryosphere, Atmosphere, Hydrosphere, Biosphere and Outer space.

Ecological concepts and natural Resources: Ecological perspective and value of environment, Environmental auditing, Biotic components, Levels of organizations in environment Ecosystem Process: Energy, Food chain, Environmental gradients, Tolerance levels of environmental factor.

Natural Resources covering Renewable and Non-renewable Resources, Forests, water, minerals, Food and land (with example of one case study); Energy, Growing energy needs, energy sources (conventional and alternative).

Hydrological cycle, water balance, energy budget, precipitation, infiltration, evaporation and evapotranspiration.

### **Module – II**

**(15 Hours)**

Environmental Pollution: Definition, Causes, effects and control measures of: Water pollution, Air pollution, Noise pollution, Soil pollution, Marine pollution, Thermal pollution, Nuclear hazards

Environmental Issues: Climate change, Global warming, Acid rain, Ozone layer depletion, Sustainable development, Bio gas, Natural gas, Biodiversity, Urban problems related to energy, water scarcity, Water conservation, rain water harvesting, artificial recharge, watershed management, carbon trading, carbon foot print

National Ambient Air quality Standards, Noise standards, Vehicle emission standards

### **Module – III**

**(12 Hours)**

Drinking water standard (IS 10500), Water Quality Criteria and wastewater effluent standards

Water treatment: Water sources and their quality, Lay out of a water treatment plant and working of each unit/ principles of each process i.e. Screening, Aeration, Sedimentation, coagulation, flocculation, Filtration, Disinfection. Miscellaneous treatment: Removal of color, tastes and odour control, removal of iron and manganese, fluoridation and defloridation. Advanced water treatment: Ion exchange, electro-dialysis, RO, desalination

Working principles of ready-made water filter/purification system commercially available

Lay out of a wastewater treatment plant and working of each unit.

### **Module – IV**

**(7 Hours)**

Solid waste management: Source, classification and composition of MSW, Storage and transport of MSW, MSW management, Waste minimization of MSW, Reuse and recycling, Biological & thermal treatment (principles only), land fill

Biomedical Waste management – sources, treatment (principles only) and disposal

Hazardous Waste Management- Introduction, Sources, Classification, treatment (principles only)

Introduction to e-waste management.

Environmental impact Assessment: Project screening for EIA, Scoping studies

Environmental policies and acts (Air, Noise, Water, Forest, E-waste, Hazardous waste acts).

### **Text Book:**

1 Environmental Engineering, G. Kiely, TMH, 2007

### **Reference Books:**

1 Environmental Engineering, H.S. Peavy, D.R. Rowe and G. Tchobanoglous, McGraw Hill, 1985.

2 Introduction to Environmental Engineering, M. L. Davis and D. A. Cornwell, McGraw Hill International, 2005.

## **CE 15002: ENGINEERING DRAWING (0-0-3) CR-02**

*(Minimum 8 sheets and 2 Auto Cad classes)*

Introduction to Engineering Drawing: Drawing instruments, lines, lettering and dimensioning.

Scales: Plain, Diagonal and Vernier Scales.

Curves: Parabola, Ellipse, Hyperbola, Cycloid, Epicycloid, Hypocycloid and Involute.

Orthographic Projections: Concepts, Orthographic projections of points, Lines, Planes and Solids.

Sections of solids; Development of surfaces

Isometric Projections: Principles, Isometric Scale, Isometric Views, Isometric Views of lines, Planes, Simple and compound Solids,

**Introduction to Auto-Cad:**

Curves: Parabola, Ellipse, Hyperbola, Cycloid, Epicycloid, Hypocycloid and Involute.

**Text Book:**

1 Engineering drawing by N.D. Bhatt and V.M Panchal, Charotar Publishing House, Anand.

**Reference Books:**

1. Engineering Drawing by Venugopal, New Age publisher.

**THIRD SEMESTER**

**MATHEMATICS - III**

## **(Multivariable Calculus and Special Functions) (3-1-0)**

### **Module 1: (10 Lectures)**

Vector and Scalar Functions and Fields, Derivatives, Gradient of a Scalar Field, Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field; Line Integrals, Path Independence of Line Integrals, Double Integrals, Green's Theorem in the Plane, Surfaces for Surface Integrals, Surface Integrals, Triple Integrals, Divergence Theorem of Gauss, Further Applications of the Divergence Theorem, Stokes's Theorem.

### **Module 2: (10 Lectures)**

Fourier series and integral, Dirichlet criterion, Parseval's identity, the convolution theorem.

