B.Tech. (Chemical Engineering)
Scheme & Syllabi

Effective from 2022-23 Admitted Batch

ANDHRA UNIVERSITY
DEPARTMENT OF CHEMICAL ENGINEERING

SCHEME AND SYLLABI
(with effect from 2022-23)

B.Tech. (Chemical Engineering)
I Year - I Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
CH-1101	BS	Maths – I	4	0	30	70	100	3
CH-1102	BS	Physics	4	0	30	70	100	3
CH-1103	ES	Organic Chemistry	4	0	30	70	100	3
CH-1104	ES	Mechanical Engineering	4	0	30	70	100	3
CH-1105	ES	Basic Electrical Engineering	4	0	30	70	100	3
CH-1106	ES	Organic Chemistry Lab.	0	3	50	50	100	1.5
CH-1107	BS	Physics Lab	0	3	50	50	100	1.5
CH-1108	ES	General Engineering Lab. (Mechanical Engineering& Electrical Engineering)	0	3	50	50	100	1.5
							Total Credits	**19.5**

B.Tech. (Chemical Engineering)
I Year - II Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
CH-1201	BS	Maths – II	4	0	30	70	100	3
CH-1202	BS	Green Chemistry	4	0	30	70	100	3
CH-1203	HSS	English	4	0	30	70	100	3
CH-1204	ES	CPNM	4	0	30	70	100	3
CH-1205	ES	Industry 4.0	4	0	30	70	100	3
CH-1206	HSS	English Language Lab	0	3	50	50	100	1.5
CH-1207	BS	Green Chemistry Lab	0	3	50	50	100	1.5
CH-1208	ES	CPNM Lab	0	3	50	50	100	1.5
							Total Credits	**19.5**

B.Tech. (Chemical Engineering)
II Year - I Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
CH-2101	BS	Maths-III	4	0	30	70	100	3
CH-2102	PC	Fluid Mechanics	4	0	30	70	100	3
CH-2103	PC	Particle and Fluid Particle Processing	4	0	30	70	100	3
CH-2104	PC	Heat Transfer	4	0	30	70	100	3
CH-2105	HSS	Managerial Economics	4	0	30	70	100	3
CH-2106	PC	Fluid Mechanics LAB	0	3	50	50	100	1.5
CH-2107	PC	Particle and Fluid Particle Processing LAB	0	3	50	50	100	1.5
CH-2108	PC	Heat Transfer LAB	0	3	50	50	100	1.5
CH-2109	SC	*MATLAB (software training)*	1	2	50	50	100	2
CH-2110	MC	Professional Ethics& Universal Human values	0	0	-	100	100	0
CH-2111	MC	NCC/NSS	0	2	-	-	-	0
							Total credits	**21.5**

B.Tech. (Chemical Engineering)
II Year - II Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
CH-2201	ES	Material Science & Engineering	4	0	30	70	100	3
CH-2202	BS	Python Programming	4	0	30	70	100	3
CH-2203	PC	Material and Energy Balances	4	0	30	70	100	3
CH-2204	PC	Chemical Engineering Thermodynamics	4	0	30	70	100	3
CH-2205	PC	General Chemical Technology	4	0	30	70	100	3
CH-2206	PC	Python Programming LAB	0	3	50	50	100	1.5
CH-2207	PC	General Chemical Technology LAB	0	3	50	50	100	1.5
CH-2208	SC	Computer Aided Machine Drawing	1	2	50	50	100	2
CH-2209	MC	Environmental Science	0	0	-	100	100	0
							Total credits	**20**
Internship – I								

B.Tech. (Chemical Engineering)
III Year - I Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
CH-3101	PC	Process Instrumentation and Control	4	0	30	70	100	3
CH-3102	PC	Mass Transfer-I	4	0	30	70	100	3
CH-3103	PC	Chemical Reaction Engineering - I	4	0	30	70	100	3
CH-3104	PE	Professional Elective-I	4	0	30	70	100	3
CH-3105	OE	Open Elective-I	4	0	30	70	100	3
CH-3106	PC	Mass Transfer-I Lab	0	3	50	50	100	1.5
CH-3107	PC	Process Instrumentation and Control Lab	0	3	50	50	100	1.5
CH-3108	SC	Analytical Techniques	1	2	50	50	100	2
CH-3109	INT	Internship – I			50	50	100	2
							Total Credits	**22**

B.Tech. (Chemical Engineering)
III Year - II Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
CH-3201	PC	Mass Transfer-II	4	0	30	70	100	3
CH-3202	PC	Chemical Reaction Engineering-II	4	0	30	70	100	3
CH-3203	PC	Financial Management for Engineer	4	0	30	70	100	3
CH-3204	PE	Professional Elective-II	4	0	30	70	100	3
CH-3205	OE	Open Elective-II	4	0	30	70	100	3
CH-3206	PC	Mass Transfer-II Lab	0	3	50	50	100	1.5
CH-3207	PC	Chemical Reaction Engineering Lab	0	3	50	50	100	1.5
CH-3208	PC	Chemical Process Equipment Design Lab	0	3	50	50	100	1.5
CH-3209	SC	Soft Skills	1	2	50	50	100	2
							Total Credits	**21.5**
Internship – II								

B.Tech. (Chemical Engineering)
IV Year - I Semester

Course code	Category	Course Title	Hours per week		Internal Marks	External Marks	Total Marks	Credits
			L	P				
CH-4101	PE	Professional Elective-III	4	0	30	70	100	3
CH-4102	PE	Professional Elective-IV	4	0	30	70	100	3
CH-4103	PE	Professional Elective-V	4	0	30	70	100	3
CH-4104	OE	Open Elective-III	4	0	30	70	100	3
CH-4105	OE	Open Elective-IV	4	0	30	70	100	3
CH-4106	HSSE	HSS Elective	4	0	30	70	100	3
CH-4107	SC	ASPEN Lab	1	2	50	50	100	2
CH-4108	INT	Internship -II			50	50	100	2
							Total Credits	22

B.Tech. (Chemical Engineering)
IV Year - II Semester

Course code	Category	Course Title	Internal Marks	External Marks	Total Marks	Credits
CH-4201	PROJ	Project work	100	100	200	14
					Total Credits	**14**

PROFESSIONAL ELECTIVES

1. Transport Phenomena
2. Fuel Cell Technology
3. Petrochemicals
4. Chemical Process Equipment Design
5. Process Modeling and Simulation
6. Petroleum Refinery Engineering
7. Multi Component Separation Processes
8. Chemical Engineering Mathematics
9. Fertilizer Technology
10. Computer Aided Design
11. Process Engineering Economics
12. Process Optimization
13. Reservoir Engineering
14. Paper Technology
15. Computer Applications in Chemical Engineering

OPEN ELECTIVES

1. Corrosion Engineering
2. Artificial Intelligence & Machine Learning
3. Data Science with Applications
4. Nano Science & Technology
5. Industrial Safety and Management
6. Fuels, Refractories and Furnaces
7. Biochemical Engineering
8. Industrial Pollution Control Engineering
9. Internet of Things
10. Design of Experiments
11. Renewable Energy Sources
12. Energy Technologies

HSS Elective

1. Industrial Management & Entrepreneurship
2. Organizational Behavior
3. Operations Research

CH-1101 MATHEMATICS-I

Course Objectives:

- To transmit the knowledge of Partial differentiation.
- To know of getting maxima and minima of function of two variables and finding errors and approximations.
- To evaluate double and triple integrals, volumes of solids and area of curved surfaces.
- To expand a periodical function as Fourier series and half-range Fourier series.

Course Outcomes:

- Find the partial derivatives of functions of two or more variables.
- Evaluate maxima and minima, errors and approximations.
- Evaluate double and triple integrals, volumes of solids and area of curved surfaces.
- To expand a periodical function as Fourier series and half-range Fourier series.
- Have a fundamental understanding of Fourier series and be able to give Fourier expansions of a given function.

SYLLABUS

Partial Differentiation: Introduction - Functions of two or more variables - Partial derivatives - Homogeneous functions – Euler's theorem - Total derivative - Change of variables – Jacobins. Mean value Theorems (without proofs).

Applications of Partial Differentiation: Geometrical interpretation -Tangent plane and Normal to a surface -Taylor's theorem for functions of two variables - Errors and approximations -Total differential. Maxima and Minima of functions of two variables - Lagrange's method of undetermined multipliers - Differentiation under the integral Sign - Leibnitz's rule.

Multiple Integrals : Introduction - Double Integrals - Change of Order of Integration - Double Integrals in Polar Coordinates - Triple Integrals - Change of Variables.

Multiple Integrals-Applications: Area enclosed by plane curves - Volumes of solids - Area of a curved surface - Calculation of Mass - Center of gravity - Moment of inertia - product of inertia – principal axes- Beta Function - Gamma Function - Relation between Beta and Gamma Functions. Error Function or Probability Integral.

Fourier Series: Introduction - Euler's Formulae - Conditions for a Fourier Expansion - Functions having points of discontinuity - Change of Interval - Odd and Even Functions - Expansions of Odd or Even Periodic Functions, Half-Range Series - Parseval's Formula. Practical Harmonic analysis.

Text Book:

Scope and Treatment as in "Higher Engineering Mathematics", by Dr. B.S. Grewal, 43rd Edition, Khanna publishers.

Reference Books:

1. Graduate Engineering Mathematics by V B Kumar Vatti., I.K.International publishing house Pvt. Ltd.
2. Advanced Engineering Mathematics by Erwin Kreyszig.
3. A text book of Engineering Mathematics, by N.P. Bali and Dr. Manish Goyal, Lakshmi Publications.
4. Advanced Engineering Mathematics by H.K. Dass. S. Chand Company.
5. Higher Engineering Mathematics by B.V. Ramana, Tata Mc Graw Hill Company.
6. Higher Engineering Mathematics by Dr. M.K.Venkataraman.

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CH-1102 PHYSICS

Course Objectives:

- To impart knowledge in basic concept of physics of Thermodynamics relevant to engineering applications.
- To grasp the concepts of physics for electromagnetism and its application to engineering. Learn production of Ultrasonics and their applications in engineering.
- To Develop understanding of interference, diffraction and polarization: connect it to a few engineering applications.
- To Learn basics of lasers and optical fibers and their use in some applications.
- To Understand concepts and principles in quantum mechanics and Nanopahse Materials. Relate them to some applications.

Course Outcomes:

- Understand the fundamentals of Thermodynamics and Laws of thermodynamics. Understand the working of Carnot cycle and concept of entropy.
- Gain Knowledge on the basic concepts of electric and magnetic fields. Understand the concept of the nature of magnetic materials. Gain knowledge on electromagnetic induction and its applications .
- Understand the Theory of Superposition of waves. Understand the formation of Newton's rings and the working of Michelson's interferometer. Remember the basics of diffraction, Evaluate the path difference. Analysis of Fraunhofer Diffraction due to a single slit
- Understand the interaction of matter with radiation, Characteristics of Lasers, Principle, working schemes of Laser and Principle of Optical Fiber. Realize their role in optical fiber communication.
- Understand the intuitive ideas of the Quantum physics and understand dual nature of matter. Compute Eigen values, Eigen functions, momentum of Atomic and subatomic particles using Time independent one Dimensional Schrodinger's wave equation. Understand the fundamentals and synthesis processes of Nanophase materials.

SYLLABUS

Thermodynamics

Introduction, Heat and Work, First law of thermodynamics and applications, Reversible and Irreversible process, Carnot cycle and Efficiency, Second law of thermodynamics, Carnot's Theorem, Entropy, Second law in terms of entropy, Entropy and disorder, Third law of thermodynamics (statement only).

Electromagnetism

Concept of electric flux, Gauss's law - some applications, Magnetic field - Magnetic force on current, torque on current loop, The Biot-Savart's Law, B near a long wire, B for a circular Current loop, Ampere's law, B for a solenoid, Hall effect, Faraday's law of induction, Lenz's law, Induced magnetic fields, Displacement current, Maxwell's equations (no derivation), Magnetic materials: Classification of magnetic materials and properties.

Ultrasonics : Introduction, Production of Ultrasonics – Piezoelectric and Magnetostriction methods, acoustic grating, applications of ultrasonics.