### **Module 3: (10 Lectures)**

Orthogonal curvilinear coordinates, Jacobians, gradient, divergence, curl and Laplacian in curvilinear coordinates, Special curvilinear coordinates.

### **Module 4: (10 Lectures)**

Gamma function, The Beta function – Dirichlet integral; Other special functions– Error function, exponential integral, sine and cosine integrals, Bessel's Equation, Bessel Functions  $J_n(x)$ , Bessel Functions of the Second Kind  $Y_n(x)$ , Legendre's Equation, Legendre Polynomials  $P_n(x)$ .

### **Text Books:**

- 1) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd. - 9<sup>th</sup> Edition  
Chapters: 5(5.3, 5.5, 5.6), 9(9.4, 9.7, 9.8, 9.9), 10, 11(11.1-11.3, 11.6, 11.7), A3.4, A3.1

### **Reference Books:**

- 1) S.C. Mallik and S. Arora, Mathematical Analysis, New Age International
- 2) [Milton Abramowitz](#) and [Irene A. Stegun](#), *Handbook of Mathematical Functions*, National Bureau of Standards, Applied Mathematics Series - 55
- 3) [Yury A. Brychkov](#), **Handbook of Special Functions: Derivatives, Integrals, Series and Other Formulas**, CRC Press
- 4) R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Taylor & Francis
- 5) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press

## **CHEMICAL PROCESS TECHNOLOGY**

### **Module-I**

Introduction to Chemical Process Technology with reference to Indian resources, industries, small scale industries and rural development.  
Preparation of process flow diagrams, Instrumentation diagrams and Process symbols.

Introduction to the following industries emphasising on process flow sheet, material requirements, process conditions, construction and design aspects.

### **Module-II**

Chlor-Alkali Industries: Manufacture of Soda ash, Caustic soda and Chlorine.  
Manufacture of Sulphuric acid, Hydrochloric acid and Nitric acid.

### **Module-III**

Electro Thermal Industries: Manufacture of Silicon and Calcium carbide.  
Extraction and refining of edible oil, Fat splitting and hydrogenation of oil.

Soaps and detergents, Recovery of glycerin, Paper & Pulp industries.

#### **Module-IV**

Fermentation Industries: Manufacture of Industrial and absolute alcohol.

Manufacture of sugar and allied products

Coal based chemical Industries

Text Books:

1. C. E. Dryden, *Dryden's outlines of Chemical Technology for the 21<sup>st</sup> century*, (Edited & revised by M. G. Rao and M Sitting) 2006
2. G. T. Austin, *Shreve's Chemical Process Industries*, 5<sup>th</sup> edition, McGraw Hill Book Co., New York, 1984

Reference Books:

1. S. D. Shukla & G. N. Pandey, *A Text Book of Chemical Technology, Vol. II*, Sangam Books, 2000.
2. W. V. Mark edited by S. C. Bhatia, *Chemical Process Industries Vol. I & Vol. II* 2<sup>nd</sup> edition, CBS Publisher and Distributor, 2007.
3. R. E. Kirk and D. F. Othmer, *Encyclopedia of Chemical Technology*, 4<sup>th</sup> edition, Interscience, New York, 1991

### **FLUID DYNAMICS**

#### **Module-I**

Fluid mechanics: Nature of fluid, Pressure concept & various pressure measuring devices. Fluid dynamics: Fluid flow phenomena, Nature and classification of flow, Dynamic properties of fluid

#### **Module-II**

Fluid dynamics: Boundary layer formation in straight tube, Universal velocity profile, Hagen and Poiseuille equation, Measurement of viscosity, Dimensional analysis applied to fluid flow problems, Buckingham's theorem, Physical significance of Reynold's number.

#### **Module-III**

Transportation of fluids: Bernoulli's equation for friction less flow and correction for frictional flow; Pumps: Types, Selection, Applications, Performance characteristics of centrifugal and reciprocating pumps; Flow past immersed bodies: Flow through packed beds, Kozney Carman equation, Filtration and Centrifugation, Motion of particles through fluids, Terminal settling velocity, Hydraulic and Pneumatic classification.

#### **Module-IV**

Fluidization: Types of fluidization, Prediction of minimum fluidization velocity and bed pressure drop, bubbling, slugging and distributors; Introduction to Non-Newtonian fluids

Text Books:

1. W.L.McCabe, J.C.Smith, P.Harriot, *Unit Operations of Chemical Engineering, McGraw-Hill Publication.*

Reference Books:

1. G.K.Batchelor, *Introduction to Fluid Dynamics*, Oxford Univ Press, 2000

### **FLUID DYNAMICS LAB-I**

1. To find the cake and filter medium resistance of Plate and Frame Filter press
2. To find the filter medium resistance of a Vacuum Leaf Filters
3. To find the flow rate using a V notch
4. To find the friction losses in a Straight pipe
5. To find the friction losses in a Bend pipe
6. Study of Pipe fittings and Valves;
7. To study the principle of a hydro-cyclone and find out the efficiency of separation

### **PROCESS TECHNOLOGY LABORATORY**

- 1.To prepare soap and determination of the alkali content of soap.
- 2.To determine the saponification value and bromine value of the oil.
- 3.To determine the fat content of food stuff.
- 4.To find the total organic carbon of the water sample.
- 5.To find out the distribution coefficient of iodine in organic solvent and water.
- 6.To determine the iron content of a given salt solution.
7. To determine the limecontent of the portland cement.
8. To determine the dye concentrate using spectrophotometer.

## **HUM01 ENGINEERING ECONOMICS (4-0-0)**

### **MODULE- 1**

Theory of Demand- Modern Utility Theory, The Neumann- Morgenstern approach, The Friedman-Savage Hypothesis, Uncertainty and Consumer Behaviour, Expected value of Perfect Information, Revealed Preference Theory, Intertemporal Choice- Slutsky equation, Annual Economic Worth, Present Value, Discount rate IRR and NPV

### **MODULE- 2**

Profit Maximisation: Theory of Production- Laws of Production, Returns to scale and variable proportions, Equilibrium of firm, and Choice of optimal combination of factors, Cost Minimisation- Calculus analysis of cost minimisation, Algebraic approach to cost minimisation, average and marginal costs- the short run Cobb- Douglas cost function, constant returns to scale and cost functions, Long run and short run curves- factor prices and cost functions , The envelop theorem for constrained optimisation , Cost control techniques, Critique of the principle of profit maximisation and Modern theories of firms- Baumol's sales maximisation hypothesis, Morris Model of Managerial Enterprise, Hall and Hitch Report and the full cost pricing principle, Bain's limit pricing theory

### **MODULE- 3**

Analysis of Public Projects: Benefit cost analysis, Public goods, Common Property, Free Rider Problem, market failure and externalities, private and social cost, Social Welfare Functions- Welfare

maximisation and pare to optimality, market responses to externalities- Mergers, social conventions, property right and bargaining case theorem

#### MODULE- 4

Linear models: simple regression model -the problem and estimation, classical normal linear regression model, Two- Variable regression- Internal estimation and hypothesis testing, Multiple Regression analysis- The problem of estimation, Dummy Variable Regression Models, Multiple parameter sensitivity analysis, linear Programming- graphic and simplex method; Game theory- the pay off matrix of game, Nash Equilibrium, the mixed strategies and the prisoner's dilemma

#### READING LIST

1. Varian, H.R. (1992). Introduction to Micro Economic Analysis, Norton and company, New York
2. Woolridge, J.M. (2009). Introductory Econometrics- A Modern Approach, South Western CENGAGE learning
3. Pearce, D.W. and Turner.(1990). Economics of Environment and Natural Resources, Harvester Wheatsheaf. New York
4. Koutsoyiannis, A.(1979). Modern Micro Economics, Macmillan, London
5. Damodaran, S. (2012). Managerial Economics, second Edition, OUP
6. Gujrati and Sangeeta. (2007). Basic Econometrics, TMH, New Delhi
7. Kolstad, C.D. (2000). Environmental Economics, OUP

## **FOURTH SEMESTER**

### **MATHEMATICS - IV**

## **Complex Analysis, and Probability and Statistics) (3-1-0)**

### ***Module 1: (10 Lectures)***

Complex Numbers, Complex Plane, Polar Form of Complex Numbers, Powers and Roots Derivative, Analytic Function, Cauchy-Riemann Equations, Laplace's Equation, Exponential Function, Trigonometric and Hyperbolic Functions, Logarithm, General Power; Line Integral in the Complex Plane, Cauchy's Integral Theorem, Cauchy's Integral Formula, Derivatives of Analytic Functions

### ***Module 2: (10 Lectures)***

Sequences, Series, Convergence Tests, Power Series, Functions Given by Power Series, Taylor and Maclaurin Series, Laurent Series, Singularities and Zeros, Infinity, Residue Integration Method, Residue Integration of Real Integrals; Geometry of Analytic Functions: Conformal Mapping, Linear Fractional Transformations, Special Linear Fractional Transformations, Conformal Mapping by Other Functions.