Optics

Interference: Principles of superposition – Young's Experiment – Coherence - Interference in thin films (reflected light), Newton's Rings, Michelson Interferometer and its applications.

Diffraction: Introduction, Differences between interference and diffraction, Fresnel and Fraunhofer diffraction, Fraunhofer diffraction at a single slit **(**Qualitative and quantitative treatment**)**.

Polarisation: Polarisation by reflection, refraction and double refraction in uniaxial crystals, Nicol prism, Quarter and Half wave plate, circular and elliptical polarization.

Lasers and Fibre Optics: Introduction, characteristics of a laser beam, spontaneous and stimulated emission of radiation, population inversion, Ruby laser, He-Ne laser, Semiconductor laser, applications of lasers

Introduction to optical fibers, principle of propagation of light in optical fibers, Acceptance Angle and cone of a fibre, Numerical aperture, Modes of propagations, classification of fibers, Fibre optics in communications, Application of optical fibers.

Modern Physics: Introduction, De Broglie concept of matter waves, Heisenberg uncertainty principle, Schrodinger time independent wave equation, application to a particle in a box. Free electron theory of metals, Kronig - Penney model (qualitative treatment), Origin of energy band formation in solids, Classification of materials into conductors, semi conductors and insulators.

Nanophase Materials

Introduction, properties, Top-down and bottom up approaches, Synthesis - Ball milling, Chemical vapour deposition method , sol-gel methods, Applications of nano materials.

Text Books :

1. Physics by David Halliday and Robert Resnick – Part I and Part II - Wiley.
2. A textbook of Engineering Physics, Dr. M. N. Avadhanulu, Dr. P.G. Kshirsagar - S. Chand
3. Engineering Physics by R.K. Gaur and S.L. Gupta –Dhanpat Rai

Reference Books:

1. Modern Engineering Physics by A.S. Vadudeva
2. University Physics by Young and Freedman

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CH-1103 ORGANIC CHEMISTRY

Course Objectives:

The student will be able to:

- appreciate the nature and scope of organic chemistry.
- apply key concepts from general chemistry including electronegativity, bonding (ionic and covalent), hybridization of atomic orbitals, and molecular orbital theory to organic systems.
- draw skeletal structures for organic compounds.
- apply acid-base concepts to organic systems; predict ordering of acid or base strength.
- name alkanes, alkenes, polyenes, alkynes, alkyl halides, aromatic compounds, carbonyl compounds, amines and their various derivatives using systematic (IUPAC) nomenclature.
- draw reaction mechanisms for some key reactions.
- recognize stereochemistry and be able to apply the Cahn-Ingold-Prelog system to designation of stereochemistry (E/Z or R/S).
- learn many of the reactions of alkanes, alkenes, polyenes, alkynes, aromatic, carbonyl, and amine compounds, and close related species. Be able to predict reactions involving these functional groups.
- be able to solve problems employing spectroscopic methods including mass spectrometry, infrared and NMR spectroscopy.
- understand the basic chemical and structural features of biomolecules, including lipids, carbohydrates, amino acids and proteins, and nucleic acids.

Course Outcomes:

At the end of the course, the student will be able to

- Determine the molecular formula for organic compounds
- Differentiate the structure and properties of biomolecules, polymers and heterocyclic compounds
- Identify the role of chemical engineer in modern drug discovery programs
- Separate the racemic mixtures using resolution methods
- Elucidate the structure of organic compounds (small molecules) using spectroscopic methods.

SYLLABUS

Numerical Problems: Determination of percentage composition of carbon, hydrogen and nitrogen, molecular weight determination by depression in freezing point and elevation of boiling point methods, molecular weight of acids by silver salt method; molecular weight of bases by chloroplatinate method, determination of molecular formula of a compound, problems relating to reactions of carboxylic acids, functional derivatives of acids, carbonyl compounds, alcohols, amines, phenols, diazonium salts applications, alkenes and their laboratory tests,

Nomenclature of alkanes, alkenes, alkynes, dienes, cyclic aliphatic hydrocarbons, structure of benzene, nomenclature of benzene derivatives, arenas, industrial preparation of ethylene, acetylene; sp, sp^2 and sp^3 hybridization; preparation and chemical reactions; conformational analysis of ethane, propane and butane, Wurtz reaction, Diels-Alder reaction, aromaticityMorkovinkov rule, Clemmensen and Wulf-Kishner reduction,

Electro-philic and Nucleo-philic Aromatic Substitution: Orientation in desubstituted benzenes, mechanism of nitration, halogenation, sulphonation, Friedel-Craft's alkylation and acylation reactions, nomenclature of alkyl halides, preparation and chemical reactions, mechanisms of SN_1, SN_2, E_1, E_2 reactions, nomenclature of aryl halides, preparation and chemical reactions: low reactivity of vinyl and aryl halides, Sandmeyer reaction,

Nomenclature of Alcohols; industrial preparation of ethyl alcohol, preparation and chemical reactions, Lucas test, nomenclature of mono, dicarboxylic acids, industrial preparation of formic, acetic, benzoic, phthalic, salicylic acids, preparation and chemical reactions, mechanism of HVZ reaction and Claisen condensation, nomenclature of functional derivatives of acids, preparation and chemical reactions, mechanism of Hoffmann bromamide reaction, acid and base catalyzed hydrolysis of ester, nomenclature of ethers and epoxides, industrial preparation of ether and ethylene oxide, preparation and chemical reactions; Williamson's synthesis,

Nomenclature of Aldehydes and Ketenes: Industrial preparation of formaldehyde, acetaldehyde, benzaldehyde, salicyaldehyde, acetone; preparation and chemical reactions; mechanisms of Cannizaro, Aldol, Reformatsky and Wittig reactions, reactions without mechanisms -Perkin, Cope, Knoevenagel and Pinacol-Pinacolone reactions, difference between aldehyde and ketone, nomenclature of phenols, industrial preparation of phenol, preparation and chemical reactions, mechanisms of Fries rearrangement, Kobe reaction, Reimer-Tiemann reaction, classification of carbohydrates, structure of glucose and fructose, reactions of glucose

and fructose, Ruff degradation, Wohls degradation, filiani-Fisher synthesis, glucose into fructose, fructose into glucose, glucose to vitamin-C, mechanism of Osazone formation,

Nomenclature of amines, industrial preparation of aniline, preparation and chemical reactions - exhaustive methylation, mechanism of Hoffmann elimination, benzedene rearrangement without mechanism, Hinsberg test, differentiation test using nitrous acid, preparation of diazonium salts and synthetic applications, preparation of sulphanilamide, sulphaguanidine, sulphamerazine, sulphapyridene (sulpha drugs), mode of action of sulpha drugs,

Preparation of Soaps and Detergents: Mode of action of soaps, differences between soaps and detergents; preparation of malonic, acetoacetic ester and their synthetic applications, preparation of Grignard reagents and their synthetic applications, preparation of polyethylene, polystyrene, teflon, PVC, polyvinyl cyanide, rubber-vulcanisation, styrene-butadiene rubber, polychloroprene, bakelite, nylon-6 and nylon 6-6, plexiglas, terylene, Ziegler-Natta polymerization, definition of thermoplastics and thermosetting plastics,

Isomerism**:** Structural and optical isomerism, geometrical isomerism, E Z configuration, sequence rules, R & S configuration, racemic mixture and their separation, asymmetric synthesis - Fischer projection formula, definitions of axial and equatorial bonds, 1-3- diaxial interaction, enatiomers, diastereomers, mesomers, isomerism in cyclic compounds, chair, boat and twisted boat structures (1-methylcyclohexane, 1, 2-cyclohexane diol), sSynthetic applications of - Zn/Hg, Na-$NH_3$$LiAH_4$, $NaBH_4$, diborane and zinc dust, soda lime, OsO_4, hydroxylamine, acetic anhydride, benzoylchloride and PCl_5.

Reference Books:

1. ‘Text Book of Organic Chemistry’ by Morrison & Boyd
2. ‘Text Book of Organic Chemistry’ by Bahl&Tuli
3. ‘Text Book of Organic Chemistry’ by M.K.Jain
4. ‘Text Book of Organic Chemistry’ by I.L.Finar (Vols.1&2 as reference books)

CH-1104 MECHANICAL ENGINEERING

Course Objectives:

- To be aware of the basics in Thermodynamics
- To get knowledge on applications of steam tables
- To understand the principles and applications of IC engines, compressors and turbines
- To comprehend the principles of belts, chain drives and gears

Course Outcomes:

At the end of the course, the student will be able to

- To Know the thermodynamic laws and various processes
- To make out the applications of steam in boilers and turbines
- To derive the various performance parameters related to IC engines and of air compressors
- To arrive basic needs of working of belts, chain drives and gears

SYLLABUS

Thermodynamics: Definitions, systems, classification of thermodynamic systems, cycles and zeroth law of thermodynamics, first law of thermodynamics, closed system, flow processes, open systems with steady flow process, applications of steady flow energy equation to engineering systems.

Second Law of Thermodynamics: Carnot cycle, inequality of Classius-reversible Carnot cycle, entropy, relation between heat and entropy, general expression for entropy change, entropy change of a perfect gas during various thermodynamic processes, air standard cycles, Otto, diesel, dual combustion cycles.

Properties of Steam and Use of Steam Tables: Boilers, classification steam boilers, simple vertical, Cochran, locomotive boiler, Babcock and Wilcox boiler, steam generation, Rankine cycle.

Impulse and Reaction Turbine: Classification of steam turbines, velocity diagram and power produced in impulse turbine, performance of steam turbines, reduction of rotor speed, I C engines: Classification-main composition of IC engines, carburettor, fuel pump injector, cooling

systems for IC engines, working of 2-stroke and 4-stroke petrol and diesel engines, power and efficiency of IC engines.

Reciprocating Air-Compressors: Single stage, work done during cycle, effect of clearance, two stage compressors, condition for minimum work, effect of inter-cooling, efficiency.

Drives: Belts, expression for the ratios of tension on the slack and tight side, power transmitted – V-belts, chain drives, gears – spur, helical, bevel gear, trains simple and compound.

Text Books:

1. A Text Book of Thermal Engineering by R.S.Khurmi and J.K.Gupta
2. 'Theory of Machines' by R.S.Khurmi

Reference Books:

1. 'Engineering Thermodynamics' by P.K.Nag
2. 'Engineering Thermodynamics' by J.B.Jones and R.E.Dugar
3. 'Engineering Thermodynamics' by R.K.Rajput
4. 'Theory of Machines' by Balani

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CH-1105 BASIC ELECTRICAL ENGINEERING

Course Objectives:

- An understanding of basic EE abstractions depends on analysis and design of electric and magnetic circuits and its elements.
- To provide the students with knowledge of fundamental laws in electrical engineering
- To develop the ability of the students to analyze electrical and magnetic circuits using the basic laws of electrical engineering
- To expose the students to the concepts of various types of electrical machines and application of electrical machines.
- To inculcate the understanding about the AC fundamentals
- To prepare the students to have a basic knowledge of transformers
- To acknowledge about three phase induction motor and its operating principle
- To know about the fundamentals of synchronous motors and its working principle

Course Outcomes:

After the completion of the course, the student should be able

- To predict the behavior of any electrical and magnetic circuits.
- student will be able to state and explain the basic laws of electromagnetic induction.
- To impart knowledge on Constructional details, principle of operation, types of Electrical Machines performance Characteristics ,speed control methods and its applications
- Ability to conduct experiments on Ac Machines to find its characteristics.
- Abel to calculate performance characteristics of transformer like regulation and efficiency
- The ability to formulate and then analyze the working of synchronous motors
- Able to solve simple problems on synchronous motors

SYLLABUS

Magnetic Circuits: Definitions of magnetic circuit, reluctance, magneto motive force (mmf), magnetic flux, simple problems on magnetic circuits, hysterisis loss (chapter 8, page nos. 155-175),

Electromagnetic Induction: Faraday's laws of electromagnetic induction, induced E.M.F., dynamically induced E.M.F, statistically induced EMF, self inductance, mutual inductance (Chapter 9, page nos. 176-190),

D.C. Generators: D.C generator principle, construction of D.C generator, E.M.F equation of D.C generator, types of D.C generators, armature reaction, losses in D.C generator, efficiency, characteristics of D.C generators, applications of D.C generators (chapter 10, 11, pages 208-238),

D.C. Motors: D.C motor principle, working of D.C motors, significance of back, E.M.F, torque equation of D.C motors, types of D.C motors, characteristics of D.C motors, speed control methods of D.C motors, applications of D.C motor, testing of D.C machines, losses and efficiency, direct load test and Swinburne's test (Chapter 12, 13, page Nos. 239-269),

A.C. Circuits: Introduction to steady state analysis of A.C circuits, single and balanced 3 phase circuits (chapter 16, page nos. 323-348),

Transformers: Transformer principle, EMF-equation of transformer, transformer on load, equivalent circuit of transformer, voltage regulation of transformer, losses in a transformer, calculation of efficiency and regulation by open circuit and short circuit tests (Chapter 20, page Nos. 423-455),

Three Phase Inductance Motor: Induction motor working principle, construction of 3-phase induction motor, principle of operation, types of 3-phase induction motor, torque equation of induction motor, slip-torque characteristics, starting torque, torque under running condition, maximum torque equation, power stages of induction motor, efficiency calculation of induction motor by direct loading (Chapter 21, page nos. 463-489),

Altemator: Altenator working principle, EMF equation of altenator, voltage regulation by Synchronised impedance method (Chapter 23, page nos. 505-515),

Synchonous motor: Synchronous motor principle of operation, construction, methods of starting of synchronous motor, (Chapter- 24, page nos. 516-526),

Text Book:

'Elements of Electrical Engineering & Electronics' by V.K. Mehta, S.Chand & Co.