### ***Module 3: (10 Lectures)***

Random Variables, Probability Distributions, Mean and Variance of a Distribution, Binomial. Poisson, and Hypergeometric Distributions, Normal Distribution

### ***Module 4: (10 Lectures)***

Introduction. Random Sampling, Point Estimation of Parameters, Confidence Intervals, Testing Hypotheses, Decisions, Regression, Fitting Straight Lines, Correlation.

### **Text Book:**

1) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd  
Chapters: 13, 14, 15(except 15.5), 16, 17(except 17.5), 24(24.5-24.8), 25(25.1-25.4, 25.9)

### **Reference Books:**

- 1) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill
- 2) R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Taylor & Francis
- 3) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press

## **PROCESS & HANDLING OF MATERIALS**

### **Module-I**

Characteristics of a single particle: Size, shape, surface area, volume, Properties of solids.  
Particle Size Distribution: Specific surface of mixture, average particle size, Number of particles

### **Module-II**

Screen analysis: Effectiveness of screen, Industrial screening equipments,  
Size reduction: Factors affecting comminution, Laws of comminution, Industrial equipments  
Particle Dynamics: Single Particle: Settling velocity, Effect of shape, Wall effect, Mixture of Particles, hindered settling

### **Module-III**

Separation of particles: Solid-solid separation: Classification, Jigging, Magnetic and Electrostatic separations, Liquid-solid separation: Sedimentation, Filtration, Hydro-Cyclones, Gas-solid separation: Flotation  
Mixing and Agitation: Phenomena of mixing and agitation, Circulation, velocities and power consumption in agitated vessels, Solid-liquid mixing, solid-solid mixing

### **Module-IV**

Particle transport and storage: Storage of solids: Hopper, Bins & Silos, Mechanical conveyers,

Gas-solid: Pneumatic transport in horizontal and vertical pipelines,

Liquid-solid: Hydraulic transport Beneficiation circuits of Minerals: Chalcopyrites, Sphalerites, Galena and Bauxite

Text Books:

1. C. M. Narayanan & B. C. Bhattacharyya, *Mechanical Operation for Chemical Engineers*, Khanna Publisher, Third Edition, 2005.
2. W I McCabe & J C Smith, P. Harriot, *Unit Operations of Chemical Engineering*, McGraw-Hill publication, 2005

Reference Books:

1. M. C. Fuerstenau and K. N. Han, *Principles of Mineral Processing*, John Wiley, N. Y, 2003
2. J. F. Richardson, J. H. Harker & J. Backhurst, *Chemical Engineering Volume II*, Butterworth-Heinemann, 1<sup>st</sup> Edn, 2002.

## CHEMICAL PROCESS CALCULATIONS

### Module-I

Chemical reactions: Excess reactant, Degree of completion, Composition of mixtures and solutions

Material balance: Calculations for (a) unit operations like mixing, evaporation, crystallization and distillation, (b) Chemical reactions and (c) Recycling

### Module-II

Behaviour of ideal gases: Various equations of state, Law of Dalton and Amagat, Densities of gaseous mixture, Vapour pressures: Liquefaction, Vaporisation, Boiling point, Vapour pressures of solids and liquids, Roults law, Polar and non-polar compounds.

### Module-III

Energy balance: Heat capacity of gases, liquids, solids and solutions, Kopp's rule, Heats of fusion and vaporisation, Trouton's rule and Kistia Kowaky equation, calculation of heat of reaction, combustion, formation and neutralisation, enthalpy concentration charts, Flame temperatures;

### Module-IV

Simple material and energy balance calculations for the following manufacturing processes – (a) Sulphuric acid, (b) Nitric acid, (c) Phosphoric acid, (d) Lime and Alkali.

Numerical techniques for solving material and energy balance equations.