Reference Book:

'A first course in Electrical Engineering' by Kothari.

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CH-1106 ORGANIC CHEMISTRY LABORATORY

Course Objectives:

- The student will learn to analyze the organic compounds. The students will be exposed to the preparation of various organic chemicals in this laboratory.

Course Outcomes:

At the end of the course, the student will be able to

- Analyze and identify the given organic compound
- Prepare organic compounds like aspirin, benzanilide, m-dinitrobenzene, benzoic acid, phthalimide, methyl orange, parabenzoquinone and nerolin
- Identify extra elements

List of Experiments:

1. Preparation of aspirin
2. Preparation of benzanilide
3. Preparation of m-dinitrobenzene
4. Preparation of benzoic acid
5. Preparation of phthalimide
6. Preparation of methyl orange
7. Preparation of parabenzoquinone
8. Preparation of nerolin
9. Detection of extra elements
10. Analysis of compound -1
11. Analysis of compound -2
12. Analysis of compound -3
13. Analysis of compound -4
14. Analysis of compound -5
15. Analysis of compound -6

CH-1107 PHYSICS LAB

Course Objectives:

- To enable the students to acquire skill, technique and utilization of the Instruments
- Draw the relevance between the theoretical knowledge and to imply it in a practical manner with respect to analyze various electronic circuits and its components.
- To impart the practical knowledge in basic concepts of Wave optics, Lasers and Fiber optics.
- To familiarize the handling of basic physical apparatus like Vernier callipers, screw gauge, spectrometers, travelling microscope, laser device, optical fibre, etc.

Course Outcomes:

- Ability to design and conduct experiments as well as to analyze and interpret
- Ability to apply experimental skills to determine the physical quantities related to Heat, Electromagnetism and Optics
- The student will learn to draw the relevance between theoretical knowledge and the means to imply it in a practical manner by performing various relative experiments.

SYLLABUS

1. Determination of Radius of Curvature of a given Convex Lens By forming Newton's Rings.
2. Determination of Wavelength of Spectral Lines in the Mercury Spectrum by Normal Incidence method.
3. Study the Intensity Variation of the Magnetic Field along axis of Current Carrying Circular Coil.
4. Determination of Cauchy's Constants of a Given Material of the Prism using Spectrometer.
5. Determination of Refractive Index of Ordinary ray μ_o and Extraordinary μ_e ray.
6. Determination of Thickness Given Paper Strip by Wedge Method.
7. Calibration of Low Range Voltmeter.
8. Calibration of Low Range Ammeter.
9. Determination of Magnetic Moment and Horizontal Component of Earth's Magnetic Field.
10. Lees Method - Coefficient of thermal Conductivity of a Bad Conductor.

11. Carey Foster's Bridge – Verification of laws of Resistance and Determination of Specific Resistance.
12. Melde's Apparatus – Frequency of electrically maintained Tuning Fork.
13. Photoelectric cell-Characteristics.
14. Planks Constants.
15. Laser- Diffraction.

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CH-1108 GENERAL ENGINEERING LABORATORY

MECHANICAL ENGINEERING LABORATORY

Course Objectives:

- To be aware of the viscosity, flash point of oil samples and calorific value of a gas
- To get knowledge on calibration of pressure gauge, flywheel and torsional pendulum
- To understand the principles and applications of Air compressors and IC engines

Course Outcomes:

- To determine the viscosity, flash point and calorific value of fluids
- To make out the applications of pressure gauge, flywheel and torsional pendulum
- To derive performance parameters related to IC engines and efficiencies of air compressor

Experiments:

1. Find the viscosity of the given sample of oil using Redwood viscometer-1
2. Find the viscosity of the given sample of oil using Redwood viscometer-II
3. Find the flash point of the given sample of oil using Abel's flash point tester
4. To calibrate pressure gauge using standard pressure and standard weights
5. Draw the valve timing diagram of a 4-stroke diesel engine and port timing diagram of a 2-stroke petrol engine
6. Perform load test at full load, half load, ¼ th load on a 4-stroke Ruston engine and draw the performance curves
7. Find the volumetric efficiency, isothermal efficiency of the given compressor
8. To determine the moment of inertia of a fly-wheel and shaft experimentally and compare the values with the calculated values
9. To determine experimentally the calorific value of a gaseous fuel by using Junkers gas calorimeter
10. To determine the modulus of rigidity of the material of the wire by torsional oscillators

ELECTRICAL ENGINEERING LABORATORY

Course Objectives: This course provides

- Insight of fundamental laws in electrical engineering.
- Deals with the constructional and operational details of DC and AC machines.
- Analyze electrical and magnetic circuits using basic laws of electrical engineering

Course Outcomes:

After the completion of the course, the student should be able to

- Understand the basic laws of electrical and magnetic circuits.
- Analyze the characteristics of DC generator and motors.
- Design of equivalent circuit of transformer.
- Apply the basic knowledge to solve problems on synchronous machines.

Experiments:

1. Study and calibration of ammeter
2. Study and calibration of voltmeter
3. Study and calibration of wattmeter
4. Study and calibration of energy meter
5. Measurement of low resistance (armature)
6. Measurement of medium resistance (field)
7. Measurement of insulation resistance
8. Measurement of filament resistance
9. Verification of KCL and KVC
10. Superposition theorem.
11. Parameters of a choke coil
12. OC and SC tests on transformer
13. Load test D.C. shunt machine
14. OC test on DC,. separately excited machine
15. Swinburne's test
16. 3-phase induction motor (No load and rotor block tests)
17. Alternator regulation by Syn. impedance method

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CH-1201 MATHEMATICS – II

Course Objectives:

- The way of obtaining rank, eigen values and eigen vectors of a matrix.
- To know the importance of Cayley-Hamilton theorem and getting canonical form from a given quadratic form.
- To solve the system of equations by using direct and indirect methods.
- To solve first order and higher order differential equations by various methods.
- To obtain the Laplace transforms and inverse Laplace transforms for a given functions and their applications.

Course Outcomes:

- Find rank, eigen values and eigen vectors of a matrix and understand the importance of Cayley-Hamilton theorem.
- Reduce quadratic form to canonical forms and solving linear systems by direct and indirect methods.
- Demonstrate solutions to first order differential equations by various methods and solve basic applications problems related to electrical circuits, orthogonal trajectories and Newton's law of cooling
- Discriminate among the structure and procedure of solving higher order differential equations with constant and variable coefficients.
- Understand Laplace transforms and its properties and finding the solution of ordinary differential equations.

SYLLABUS

Linear Algebra: Rank of a matrix- Echelon form, Normal Form - Solution of Linear System of Equations - Consistency of Linear System of Equations - Direct & Indirect Methods: Gauss elimination method, LU Factorization method, Gauss Seidal Method. Complex Matrices: Hermitian, Skew-Hermitian and Unitary Matrices and their Properties.

Eigen Values and Eigen Vectors : Eigen Values and Eigen Vectors of a Matrix - Cayley-Hamilton theorem - Inverse and Powers of a Matrix using Cayley-Hamilton's theorem and its applications. Diagonalization of a Matrix - Quadratic Forms - Reduction of Quadratic Form to Canonical Form - Nature of a Quadratic Form.

Ordinary Differential Equations of First Order and its Applications: Formation of ordinary differential equations (ODEs) - Solution of an ordinary differential equation - Equations of the first order and first degree - Linear differential equation - Bernoulli's equation - Exact differential equations - Equations reducible to exact equations - Orthogonal Trajectories - Simple Electric (LR & CR) Circuits - Newton's Law of Cooling - Law of Natural growth and decay.

Differential Equations of Higher Order: Solutions of Linear Ordinary Differential Equations with Constant Coefficients - Rules for finding the complimentary function - Rules for finding the particular integral - Method of variation of parameters - Cauchy's linear equation - Legendre's linear equation - Simultaneous linear differential equations.

Laplace Transforms : Introduction - Existence Conditions - Transforms of Elementary Functions - Properties of Laplace Transforms - Transforms of Derivatives - Transforms of Integrals - Multiplication by t^n - Division by t – Evaluation of integrals by Laplace Transforms - Inverse Laplace Transform - Applications of Laplace Transforms to Ordinary Differential Equations - Simultaneous Linear Differential Equations with Constant Coefficients - Second Shifting Theorem - Laplace Transforms of Unit Step Function, Unit Impulse Function and Laplace Transforms of Periodic Functions.

Text Book:

Scope and Treatment as in "Higher Engineering Mathematics", by Dr. B.S. Grewal, 43r^d edition, Khanna publishers.

Reference Books:

1. Graduate Engineering Mathematics by V B Kumar Vatti., I.K. International publishing house Pvt. Ltd.
2. Advanced Engineering Mathematics by Erwin Kreyszig.
3. A text book of Engineering Mathematics, by N.P. Bali and Dr. Manish Goyal. Lakshmi Publications.
4. Advanced Engineering Mathematics by H.K. Dass. S. Chand Company.
5. Higher Engineering Mathematics by B.V. Ramana, Tata Mc Graw Hill Company.

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CH-1202 GREEN CHEMISTRY

SYLLABUS

Course Objectives:

CO 1: To apply the basic knowledge of Chemistry to the Engineering Discipline.
CO 2: To develop knowledge about water and its treatment for industrial and potable purposes.
CO 3: To develop understanding in the areas of Batteries, Fuels Mechanism of Corrosion of Metals and Corrosion Control Methods, Green Chemistry and Technology and Processes involving Green Chemistry and apply the knowledge for solving existing challenges faced in various engineering and societal areas.

Learning outcome:

LO 1: The students are able to apply the basic concepts and principles studied in Chemistry to the field of Engineering.
LO 2: The students are able to apply chemistry to different branches of engineering
LO 3: The students are able to acquire the knowledge in the areas of Water Chemistry, Mechanism of Corrosion of Metals and Corrosion Control Methods, Batteries, Fuel Cells, Green Chemistry and Technology and Processes involving Green Chemistry and suggest innovative solutions for existing challenges in these areas.

Unit 1: Water Technology

Sources of Water – Impurities and their influence of living systems – WHO Limits – Hardness and its Determination – Boiler Troubles and their removal – Water Softening Methods – Lime-Soda, Zeolite and Ion Exchange - Municipal Water Treatment-Break Point Chlorination – Desalination of Sea Water – Reverse Osmosis Method, Electro-dialysis.

Unit 2: Batteries

Primary batteries: The chemistry - Types: Zinc-carbon (Leclanche type), zinc alkaline (Duracell), zinc/air batteries; Lithium primary cells – liquid cathode, solid cathode and lithium-ferrous sulphide cells. Secondary batteries: Lead acid and VRLA (valve regulated (sealed) lead acid), nickel-cadmium, nickel-zinc, nickel-metal hydride batteries, lithium ion batteries, ultrathin lithium polymer cells. Advanced Batteries for electric vehicles, requirements of the battery – sodium-beta and redox batteries.