Text Books:

- 1.O.A.Hougen et. al. *Chemical Process Principles* (Vol I)
- 2.R.M.felder & R.W. Rousseau, *Elementary Principle of Chemical Processes*, John Wiley,2004
- 3 K.V.Narayanan & B.Lakshikutty, *Stoichiometry and process Calculations*,PHI pub. Pvt ltd.,2013

Reference Books:

- 1.R.K.Dave,chemical *Reactions and stoichiometry*, Campus Books international,2000
- 2.M.Sylvin, *Problems in Stoichiometry*,Sarup & Sons,2003

## FUEL AND COMBUSTION

### Module-I

Solid fuels: Coal origin, Chemical composition, Calorific value, Classifications,



Characteristics and Distribution of Indian coals, Storage and spontaneous combustion of coal, Coal washing and blending, Petrographic constituents of coal, Carbonization of coal, Manufacture and properties of metallurgical coke, Recovery of byproducts

### **Module-II**

Liquid fuels: Origin and composition of crude oil, Crude oil distillation and its products with special reference to gasoline, kerosene and diesel oil, Cracking and reforming, Shale oil

### **Module-III**

Gaseous fuels: Natural gas, Coal gas, Coke oven and blast furnace gas, Manufacture of water gas and producer gas, Carbureted water gas

Synthetic fuels: Hydrogenation of coal, Fischer-Tropsch synthesis

### **Module-IV**

Combustion: Combustion of solid, liquid and gaseous fuels, combustion stoichiometry and thermodynamics, Calculation of volumes and weights of air required for combustion, the gas analysis

Text Books:

- 1 S. Sarkar, *Fuels and Combustion*, Univ press, 3<sup>rd</sup> Edn.
- 2.S.N.Saha, *Fuel Combustion Energy Technology*, Dhanpat Rai pub. Co.

Reference Books:

- 1.Himus, *Elements of Fuel Technology*

### **MATERIAL HANDLING LAB**

1. Determination of average particle size of a mixture of particles by sieve analysis
2. To Study and operation of Jaw crusher and thereby verification of Rittinger's constant and to determine the reduction ratio, maximum feed size and theoretical capacity of crushing rolls
3. To determine the effect of number of balls on grinding of a Ball mill and comparison of its critical speed with operating speed.
4. To find out the enrichment of the coal sample by froth floatation cell
5. To find out the effectiveness of a vibrating screen.
6. To study the operation of a Hammer mill and a pulveriser and finding their reduction ratio
7. To study the operation of a cyclone separator and a magnetic separator and finding their efficiencies.

### **FLUID DYNAMICS LAB-II**

1. To study the Reynold's apparatus and verify experimentally
2. To study the working principle of a reciprocating pump and to determine the percentage of slip
3. To study the working principle of a centrifugal pump and determine its efficiency
4. To determine the cake resistance of a batch basket centrifuge
5. To find out the flow profile of water from hook's gauge
6. To determine the coefficient of velocity, coefficient of discharge, coefficient of resistance, coefficient of contraction.

### **FUEL TECHNOLOGY LAB-I**

1. To determine the composition of the supplied sample of Coal by Proximate Analysis
2. To determination of Caking Index of the supplied sample of Coal
3. To determine the washability characteristics of the supplied sample of Coal.
4. To determine the ultimate analysis of the supplied sample of coal
5. To determine the Swelling Index of the supplied sample of coal.
6. To ascertain the agglomerating characteristics of the coal sample
7. To determine the Gross calorific value of the supplied sample of coal using Bomb Calorimeter.

## **FUEL TECHNOLOGY LAB-II**

1. To find the effect of temperature on viscosity of the supplied samples of liquid fuel using Red wood viscometer and Engler's viscometer
2. To find the Flash and Fire point of the supplied samples of liquid fuel using Penslery Martein closed cup apparatus and Abel open cup apparatus.
3. To find the Aniline point of the supplied samples of liquid fuels.
4. To find the Carbon Residue of the supplied sample of lubricating oil / oil mixture using Conradson apparatus.
5. To find the moisture content of the supplied samples of liquid fuel / Crude oil.
6. To find the Pour point and Solidification point of the supplied samples of liquid fuels
7. To determine the Smoke Point of kerosene oil using Smoke Point Apparatus.
8. To find the Calorific value of LPG using calorimeter.

## **HUM01 ENGINEERING ECONOMICS (4-0-0)**

### **MODULE- 1**

Theory of Demand- Modern Utility Theory, The Neumann- Morgenstern approach, The Friedman-Savage Hypothesis, Uncertainty and Consumer Behaviour, Expected value of Perfect Information, Revealed Preference Theory, Intertemporal Choice- Slutsky equation, Annual Economic Worth, Present Value, Discount rate IRR and NPV