Unit 3: Fuel Cells

Fuel Cells: Description, working principle, anodic, cathodic and cell reactions, fabrication of electrodes and other components, applications, advantages, disadvantages and environmental aspects of the following types of fuel cells: Proton Exchange Membrane Fuel Cells, alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate, direct methanol fuel cells- Membranes and Fuels

Unit 4: Corrosion

Corrosion: Origin and Theory – Types of Corrosion: Chemical and Electrochemical; Pitting, Inter granular, Waterline, Stress – Galvanic Series – Factors Effecting Corrosion. Corrosion Controlling Methods, Protective Coatings, Metallic Coatings, Electroplating and Electroless Plating.

Unit 5: Green Chemistry and Technology

Introduction and significance of green chemistry, Goals of green chemistry, 12 principles of green chemistry, toxicity of chemicals, material safety data sheet (MSDS), concept of zero pollution technologies, atom economy, functional toxicity vs non-functional toxicity, functional group approaches to green chemistry, Elimination of toxic functional group, optimization of frameworks for the design of greener synthetic pathways, Applications of green chemistry - Green solvents, green fuels and propellants, biocatalysis.

Text Books

1. Engineering Chemistry – PC Jain and M. Jain – Dhanpath Rai and Sons, New Delhi.
2. A Text book of Engineering Chemistry – S. S. Dara – S. Chand & Co. New Delhi.
3. Hand Book of Green Chemistry and Technology; by James Clarke and Duncan Macquarrie; Blakwell Publishing.

CH-1203 ENGLISH

Course Objectives:

- To make students understand the explicit and implicit meanings of a text/topic;
- To give exposure to new words and phrases, and aid to use them in different contexts;
- To apply relevant writing formats to draft essays, letters, emails and presentations; and
- To adapt oneself to a given situation and develop a functional approach to finding solutions: adaptability and problem solving.

Course Outcomes:

- Students will be able to analyse a given text and discover the various aspects related to language and literature;
- Learn the various language structures, parts of speech and figures of speech;
- Develop one's reading and writing abilities for enhanced communication; and
- Learn to apply the topics in real-life situations for creative and critical use.

SYLLABUS

On the conduct of life: William Hazlitt

Life skills: Values and Ethics

If: Rudyard Kipling

The Brook: Alfred Tennyson

Life skills: Self-Improvement

How I Became a Public Speaker: George Bernard Shaw

The Death Trap: Saki

Life skills: Time Management

On saving Time: Seneca

Chindu Yellama

Life skills: Innovation

Muhammad Yunus

Politics and the English Language: George Orwell

Life skills: Motivation

Dancer with a White Parasol: Ranjana Dave

Grammar:

Prepositions – Articles – Noun-Pronoun Agreement, Subject-Verb Agreement – Misplaced Modifiers – Clichés, Redundancies.

Vocabulary:

Introduction to Word Formation – Root Words from other Languages – Prefixes and Suffixes – Synonyms, Antonyms – Common Abbreviations

Writing:

Clauses and Sentences – Punctuation – Principals of Good Writing – Essay Writing – Writing a Summary

Writing: Essay Writing

Life skills: Innovation

Muhammad Yunus

Text Book:

Language and Life: A Skills Approach Board of Editors, Orient Blackswan Publishers, India. 2018.

References Books:

1. Practical English Usage, Michael Swan. OUP. 1995.
2. Remedial English Grammar, F.T. Wood. Macmillan.2007
3. On Writing Well, William Zinsser. Harper Resource Book. 2001
4. Study Writing, Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
5. Communication Skills, Sanjay Kumar and PushpLata. Oxford University Press. 2011.
6. Exercises in Spoken English, Parts. I-III. CIEFL, Hyderabad. Oxford University Press.

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CH-1204 ‘C’-Programing and Numerical Methods

Course Objectives:

- The course is designed to provide complete knowledge of C language.
- To provide students with understanding of code organization and functional hierarchical decomposition with using complex data types.
- To provide knowledge to the Students to develop logics which will help them to create programs, applications in C.
- This course aims to identify tasks in which the numerical techniques learned are applicable and apply them to write programs, and hence use computers effectively to solve the task.
- This course provides the fundamental knowledge which is useful in understanding the other programming languages.

Course Outcomes:

- Identify basic elements of C programming structures like data types, expressions, control statements, various simple functions and Apply them in problem solving.
- Apply various operations on derived data types like arrays and strings in problem solving.
- Design and Implement of modular Programming and memory management using Functions, pointers.
- Apply Structure, Unions and File handling techniques to Design and Solve different engineering programs with minimal complexity.
- Apply Numerical methods to Solve the complex Engineering problems.

SYLLABUS

Introduction to C: Basic structure of C program, Constants, Variables and data types, Operators and Expressions, Arithmetic Precedence and associativity, Type Conversions. Managing Input and Output Operations Formatted Input, Formatted Output.

Decision Making, Branching, Looping, Arrays & Strings: Decision making with if statement, Simple if statement, The if…else statement, Nesting of if…else statement, the else..if ladder, switch statement, the (?:) operator, the GOTO statement., The while statement, the do statement, The for statement, Jumps in Loops ,One, Two-dimensional Arrays, Character Arrays. Declaration

and initialization of Strings, reading and writing of strings, String handling functions, Table of strings.

Functions: Definition of Functions, Return Values and their Types, Function Calls, Function Declaration, Category of Functions: No Arguments and no Return Values, Arguments but no Return Values, Arguments with Return Values, No Argument but Returns a Value, Functions that Return Multiple Values. Nesting of functions, recursion, passing arrays to functions, passing strings to functions, the scope, visibility and lifetime of variables.

Pointers: Accessing the address of a variable, declaring pointer variables, initializing of pointer variables, accessing variables using pointers, chain of pointers, pointer expressions, pointers and arrays, pointers and character strings, array of pointes, pointers as function arguments, functions returning pointers, pointers to functions, pointers to structures-Program Applications

Structure and Unions: Defining a structure, declaring structure variables, accessing structure members, structure initialization, copying and comparing structure variables, arrays of structures, arrays within structures, structures within structures, structures and functions and unions, size of structures and bit-fields- Program applications.

File Handling: Defining and opening a file, closing a file, Input/ Output operations on files, Error handling during I/O operations, random access to files and Command Line Arguments-Program Applications

Numerical Methods: Solutions of Algebraic and Transcendental Equations, Bisection Method, Newton Raphson Method. Newton's forward and backward Interpolation, Lagrange's Interpolation in unequal intervals. Numerical Integration: Trapezoidal rule, Simpson's 1/3 rules. Solutions of Ordinary First Order Differential Equations: Euler's Method, Modified Euler's Method and Runge-Kutta Method.

Text Books:

1. Programming in ANSI C, E Balagurusamy, 6th Edition. McGraw Hill Education (India) Private Limited.
2. Introduction to Numerical Methods, SS Sastry, Prentice Hall

Reference Books:

1. Let Us C ,YashwantKanetkar, BPB Publications, 5th Edition.
2. Computer Science, A structured programming approach using C", B.A.Forouzan and R.F.Gilberg, " 3rd Edition, Thomson, 2007.
3. The C –Programming Language' B.W. Kernighan, Dennis M. Ritchie, PHI.
4. Scientific Programming: C-Language, Algorithms and Models in Science, Luciano M. Barone (Author), Enzo Marinari (Author), Giovanni Organtini, World Scientific.

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CH-1205 INDUSTRY 4.0

SYLLABUS

Unit-1: Introduction to Industry 4.0

Introduction, Idea of Industry 4.0, Various Industrial Revolutions, Origin concept of Industry 4.0,Industry 4.0 Production system, How is India preparing for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory.

Unit-2: Trends in Industry 4.0

Introduction, Main Concepts and Components of Industry 4.0, State of Art Technologies, Proposed Framework for Industry 4.0, Trends of Industrial Big Data and Smart Business Transformation.

Unit-3: Roadmap for Industry 4.0

Introduction, Proposed Framework for Technology Roadmap: Strategy Phase, Development Phase, Smart Manufacturing, Types of Smart Devices, Smart Logistics, Smart Cities, Predictive Analytics.

Unit-4: Advances in the Era of Industry 4.0

Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Things, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly, IIoT- Industrial IoT.

Unit-5: The Role of Industry 4.0 and Future Aspects

Introduction, Challenges & Future of Works and Skills for Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world.

(MATERIAL IS READILY AVAILABLE ON INTERNET)

CH-1206 ENGLISH LANGUAGE LAB

Course Objectives:

- To make students recognize the sounds of English through Audio-Visual aids;
- To help students build their confidence and help them to overcome their inhibitions and self- consciousness while speaking in English;
- To familiarize the students with stress and intonation and enable them to speak English effectively; and
- To give learners exposure to and practice in speaking in both formal and informal contexts.

Course Outcomes:

- Students will be sensitized towards recognition of English sound patterns and the fluency in their speech will be enhanced;
- A study of the communicative items in the laboratory will help students become successful in the competitive world;
- Students will be able to participate in group activities like roleplays, group discussions and debates; and
- Students will be able to express themselves fluently and accurately in social as well professional context.

SYLLABUS

Introduction to Phonetics: The Sounds of English (Speech sound – vowels and consonants) - Stress and Intonation - Accent and Rhythm.

Listening Skills: Listening for gist and specific information - listening for Note taking, summarizing and for opinions - Listening to the speeches of eminent personalities.

Speaking Skills: Self-introduction - Conversation Skills (Introducing and taking leave) - Giving and asking for information - Role Play - Just A Minute (JAM) session - Telephone etiquette.

Reading and Writing Skills: Reading Comprehension – Précis Writing - E-Mail writing - Punctuation.

Presentation Skills: Verbal and non-verbal communication - Body Language - Making a Presentation.

Reference Books:

1. Ashraf Rizvi. Effective Technical Communication. Tata McGraw Hill Education Private Limited, New Delhi.
2. Speak Well. Orient Blackswan Publishers, Hyderabad.
3. Allan Pease. Body Language. Manjul Publishing House, New Delhi.

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CH-1207 GREEN CHEMISTRY LAB

Course Objectives:

CO 1: To develop the fine skills of quantitative determination of various chemical components through
titrimetric analysis

CO 2: To prepare ion exchange/ zeolite column for removal of hardness

CO 3: To develop the skill of green synthesis through the preparation of a polymer/ drug

Learning Outcomes:

LO 1: The students are able to determine the amount of various chemical species in solutions by titrations quantitatively with accuracy

LO 2: The students are able to develop novel materials to be used as zeolite and prepare columns for
removal of hardness of water

LO 3: The students develop skills to synthesise a polymer or a drug

SYLLABUS

1. Determination of Sodium Hydroxide with HCl (Na_2CO_3 Primary Standard)
2. Determination of Alkalinity (Carbonate and Hydroxide) of water sample
3. Determination of percentage of Iron in the given rust solution by external indicator method
4. Determination of total Hardness of Water sample by EDTA method
5. Preparation and analysis of Ionexchange/ Zeolite column for removal of hardness of water
6. Green Synthesis of Polymer/ drug

Reference Books:

1. Vogel's Quantitative Chemical Analysis – V – Edition – Longman.
2. Experiments in Applied Chemistry (For Engineering Students) – Sinita Rattan – S. K. Kataria & Sons, New Delhi

CH-1208 CPNM LAB

Course Objectives:

- To impart writing skill of C programming to the students and solving problems.
- To write and execute programs in C to solve problems such as Modularize the problems into small modules and then convert them into programs.,
- To write and execute programs in C to solve problems such as arrays, files, strings, structures and different numerical methods.
- This reference has been prepared for the beginners to help them understand the basic to advanced concepts related to Objective-C Programming languages.

Course Outcomes:

- Understand various computer components, Installation of software. C programming development environment, compiling, debugging, and linking and executing a program using the development environment.
- Analyzing the complexity of problems, Modularize the problems into small modules and then convert them into programs.
- Construct programs that demonstrate effective use of C features including arrays, strings, structures, pointers and files.
- Apply and practice logical ability to solve the real world problems.
- Apply Numerical methods to Solve the complex Engineering problems.