### **MODULE- 2**

Profit Maximisation: Theory of Production- Laws of Production, Returns to scale and variable proportions, Equilibrium of firm, and Choice of optimal combination of factors, Cost Minimisation- Calculus analysis of cost minimisation, Algebraic approach to cost minimisation, average and marginal costs- the short run Cobb- Douglas cost function, constant returns to scale and cost functions, Long run and short run curves- factor prices and cost functions , The envelop theorem for constrained optimisation , Cost control techniques, Critique of the principle of profit maximisation and Modern theories of firms- Baumol's sales maximisation hypothesis, Morris Model of Managerial Enterprise, Hall and Hitch Report and the full cost pricing principle, Bain's limit pricing theory

### **MODULE- 3**

Analysis of Public Projects: Benefit cost analysis, Public goods, Common Property, Free Rider Problem, market failure and externalities, private and social cost, Social Welfare Functions- Welfare maximisation and pare to optimality, market responses to externalities- Mergers, social conventions, property right and bargaining case theorem

## MODULE- 4

Linear models: simple regression model -the problem and estimation, classical normal linear regression model, Two- Variable regression- Internal estimation and hypothesis testing, Multiple Regression analysis- The problem of estimation, Dummy Variable Regression Models, Multiple parameter sensitivity analysis, linear Programming- graphic and simplex method; Game theory- the pay off matrix of game, Nash Equilibrium, the mixed strategies and the prisoner's dilemma

### READING LIST

8. Varian, H.R. (1992). Introduction to Micro Economic Analysis, Norton and company, New York
9. Woolridge, J.M. (2009). Introductory Econometrics- A Modern Approach, South Western CENGAGE learning
10. Pearce, D.W. and Turner.(1990). Economics of Environment and Natural Resources, Harvester Wheatsheaf. New York
11. Koutsoyiannis, A.(1979). Modern Micro Economics, Macmillan, London
12. Damodaran, S. (2012). Managerial Economics, second Edition, OUP
13. Gujrati and Sangeeta. (2007). Basic Econometrics, TMH, New Delhi
14. Kolstad, C.D. (2000). Environmental Economics, OUP

## **BHU-1301 Organisational Behaviour (3-1-0)**

### **Module-1(8 hours)**

OB: Learning objectives, Definition & Meaning, Why to study OB, An OB model, New challenges for OB Manager

LEARNING: Nature of learning, How learning occurs, Learning & OB

Case Study Analysis

### **Module-2 (10 hours)**

PERSONALITY: Meaning & Definition, Determinants of Personality, Personality Traits, Personality & OB

PERCEPTION: Meaning & Definition, Perceptual process, Importance of Perception in OB

MOTIVATION: Nature & Importance, Herzberg's Two Factor theory, Maslow's Need Hierarchy theory, Alderfer's ERG theory

Case Study Analysis

### **Module-3 (10 hours)**

COMMUNICATION: Importance, Types, Barriers to communication, Communication as a tool for improving Interpersonal Effectiveness

GROUPS IN ORGANISATION: Nature, Types, Why do people join groups, Group Cohesiveness & Group Decision Making- managerial Implications, Effective Team Building

LEADERSHIP: Leadership & management, Theories of leadership- Trait theory, Behavioural Theory, Contingency Theory, Leadership & Followership, How to be an Effective Leader

CONFLICT: Nature of Conflict & Conflict Resolution

TRANSACTIONAL ANALYSIS: An Introduction to Transactional Analysis

Case Study Analysis

### **Module-4 (12 hours)**

ORGANISATIONAL CULTURE: Meaning & Definition, Culture & Organisational Effectiveness

HUMAN RESOURCE MANAGEMENT: Introduction to HRM, Selection, Orientation, Training & Development, Performance Appraisal, Incentives

ORGANISATIONAL CHANGE: Importance of Change, Planned Change & OB Techniques

INTERNATIONAL OB: An Introduction to Individual & Interpersonal Behaviour in Global Perspectives

## Case Study Analysis

### **Text Books/References:**

- [1] Stephen P. Robbins, Organisational Behaviour, Printice hall of India, New Delhi,2000.
- [2] K. Aswathappa, Organisational Behaviour, Himalaya Publishing House, Bombay, 1997.
- [3] S. S. Khanka, "Organisational Behaviour", S. Chand Publication, Revised edition 2009.

### **Course Objectives:**

1. To predict, understand and control the human behaviour in an organisation
2. To develop interpersonal relation in organisation
3. To maintain cordial industrial relation
4. To manage human resources efficiently in an organisation

### **Course Outcomes:**

1. Students will be able to maintain the interpersonal and industrial relation when they will join into one organization.
2. Able to develop effective leadership quality.
3. Able to apply appropriate motivational techniques in accordance to the nature of the individual employee.
4. Able to manage human resources efficiently in an organisation.