SYLLABUS

1. Write a program to read x, y coordinates of 3 points and then calculate the area of a triangle formed by them and print the coordinates of the three points and the area of the triangle. What will be the output from your program if the three given points are in a straight line?
2. Write a program, which generates 100 random integers in the range of 1 to 100. Store them in an array and then print the arrays. Write 3 versions of the program using different loop constructs. (e.g. for, while, and do while).
3. Write a set of string manipulation functions e.g. for getting a sub-string from a given position, Copying one string to another, Reversing a string, adding one string to another.
4. Write a program which determines the largest and the smallest number that can be stored in different data types like short, int, long, float, and double. What happens when you add 1 to the largest possible integer number that can be stored?

5. Write a program, which generates 100 random real numbers in the range of 10.0 to 20.0, and sort them in descending order.
6. Write a function for transposing a square matrix in place (in place means that you are not allowed to have full temporary matrix).
7. First use an editor to create a file with some integer numbers. Now write a program, which reads these numbers and determines their mean and standard deviation.
8. Given two points on the surface of the sphere, write a program to determine the smallest arc length between them.
9. Implement bisection method to find the square root of a given number to a given accuracy.
10. Implement Newton Raphson method to det. a root of polynomial equation.
11. Given table of x and corresponding f(x) values, Write a program which will determine f(x) value at an intermediate x value by using Lagrange's interpolation/
12. Write a function which will invert a matrix.
13. Implement Simpson's rule for numerical integration.
14. Write a program to solve a set of linear algebra

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CH-2101 MATHEMATICS-III

Course Objectives:

The objectives, in particular are to learn about:

- Differentiation of vector functions of real variables, curves in space, differential operators, the concept of gradient, divergence and curl and their potential applications.
- The concepts of Line-, Surface and Volume integrals and transformation theorems such as Green's theorem in the plane, Stoke's theorem, Gauss Divergence theorem and their applications.
- Formation of Partial Differential Equations and solution of first order first degree linear, non-linear Partial Differential Equations, Homogeneous and Non homogeneous linear partial differential equations with constant coefficients.
- The method of separation of variables and how to use it to find the solution of one dimensional wave (string equation), one-and two-dimensional Heat flow equations, Laplace's equation in Cartesian and polar coordinates.
- The concept of integral transforms, namely, Fourier transforms, Fourier Sine, Cosine and related inversetransforms, and their applications in solving several Physical and Engineering problems.

Course Outcomes:

At the end of the course, the students would be able to:

- Understand differential operations and the concepts of Gradient, Divergence and Curl and their applications.
- Apply the concepts of Line integrals, Surface Integrals, Volume Integrals and their potential applications: work done by a force field, circulation and Flux etc. Also, find out the relation between Line, Surface and Volume integrals: Green's theorem in the plane, Stoke's and Divergence theorems.
- Understand the formation of partial differential equations and the solving Linear and Non linear first order partial differential equations. Also, how to find the solution of Linear Partial Differential Equations with constant coefficients by finding the complementary function and particular integrals.
- Apply the method of separation of variables to solve the important governing equations of one dimensional wave equation, One and Two dimensional heat flow equations, Laplace's equations in Cartesian and polar coordinates.
- Apply the knowledge of Fourier transform techniques in solving several Initial and Boundary value problems of Engineering, such as problems in Conduction of heat / Thermodynamics, Hydraulics transverse vibrations of a string, oscillations of an elastic

beam, bending of beams, electrical circuits, free and forced vibrations of a membrane and transmission lines , etc.

SYLLABUS

Vector Calculus-Differentiation: Differentiation of vectors, curves in space, velocity and acceleration, relative velocity and relative acceleration, scalar and vector point functions, vector operator ∇ applied to scalar point functions- gradient, ∇ applied to vector point functions- divergence and curl. Physical interpretation of gradient, divergence and culrl (i.e., $\nabla f,\ \nabla.\overline{F},\ \nabla\times\overline{F}$), Irrotational and Solenoidal fields, the relations obtained after ∇ applied twice to point functions, ∇ applied to products of two functions.

Vector Integration: Integration of vectors, line integral, circulation, work done, surface integral-flux, Green's theorem in the plane, Stoke's theorem, volume integral, Gauss Divergence theorem. (All theorems without proofs) Introduction of orthogonal curvilinear coordinates, cylindrical and spherical polar coordinates

Partial Differential Equations: Formation of partial differential equations, solutions of partial differential equations- equations solvable by direct integration, linear equations of first order: Lagrange's Linear equation, non-linear equations of first order, Charpit's method. Homogeneous linear equations with constant coefficients- rules for finding the complementary function, rules for finding the particular integral (working procedure), non- homogeneous linear equations.

Applications Of Partial Differential Equations: Method of separation of variables, One dimensional wave equation-vibrations of a stretched string, one dimensional Heat flow equation, Two dimensional heat flow in steady state - solution of Laplace's equation in Cartesian and polar coordinates (two dimensional).

Integral Transforms (Fourier Transform): Introduction, definition, Fourier integral, Sine and Cosine integrals, Complex form of Fourier integral, Fourier transform, Fourier Sine and Cosine transforms, Finite Fourier Sine and Cosine transforms, properties of Fourier transforms.

Convolution theorem for Fourier transforms, Parseval's identity for Fourier transforms, Fourier transforms of the derivatives of a function, simple applications to Boundary value problems.

Text Book:

Scope and treatment as in "Higher Engineering Mathematics", by Dr. B.S.Grewal, **43rd Edition**, Khanna Publishers.

Reference Books:

1. Graduate Engineering Mathematics by V B Kumar Vatti, I.K.International publications
2. Advanced Engineering Mathematics by Erwin Kreyszig.
3. A text book of Engineering Mathematics by N.P. Bali and Dr. Manish Goyal, Lakshmi Publications.
4. Mathematical Methods of Science & Engineering aided with MATLAB by Kanti B.Dutta, Cengage Learning India Pvt. Ltd.
5. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw Hill Company.
6. Advanced Engineering Mathematics by H.K.Dass. S.Chand Company.

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CH-2102 FLUID MECHANICS

Course Objectives:

To provide

- Knowledge on pressure distribution in static fluids.
- Knowledge on rheological behavior of fluids, types of fluid flow, boundary layers and basic equations of fluid flow.
- Knowledge of incompressible & compressible fluid flow in pipes
- Knowledge on fluid flowing past solid surfaces
- Knowledge on pipes, fittings, transportation and metering devices.

Course Outcomes:

At the end of the course, the student will be able to

- Derive dimensionless groups by using dimensional analysis.
- Solve problems related to manometers and decanters using the principles of fluid statics.
- Determine the pipe size / flow rate / power requirements under laminar and turbulent flow conditions.
- Solve problems involving motion of particles in fluid, fluid–solid operations in packed beds and fluidized beds.
- Select machinery and measuring devices for fluid flow.

SYLLABUS

Dimensional Analysis: Units and Dimensions, Dimensional Homogeneity, Dimensional Analysis, Buckingham π theorem, Geometric similarity, kinematic similarity, and dynamic similarity.

Fluid Statics and Applications: Nature of fluids, Hydrostatic Equilibrium, Applications of fluid statics – Manometers, continuous gravity decanter and centrifugal decanter.

Fluid Flow Phenomena: Laminar flow, shear rate, shear stress. Rheological properties of fluids – Newtonian fluids, Non Newtonian fluids, time dependent flow, viscoelastic fluids. Viscosity, Reynolds number, Turbulence - nature of turbulence, deviating velocities, intensity and scale of

turbulence, Reynolds stresses and eddy viscosity. Boundary layers - boundary layer formation over flat plate, flow in boundary layers, laminar and turbulent flow in boundary layers, boundary layer formation in straight tubes, boundary layer separation and wake formation.

Basic Equations of Fluid Flow: Continuity equation (Mass Balance in a flowing fluid), equation of motion (Differential Momentum Balance), Navier - stokes equations, Euler's equation, Couette flow, Macroscopic Momentum Balance, layer flow with free surface, Bernoulli equation (Energy equation), corrections for effect of solid boundaries and pump work.

Incompressible Flow in Pipes and Channels : Shear Stress and skin friction in pipes, Relation with skin friction and wall shear, Friction factor, relations between skin friction parameters, equivalent diameter, laminar flow in pipes and channels, velocity distribution, average velocity, Kinetic energy correction factor and momentum correction factor for laminar flow, Hagen-Poiseuille equation, laminar flow of non-Newtonian liquids, laminar flow in annulus. Turbulent flow in pipes and channels, Velocity distribution for turbulent flow, universal velocity distribution equations, its limitations, flow quantities for turbulent flow in smooth round pipes, Reynolds number- friction factor law for smooth tubes, effect of roughness, friction factor chart, drag reduction, friction from changes in velocity or direction – sudden expansion, sudden contraction, pipe fittings, friction losses in Bernoulli equation, velocity heads, separation of boundary layer in diverging channel, minimizing losses.

Flow in Compressible Fluids: Definitions and basic equations, processes of compressible flow, isentropic flow through nozzles, Adiabatic friction flow, Isothermal friction flow

Flow Past Immersed Objects: Drag and drag coefficients, flow through bed of solids, Motion of particles through fluids - mechanics of particle motion, equation for one-dimensional motion of particles through fluid, terminal velocity, criterion for settling, free and hindered settling. Fluidization – conditions, minimum fluidization velocity, types of fluidizations and its applications.

Transportation and Metering of Fluids: Pipes, fittings, valves. Positive displacement Pumps – reciprocating, rotary and peristaltic pumps. Centrifugal pumps - theory, construction, performance, single and multistage pumps. Fans, Blowers and Compressors. Vacuum pumps – jet ejectors.

Metering of Fluids: Full bore meters – Venturi meter, Orifice meter, Rotameters, Vortex-Shedding meters, Magnetic meters and Coriolis meters. Insertion meters – Pitot Tube, Thermal meters, notches and weirs.

Text Book:

"Unit Operations of Chemical Engineering" Seventh Edition, by W.L. McCabe, J C Smith and P Harriot, Mc Graw Hill

Reference Book:

"Chemical Engineering" Volume I by Coulson J.M. and Richardson J.F, Elsevier

"Fluid Mechanics" 2nd edition by Noel de Nevers, Mc Graw Hill

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CH-2103 PARTICLE & FLUID PARTICLE PROCESSING

Course Objectives:

Mechanical Operations is one of the core subjects for chemical engineers, where student can learn some of the unit operations necessary for process industry. Main objectives of the inclusion of this subject are:

- To make the students exposed to different geometrical sizes of raw materials used in the industries, area of calculation of the particles w.r.t their sizes
- To get familiarity with the different laws of grinding
- To do the power consumption calculations
- To learn different separation process on their physical properties
- To differentiate between the process such as mixing and agitation
- To know the movement of particles in different liquids (viscous)

Course Outcomes:

At the end of the course, student will be able to

- Select suitable size reduction equipment based on performance and power requirement.
- Analyze particle size distribution of solids
- Evaluate solid-fluid separation equipment
- Determine the power required for agitation, blending and mixing
- Select conveyers for the transportation of materials in the industry

SYLLABUS

Characteristics of Solid Particles: shape, size, differential and cumulative screen analysis, specific surface area, particle population, different mean diameters for a mixture of particles.

Principles of Communication: Laws of crushing, description and working of size reduction equipment - jaw, gyratory and roll crushers, hammer mills, revolving mills, attrition mills, fluid

energy mill, cutting machines, open and closed circuit grinding, wet and dry grinding, grindability index.

Size Separation: screening, industrial screens - grizzly, gyratory and vibratory screens, revolving screens, trammels, capacity and effectiveness of screens, magnetic separation, electrostatic separation, froth flotation.

Filtration: Description and working of filtration equipment, plate and frame filter press, shell and leaf filters, rotary drum filter, filter aid, centrifugal filtration, top suspended batch centrifuge, theory of filtration, washing of cakes.

Motion of Particles Through Fluids: Drag, free and hindered settling, settling velocities, classification, sink and float methods, differential setting methods - jigging and tabling, cyclone separators.

Batch Sedimentation: Thickeners, flocculation, centrifugal sedimentation, gravity and centrifugal decanters.

Agitation of Liquids: Power consumption in agitated vessels, scale up of agitation equipment, mixing equipment for mixing of solids and pastes, mixers for dry powders, mixing index.

Conveying: types of conveyors – mechanical, belt, chain and screw conveyors, elevators, pneumatic conveyors, size enlargement - need and applications.

Text Book:

'Unit Operations of Chemical Engineering' by W.L. McCabe, J.C. Smith and P.Harriot, McGraw- Hill Book Company

Reference Books:

1. 'Chemical Engineering -Vol.2' by J.H.Coulson and J.F.Richardson, Pergaman press and ELBS
2. 'Chemical Engineer's Hand Book' by R.H.Perry {ed}, McGraw-Hill Book Co.
3. 'Unit Operations' by Brown et al., Asian Publishing House
4. 'Introduction to Chemical Engineering' by Badger and Banchero, McGraw-Hill Book Company

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CH-2104 HEAT TRANSFER

Courses Objectives:

- To study the fundamental concepts of heat transfer viz., conduction, convection, radiation.
- To use these fundamentals in typical engineering applications (Heat exchanger and Evaporator, boiling and condensation.) and current research

Course Outcomes:

At the end of the course, the student will be able to

- Analyze problems involving steady state heat conduction in simple geometries
- Develop equations for different types of convection and solve for heat transfer rate by convection in flow through pipes and flow over a flat plate
- Design of shell and tube heat exchangers using LMTD and effectiveness method
- Estimate the rate of radiation heat transfer with and without participating medium and ability to identify the roll of radiation shields
- Estimate steam economy, capacity of single and multiple effect evaporators
- Understand the concepts of boiling and condensation

SYLLABUS

Nature of Heat Flow: Conduction, convection, natural and forced convection, radiation.

Heat transfer by Conduction : Basic laws of conduction, thermal conductivity; Steady-state conduction – compound resistances in series, heat flow through a cylinder; Unsteady-state conduction – one dimensional heat flow with constant surface temperature, het flow with variable surface temperature, semi-infinite solid.

Heat transfer by Convection: Principles of heat flow in fluids – Typical heat exchange equipment, countercurrent and parallel flows, energy balances, heat flux and heat transfer coefficients, overall heat transfer coefficients, integration over total surface, LMTD, individual heat transfer coefficients.

Heat Transfer to Fluids without Phase Change : Boundary layers, laminar flow heat transfer, correction for heating and cooling, heat transfer in turbulent flow, estimation of wall temperature, cross-sections other than circular, analogy between transfer of momentum and heat, heat transfer

to liquid metals, heating and cooling of fluids outside tubes, natural convection.

Heat Transfer to Fluids with Phase Change: heat transfer from condensing vapors, heat transfer to boiling liquids.

Radiation Heat Transfer: Fundamental facts concerning radiation, emission of radiation, absorption of radiation by opaque solids, radiation between surfaces, radiation to semitransparent materials, combined heat transfer by conduction-convection-radiation.

Heat-exchange Equipment: General design of heat exchange equipment, shell and tube heat exchangers, plate-type exchangers, extended surface equipment, heat pipes, scraped-surface exchangers, condensers and vaporizers, heat transfer in agitated vessels, heat transfer in packed beds.

Evaporation: Evaporation, types of evaporators, performance of tubular evaporators, multiple-effect evaporators, methods of feeding, vapor compression.

Text Book:

Unit Operations of Chemical Engineering, 7th Ed. by W. L. McCabe, J. C. Smith and P. Harriot, McGraw Hill International Edition, Singapore (2005).

Reference Book:

Process Heat Transfer, by D. Q. Kern, Tata McGraw Hill, New Delhi.

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CH-2105 MANAGERIAL ECONOMICS

Course Objectives:

1. To bring about an awareness about the nature of Managerial Economics and its linkages with other disciplines.
2. To understand the Micro and Macro Environment of Business.
3. To familiarize the prospective engineers with the concepts and tools of Managerial Economics with an objective to understand the real world of business.

Course Outcomes:

After completion of the course, student will be able to:

1. Understand the various economic activities in business and industry.
2. Analyse the real world business problems.
3. Make optimal business decisions for the effective and efficient management of Organisations.

Unit –I

Significance of Economics and Managerial Economics:

Economics: Definitions of Economics- Wealth, Welfare and Scarcity definitions Classification of Economics- Micro and Micro Economics.

Managerial Economics: Definition, Nature and Scope of Managerial Economics, Differences between Economics and Managerial Economics, Main areas of Managerial Economics, Managerial Economics with other disciplines.

Unit-II

Demand and Utility Analysis:

Demand - Definition, Meaning, Nature and types of demand, Demand function, Law of demand - Assumptions and limitations. Exceptional demand curve.

Elasticity of demand - Definition, Measurement of elasticity, Types of Elasticity (Price, Income, Cross and Advertisement), Practical importance of Price elasticity of demand, Role of income elasticity in business decisions, Factors governing Price Elasticity of demand.

Utility Analysis: Utility- Meaning, Types of Economic Utilities, Cardinal and Ordinal Utility, Total Utility, Marginal Utility, The law of Diminishing Marginal Utility and its Limitations**.**

Unit –III

Theory of Production and Cost analysis:

Production - Meaning, Production function and its assumptions, use of production function in decision making;

Cost analysis - Nature of cost, Classification of costs - Fixed vs. Variable costs, Marginal cost, Controllable vs. Non - Controllable costs, Opportunity cost, Incremental vs. Sunk costs, Explicit vs. Implicit costs, Replacement costs, Historical costs, Urgent vs. Postponable costs, Escapable vs. Unavoidable costs, Economies and Diseconomies of scale.

Unit –IV

Market Structures : Definition of Market, Classification of markets; Salient features or conditions of different markets - Perfect Competition, Monopoly, Duopoly , Oligopoly, Importance of kinked demand curve ;Monopolistic Competition.

Unit –V

Pricing and Business Cycles:

Pricing Analysis : Pricing – Significance; Different Pricing methods- Cost plus pricing, Target pricing, Marginal cost pricing, Going -rate pricing, Average cost pricing, Peak load pricing , Pricing of joint Products, Pricing over the life cycle of a Product, Skimming pricing Penetration pricing, Mark- up and Mark- down pricing of retailers.

Business cycles - Definition, Characteristics, Phases, Causes and Consequences; Measures to solve problems arising from Business cycles.

Text Books:

1. Sankaran,S., **Managerial Economics,**Marghan Publications, 2015, Chennai.
2. Aryasri, A.R., **Managerial Economics and Financial Analysis,** MC Graw Hill Education, New Delhi,2015.

Reference Books:

1. Dwivedi, D.N., **Managerial Economics,**Vikhas Publishing House Pvt. Ltd. 6th Edition, New Delhi,2004.
2. Dewett, K.K., **Modern Economic Theory**, S.Chand& Company Ltd., New Delhi, 2005.

CH-2106 FLUID MECHANICS LABORATORY

Course Objectives:

- The student will be exposed to various fluid measuring devices. The pressure drop calculation experimentally across the pipe fittings, valves, packed bed, fluidized bed and annulus will also be dealt in this lab.

Course Outcomes:

At the end of the course, the student will be able to

- Distinguish laminar and turbulent flows.
- Determine the characteristics of flow meters
- Determine the characteristics of packed & fluidized beds and centrifugal pumps
- Calculate pressure drop across a pipe, valves and fittings.

List of Experiments:

1. Identification of laminar and turbulent flows (Reynolds apparatus)
2. Measurement of point velocities (Pitot tube)
3. Verification of Bernoulli equation
4. Calibration of rotameter
5. Variation of orifice coefficient with Reynolds number
6. Determination of venturi coefficient
7. Friction losses in fluid flow in pipes
8. Pressure drop in a packed bed for different fluid velocities
9. Pressure drop and void fraction in a fluidized bed
10. To study the coefficient of contraction for a given open orifice
11. To study the coefficient of discharge in a V - notch
12. To study the characteristics of a centrifugal pump

CH-2107 PARTICLE & FLUID PARTICLE PROCESSING LABORATORY

Course Objectives:

- Solid processing is an essential component in process industries. In the present day, when the world is facing the challenge of dealing with depleting mineral resources, this subject assumes high importance to the students of chemical engineering. The student is introduced to the concepts of sampling, processing of solid raw materials. The student also gets hands on training on operating various machines used for processing of solids.

Course Outcomes:

At the end of the course, the student will be able to

- Select suitable methods for size reduction of minerals or other intermediates
- Analyze particle size distribution of solids
- Evaluate suitable mechanical separations of powders, solid-liquid and solid-gas mixtures

List of Experiments:

1. To take a representative sample from a bulk by two methods, viz. Riffle and cone & quartering and to find out the average size (volume-surface mean diameter) of the samples
2. To determine the grindability index {GI} of coal by hard groove machine
3. To determine the time of grinding in a ball mill for producing a product with 80% passing a given screen
4. To verify the laws of crushing using any size reduction equipment like crushing rolls, ball mill or vibrating mill and to find out the work Index {WI} of the material
5. To compare open circuit and closed circuit grinding by means of a ball mill
6. To determine the optimum time of sieving for a given sample of material
7. To find the effectiveness of hand screening of a given sample by a given screen
8. To find the screen effectiveness of a trommel
9. To separate a mixture of coal into two fractions using sink and float method
10. To separate a mixture of coal into two fractions using froth flotation technique
11. To find the size analysis of a given fine sample using beaker decantation method

12. To separate a mixture of particles by jigging
13. To concentrate a given material by means of tabling
14. To obtain batch sedimentation data and to calculate the minimum thickener area under given conditions
15. To determine the specific cake resistance and filter medium resistance of a slurry in plate and frame filter press.

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CH-2108 HEAT TRANSFER LABORATORY

Course Objectives:

- The student will calculate the thermal resistance and calculation of heat transfer coefficients for both natural and forced convection scenarios. The student will conduct experiments to calculate emissivity of the given plate, radiation constant of the given rod and Stefen Boltzman constant.

Course Outcomes:

At the end of the course, the student will be able to

- Determine thermal conductivity of composite solids and thermal conductivities of lagging material in lagged pipe apparatus.
- Determine heat transfer coefficients in forced and natural convection.
- Determine the Stefan Boltzmann constant and emissivity of the given plate.
- Calculate radiation constant for hot rod loosing heat to the infinite stagnant ambient.
- Analyze the heat exchanger performance(double pipe) for co-current and counter-current flows and determine overall heat transfer coefficient.

List of Experiments:

1. Determination of total thermal resistance and thermal conductivity of composite wall.
2. Determination of total thermal resistance and thermal conductivity of Lagged pipe.
3. Determination of the natural convective heat transfer coefficient for a vertical tube.
4. Determination of forced convective heat transfer coefficient for air flowing through a pipe.
5. Determination of over-all heat transfer coefficient in double pipe heat exchanger.
6. Study of the temperature distribution along the length of a pin fin under natural and forced convection conditions.
7. Estimation of unsteady state film heat transfer coefficient between the medium in which the body is cooled.
8. Determination of Stefan-Boltzmann constant.
9. Determination of emissivity of a given plate at various temperatures.
10. Determination of radiation constant of a given surface.
11. Determination of the thermal conductivity of a metal rod.
12. Determination of critical heat flux point for pool boiling of water

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CH-2109 MATLAB

Course Objectives:

- The student will learn to apply the knowledge of *MATLAB* for solving Chemical Engineering problems.

Course Outcomes:

At the end of the course, the student will be able to

- Apply MAT Lab to create and print arrays and execute function files
- Solve linear equations using MAT Lab
- Determine the curve fit equation for the given data
- Draw 2D plots and 3D plots for the given data

SYLLABUS

Introduction: Tutorial lessons: MATLAB session, working with arrays of numbers, creating and printing simple data, saving and executing a script file, creating and executing function files, working with files and directories.

Interactive Computation: Matrices and vectors, matrix and array operations, creating and using inline functions, using built in functions and online help, saving and loading data, plotting simple graphs.

Script files: function files, language specific features, advanced data objects.

Applications: linear algebra, curve fitting and interpolation, data analysis and statistics, numerical integration, ordinary differential equations, nonlinear algebraic equations.

Basic 2D plots: using subplot to layout multiple graphs. 3-D plots, symbolic Math tool box: two useful tools in symbolic Math tool box, using symbolic Math tool box.

Text Book:

`Getting started with MATLAB: A quick introduction for scientists and engineers' by Rudra Pratap, Oxford University press

CH-2110 PROFESSIONAL ETHICS AND UNIVERSAL HUMAN VALUES

Common for all B.Tech and B.Tech+M.Tech Integrated Courses
(w.e.f. 2022-2023)

Course Objectives:

- To recognize the moral values that should guide the Engineering profession.
- To resolve moral issues concerning one's profession.
- To develop and exhibit a set of moral beliefs and attitudes that engineers should inculcate.
- To inculcate social values and morality in one's life.
- To develop awareness about Professional/Engineering Ethics and Human Values.

Learning Outcomes:

Students will be able to:

- Apply the conceptual understanding of ethics and values into everyday practice.
- Understand the importance of moral awareness and reasoning in life.
- Acquire professional and moral etiquette that an engineer requires.
- Develop the acumen for self-awareness and self-development.
- Develop cultural tolerance and integrity.
- Tackle real-life challenges with empathy.

CONTENTS

Unit - I: HUMAN VALUES

Values - Respect - Caring - Sharing - Honesty- Courage - Self confidence - Communal Harmony Morals - Virtues

Unit –II PROFESSIONAL VALUES

Integrity - Discipline - Valuing time - Cooperation - Commitment - Code of conduct - Challenges in the workplace

Unit – III PROFESSIONAL ETHICS

Overview - Engineering ethics - Moral issues - Profession - Models of professional roles - Responsibility

Unit – IV RESPONSIBILITIES AND RIGHTS

Safety and risk - Collegiality and loyalty - Confidentiality - Occupational crime - Human rights - Employee rights - Intellectual property rights

Unit – V GLOBAL ISSUES

Globalization - Environmental ethics - Computer ethics - Code of ethics - Multinational corporations - Engineers as advisors in Planning and Policy making

Suggested Textbook:

R.S. Nagarazan. *A Textbook on Professional Ethics and Human Values.* New Age International Publishers. 2006.

Reference Books:

Premvir Kapoor. *Professional Ethics and Human Values.* Khanna Publishing House. 2019.

B.S. Raghavan. *Human Values and Professional Ethics*. S.Chand Publications. 2012.

R.R. Gaur & Others. *A Foundation Course in Human Values and Proff. Ethics*. Excel Books. 2009.

A. N. Tripathi. *Human Values*. New Age International (P) Limited. 2009

R. Subramanian. *Professional Ethics*. OUP India. 2013.

CH-2111 NCC/NSS

All the students should enroll either in NCC or NSS and get a satisfactory report.

Course Outcomes:

- To provide a suitable environment to motivate the youth to take up a career in the armed forces
- Develop character discipline secular outlook the spirit of adventure, sportsman spirit and ideals of selfless service amongst cadets by working on teams honing qualities and dignity of labour.

CH-2201 MATERIALS SCIENCE & ENGINEERING

Course Objectives:

Materials science and engineering is an important subject to every engineer to understand about the materials' behavior in different environments. Main objectives of the study are as follows:

- To understand the structure of atoms
- To learn something about the crystalline nature of the materials
- To know about the influence of atoms controlling the properties of materials
- To know the equivalency of the materials for replacement
- To learn to prepare alloys, composites for conventional materials
- To find the relation between arrangement an thermodynamic properties of materials

Course Outcomes:

- To know about the appropriate utility of materials based on their nature.
- To know the behavior of the materials w.r.t their directions.
- To know the behaviour of materials exposed to different conditions in different phases.
- To calculate the stability materials and knew the importance of crystalllinity.
- Selectivity of the materials for suitable design to manufacture the machines
- To improve the properties choosing alternative materials suchas alloys, composites instead of conventional materials (to minimize fractures, wear and tear).
- Leads to prepare some knew semiconductors for important purposes.

SYLLABUS

An introduction to materials: Classification of engineering materials, brief review of atomic structure, calculation of energy of electron of Bohr's atomic model, Bonds in materials – classification, properties of ionic, covalent and metallic solids, variation in bonding character and properties. Crystal Geometry and crystal structure – solids- crystalline solids and amorphous solids (non-crystalline), differences between crystalline and non-crystalline materials. Ideal crystal, space Lattice, unit cell, primitive cell, non-primitive cell, lattice co-ordinates, Bravis lattices for crystal systems, crystal systems and their properties, symmetry and elements of symmetry, Atomic packing faction and packing efficiency (SC, BCC, FCC, Diamond cubic and HCP structures), c/a ratio for HCP structure. Miller indices for directions and linear density

calculation, planes in crystals and their representation, planar density calculation, coordination number. Determination of crystal Structure by X-ray diffraction method – Debye method, numerical problems for different cubic structures (SC, BCC and FCC).

Fundamentals of Thermodynamics : Stability and meta-stability of materials, internal energy (E), enthalpy (H), Gibb's free Energy (G), and thermal entropy and configurational entropy (S). solid solutions-types, crystal imperfections – classification, point defects- classification and estimation of point defects in the crystals; Imperfections (dislocations) – classification (edge and screw); Berger circuits and Burgers Vector, planar defects, volume defects, dislocation reactions, role of dislocations in determining crystal properties; surface defects - types

Mechanical Properties: Stress –types of stresses; Strain-types of strain; true stress and true strain, engineering stress and engineering strain of the materials, relation between engineering strain and true strain, relation between engineering stress and true stress; Hooke's Law; Poisson's Ratio, stress-strain diagram and its uses; different moduli of elasticity – Young's modulus, shear modulus, and bulk modulus; relation between different moduli of elasticity, strain vs stress relationship diagrams for different materials (metals, non-metals, rubbers and plastics and polymers); elastic deformation and plastic deformation and their differences. Critical Resolved shear stress (CRSS). Fracture – types, ductile fracture and its mechanism, brittle fracture and its mechanism (Griffith's criteria), fatigue factors affecting the fatigue, creep and creep failure mechanisms, creep resistance materials. Composite materials – classification, advantages of composite materials over conventional materials, Limitations of composite materials, factors affecting the performance of fibrous composites, factors affecting the performance of matrix in composites,

Phase- time scale for phase changes, Phase diagrams- phase rule, single component systems, Binary phase changes, the lever rule and numerical problems, advantages of phase diagrams, advantages of alloying of metals on the properties of steels, Iron-iron carbide (Fe-Fe_3C) phase diagram, limitations of plain carbon steels, types of steels used in chemical industries,

Corrosion and Prevention: Principles and mechanism of corrosion, types of corrosion cells: composition cell, concentration cell, stress cells, Different forms of corrosion, prevention and control of corrosion: proper selection of materials, proper design and fabrication procedure, application of protective coatings.

Text Books:

1. `Materials Science & Engineering' by V.Raghavan, Prentice Hall of India Ltd, New Delh
2. `Elements of Materials Science & Engineering', 5th Edition, Lawrence H.VanVlack, Addision-Weley Publishing Company

Reference Books:

1. `Science of Engineering Materials', Vols.1-3, by Manas Chanda, McMillan Company of India, Delhi
2. `Principles of Materials Science & Engineering', William F.Smith, McGraw-Hill Publishing Co.
3. `Essentials of Materials Science' by A.G. Guy.
4. A textbook of Engineering physics, by Dr.M.N.Avadhanulu and Dr.P.G.Kshirsagar; S.Chand and company pvt Ltd. Chapters 26 and 27.
5. An introduction to corrosion science and engineering By Herbert Uhilig and R. Winston Revie, Published by John Wiley and sons, New York.
6. Corrosion Engineering by Mars.G.Fontana, McGraw-Hill, publication

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CH-2202 PYTHON PROGRAMMING

Course Objectives

1. To develop skills on procedural oriented and object oriented programming in Python
2. To understand and apply different data wrangling techniques using Python.
3. To perform data analysis using python libraries like NumPy, Pandas and exploratory data analysis using Matplotlib

Course Outcomes

At the end of the course, a student should be able to:

1. acquire programming knowledge on Basics of Python
2. acquire programming knowledge on Text and File Handling
3. develop Python programs to Mean, Median, Mode, Correlation
4. acquire programming knowledge on NumPy, Pandas Library
5. acquire programming knowledge on Graph Visualizations in Python and Data Analysis using Python

Syllabus

1. **Introduction to Python: Rapid Introduction to Procedular Programming, Data Types**: Identifiers and Keywords, Integral Types, Floating Point Types

   Strings: Strings, Comparing Strings, Slicing and Striding Strings, String Operators and Methods, String formatting with str.format

   Collections Data Types: Tuples, Lists, Sets, dictionaries, Iterating and copying collections
2. **Python Control Structures, Functions and OOP: Control Structures and Functions**: Conditional Branching, Looping, Exception Handling, Custom Fuctions

   Python Library Modules: random, math, time, os, shutil, sys, glob, re, statistics, creating a custom module

   Object Oriented Programming: Object Oriented Concepts and Terminology, Custom Classes, Attributes and Methods, Inheritance and Polymorphism, Using Properties to Control Attribute Access

   File Handling: Writing and Reading Binary Data, Writing and Parsing Text Files
3. **NumPy Arrays and Vectorized Computation**: NumPy arrays, Array creation, Indexing and slicing, Fancy indexing, Numerical operations on arrays, Array functions, Data processing using arrays, Loading and saving data, Saving an array, Loading an array, Linear algebra with NumPy, NumPy random numbers
4. **Data Analysis with Pandas**: An overview of the Pandas package, The Pandas data structure-Series, The DataFrame, The Essential Basic Functionality: Reindexing and altering labels , Head and tail, Binary operations, Functional statistics , Function application Sorting, Indexing and selecting data, Computational tools, Working with Missing Data, Advanced Uses of Pandas for Data Analysis - Hierarchical indexing, The Panel data
5. **Data Analysis Application Examples**: Data munging, Cleaning data, Filtering, Merging data, Reshaping data, Data aggregation, Grouping data
6. **Data Visualization**: The matplotlib API primer-Line properties, Figures and subplots, Exploring plot types-Scatter plots, Bar plots, Histogram plots, Legends and annotations, Plotting functions with Pandas

Text Books

1. Programming in Python 3: A Complete Introduction to Python Language, Mark Summerfield, Second Edition, Addison-Wesley Publications
2. Python: End-to-End Data Analysis Learning Path, Module 1: Getting Started with Python Data Analysis , Phuong VothiHong , Martin Czygan, , Packt Publishing Ltd

Reference Books

1. Learning Python, 5th Edition, Mark Lutz, Orielly Publications
2. Python for Data Analysis, Wes McKinney, Orielly Publications
3. How to Think Like a Computer Scientist: Learning with Python 3 Documentation 3rd Edition, Peter Wentworth, Jeffrey Elkner, Allen B. Downey, Chris Meyers
4. Core Python Programming, Second Edition, Wesley J. Chun, Prentice Hall
5. Python Cookbook – Recipes for Mastering Python 3,3rdEdition, David Beazley, Brian K. Jones, Oreilly

CH-2203 MATERIAL & ENERGY BALANCES

Course Objectives:

- To give intensive quantitative training in the practical applications of the principles of physical chemistry to the solution of complicated industrial problems and in methods of predicting missing physicochemical data from generalized principles.

Course Outcomes:

At the end of the course, the student will be able to

- Convert physico-chemical quantities from one system of units to another.
- Identify basis and degrees of freedom.
- Perform material and energy balances on single units without and with chemical reactions.
- Solve the material and energy balance problems on multi-unit processes with recycle, purge and bypass.
- Analyze the ideal and real behavior of gases, vapors and liquids.

SYLLABUS

Stoichiometry and Composition Relationships: The gram-mole and pound-mole, limiting reactant, excess reactant, degree of completion, basis of calculation, weight percent, volume percent and mole percent, density and specific gravity- Baume and API gravity scales.

Behavior of Ideal Gases: Application of the ideal-gas law, Dalton and Amagat laws to gaseous mixtures, composition of gases on dry basis and on wet basis.

Vapor Pressures: Effect of temperature on vapor pressure, Antoine equation, reference substance vapor pressure plots, vapor pressure of immiscible liquids, ideal solutions and Raoult's law, non-volatile solutes.

Humidity: Percentage saturation, relative saturation or relative humidity, dew point, vaporization, condensation, wet and dry bulb temperatures, adiabatic vaporization and adiabatic saturation temperature.

Material Balances: Tie substance, yield, conversion, processes involving chemical reactions, material balance- calculations involving drying, dissolution, and crystallization, processes involving recycle, bypass and purge.

Heat Capacities of Gases and Gaseous Mixtures: Effect of temperature on heat capacity of gas, mean heat capacity of gas, Kopp's rule, latent heats, heat of fusion, heat of vaporization, Trouton's rule, Kistyakowsky equation for non-polar liquids, estimation of latent heat of vaporization using Classius-Clayperon equation, enthalpy of humid air and humid heat capacity.

Standard Heat of Reaction: Standard heat of formation, laws of thermochemistry, standard heat of combustion, calculation of heat of formation from heats of combustion, calculation standard heat of reaction from heats of formation and from heats of combustion, standard integral heat of solution, effect of temperature on heat of reaction, Kirchoff's equation, adiabatic and non-adiabatic reactions, theoretical and actual flame temperatures.

Text Book:

'Chemical Process Principles, Part-I - Material and Energy balances' by Olaf A Hougen, K.M. Watson and R.A.Ragatz, CBS Publishers and Distributors (1995)

Reference Books:

1. 'Basic principles and Calculations in Chemical Engineering' by David M. Himmelblau, Prentice Hall of India Pvt Ltd, 1995
2. 'Stoichiometry' by B.I. Bhatt and S.M. Vora, 3rd Edition, Tata McGraw Hill Publishing Company Limited, New Delhi (1996)
3. 'Stoichiometry for Chemical Engineers' by Williams and Johnson, McGraw Hill Publishers.

CH-2204 CHEMICAL ENGINEERING THERMODYNAMICS

Course Objectives:

Knowledge of thermodynamics helps student compute heat and work requirements of a process.

The student would also learn

- How to estimate data in case of absence of experimental data.
- Solution thermodynamics and its applications.
- Concept of Phase & Chemical reaction equilibrium.

Course Outcomes:

At the end of the course, the student will be able to

- Apply the first and second laws of thermodynamics to chemical processes and Compute the properties of ideal and real gas mixtures.
- Evaluate heat effects involved in industrial chemical processes.
- Evaluate the efficiency of expansion and compression flow processes and analyze refrigeration and liquefaction processes.
- Determine thermodynamic properties of gaseous mixtures and solutions, Estimate Bubble-P & T, Dew-P & T for binary and multi-component systems and Calculate vapor-liquid equilibrium (VLE) composition for ideal and non-ideal systems.
- Determine equilibrium constant and composition of product mixture for single and multiple reactions.

SYLLABUS

The First Law and other Basic Concepts: Introduction to Basic laws and Terminologies in Thermodynamics- Statement of First law, the steady-state, steady-flow process, the reversible process.

Volumetric Properties of Pure Fluids: PVT behavior of pure substances, the ideal gas, virial equations and its applications, cubic equations of state, generalized correlations for gases and liquids.

Heat Effects: Latent heats of pure substances, Temperature dependence of heat effects of chemical reactions.

The Second Law of Thermodynamics: Statements of second law- Clausius Inequality-Mathematical Statement of Second law, Third law of thermodynamics.

Thermodynamic Properties of Pure Fluids: Property relations for homogeneous phases, residual properties.

Solution Thermodynamics: chemical potential, partial properties, ideal gas mixtures, fugacity and fugacity coefficient for a pure species and species in solution, generalized correlations for the fugacity coefficients, the ideal solution, excess properties. VLE-Duhem's theorem, VLE- qualitative behavior, Raoults law and modified Raoults law, dew point and bubble point calculations, flash calculations.VLE for Ideal solutions, Calculation of activity coefficients.

Chemical Reaction Equilibria: Criteria for chemical reaction equilibrium, the standard Gibbs energy change and the equilibrium constant, Effect of temperature, pressure, composition and other factors.

Text Book:

`Introduction to Chemical Engineering Thermodynamics' by J.M.Smith, H.C.Van Ness and M.M.Abbott., 6th Edition, Tata McGraw-Hill Edition 2003.

Reference Books:

1. `Chemical Engineering Thermodynamics' by B.F.Dodge, McGraw-Hill Book Co.,
2. `Schaum Outline of Theory and Problems of Thermodynamics' by Michael M. Abbott and Hendrick C.VanNess, McGraw-Hill International Book Co., Singapore, 1981.
3. `Chemical Engineering Thermodynamics' by Y.V.C.Rao, University Press (India) Ltd., Hyderabad 1997.
4. K.V.Narayanan, A Textbook of Chemical Engineering Thermodynamics, PHI Learning, 2004.

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CH-2205 GENERAL CHEMICAL TECHNOLOGY

Course Objectives:

- To provide the student understanding of importance of chemical process industries over the other manufacturing industries.
- To provide the brief introduction of chemical process equipments, the application of thermodynamics, the chemical process principles, the equipment design and also the corrosion and the safety aspects to consider in the chemical manufacturing processes.
- To provide basic inorganic chemistry background required for the undergraduate students of engineering.
- To provide an overview of chemical properties of inorganic chemicals and the manufacturing processes.
- To provide an overview of applications of materials which the engineers are likely to use during their professional career.

Course Outcomes:

At the end of the course, the student will be able to

- Selection of a process for manufacture of chemicals
- Draw process flow diagrams
- Identify the engineering problems in chemical processes
- List chemical reactions and their mechanism involved

SYLLABUS

Nitrogen industries: Manufacture of ammonia, nitric acid, urea and ammonium nitrate.

Phosphorous and phosphoric acid industries: Methods for production of phosphorous and phosphoric acid, manufacture of super phosphate and triple super phosphate.

Cement: Types of cement, manufacture of ordinary Portland cement, slag cement.

Coal and Coal chemicals: distillation of coal and coal tar, low and high temperature carbonization of coal.

Petrochemicals: Derivatives of C_2: Polyethylene, Ethanol, Ethylene oxide; Derivatives of C_3: Isoproponol, Acetone, Propylene oxide

Extraction of Vegetable Oils: Purification, acid value, hydrogenation of oils, Manufacture of fatty acids, soaps and detergents classification and manufacture.

Paints and Varnishes: Constituents of paints, functions of paint, manufacturing procedures, Pigments-manufacture of lithophone, varnishes

Manufacture of Pulp and Paper: Kraft process and sulphite process, production of paper

Manufacture of Sugar

Textbooks:

1. "Dryden's Outlines of Chemical Technology" by M.Gopala Rao & Marshall Sitting (Editors). Affiliated East West Press Pvt. Ltd.
2. "Shreve's Chemical Process Industries" by G.T.Austin, McGraw Hill Books

Reference Book:

"Encyclopedia of Chemical Technology" by R.E.Kirk & D.F.Othmer (Editors)Interscience.

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CH-2206 PYTHON PROGRAMMING LABORATORY

Course Objectives

1. familiarize students with key data structures in Python including lists and dictionaries and apply them in context of searching, sorting, text and file handling
2. introduce students to calculation of statistical measures using Python such as measures of central tendency, correlation
3. familiarize students with important Python data related libraries such as Numpy and Pandas and use them to manipulate arrays and dataframes
4. introduce students to data visualization in Python through creation of line plots, histograms, scatter plots, box plots and others
5. implementation of basic machine learning tasks in Python including pre-processing data, dimensionality reduction of data using PCA, clustering, classification and cross-validation.

Course Outcomes

After completion of the course the student should be able to:

1. implement searching, sorting and handle text and files using Python data structures such as lists and dictionaries
2. calculate statistical measures using Python such as measures of central tendency, correlation
3. use Python data related libraries such as Numpy and Pandas and create data visualizations
4. implement basic machine learning tasks pre-processing data, compressing data, clustering, classification and cross-validation.

Syllabus

1. Python Programs on lists & Dictionaries
2. Python Programs on Searching and sorting
3. Python Programs on Text Handling
4. Python Programs on File Handling
5. Python Programs for calculating Mean, Mode, Median, Variance, Standard Deviation
6. Python Programs for Karl Pearson Coefficient of Correlation, Rank Correlation
7. Python Programs on NumPy Arrays, Linear algebra with NumPy
8. Python Programs for creation and manipulation of DataFrames using Pandas Library

9. Write a Python program for the following.
    - Simple Line Plots,
    - Adjusting the Plot: Line Colors and Styles, Axes Limits, Labeling Plots,
    - Simple Scatter Plots,
    - Histograms,
    - Customizing Plot Legends,
    - Choosing Elements for the Legend,
    - Boxplot
    - Multiple Legends,
    - Customizing Colorbars,
    - Multiple Subplots,
    - Text and Annotation,
    - Customizing Ticks
10. Python Programs for Data preprocessing: Handling missing values, handling categorical data, bringing features to same scale, selecting meaningful features
11. Python Program for Compressing data via dimensionality reduction: PCA
12. Python Programs for Data Clustering
13. Python Programs for Classification
14. Python Programs for Model Evaluation: K-fold cross validation

Reference Books

1. Core Python Programming, Second Edition, Wesley J. Chun, Prentice Hall
2. Chris Albon, “Machine Learning with Python Cookbook-practical solutions from preprocessing to Deep learning”, O’REILLY Publisher,2018
3. Mark Summerfield, Programming in Python 3--A Complete Introduction to the Python Language, Second Edition, Additson Wesley
4. Phuong Vo.T.H , Martin Czygan, Getting Started with Python Data Analysis, Packt Publishing Ltd
5. Armando Fandango, Python Data Analysis, Packt Publishing Ltd
6. Magnus Vilhelm Persson and Luiz Felipe Martins, Mastering Python Data Analysis, Packt Publishing Ltd
7. Sebastian Raschka& Vahid Mirjalili, “Python Machine Learning”, Packt Publisher, 2017

CH-2207 GENERAL CHEMICAL TECHNOLOGY LABORATORY

Course Objectives:

- The student will be made familiar with analysis of water, oils, coal, lime stone, bleaching powder saw dust etc. and preparations of soap, copper and chrome yellow pigments, Phenol formaldehyde resins.

Course Outcomes:

At the end of the course, the student will be able to

- Synthesize products such as soap, phenol formaldehyde resin, Chrome yellow pigment, and Copper pigment
- Estimation of total solids, dissolved solids,pH, chlorides, sulphates, temporary and permanent hardness in water
- Analyse acid value, Iodine value and sopanification value of oil
- Estimate the purity of various materials

List of experiments:

A. Analysis of water:

1. Total solids, dissolved solids,pH
2. Chlorides and sulphates
3. Temporary, permanent and total hardness.

B. Analysis of oils:

4. Acid value

5. Iodine value

6. Saponification value

C. Miscellaneous analysis:

7. Analysis of coal: Proximate analysis

8. Analysis of lime: Estimation of acid insoluble's, available lime and calcium carbonate

9. Analysis of bleaching powder: Estimation of chlorine content.

10. Analysis of starch/glucose: Estimation of total reducing sugars

11. Analysis of saw dust: Estimation of total cellulose and –cellulose

E. Miscellaneous preparations:

12. Preparation of soap

13. Preparation of copper pigment

14. Preparation of chrome yellow pigment

15. Preparation of phenol formaldehyde resin

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CH-2208 COMPUTER AIDED MACHINE DRAWING

OBJECTIVES:

- To make the students understand and interpret drawings of machine components ϖ
- To prepare assembly drawings both manually and using standard CAD packages ϖ
- To familiarize the students with Indian Standards on drawing practices and standard components
- To gain practical experience in handling 2D drafting and 3D modeling software systems.

DRAWING STANDARDS & FITS AND TOLERANCES Code of practice for Engineering Drawing, BIS specifications – Welding symbols, riveted joints, keys, fasteners – Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc. - Limits, Fits – Tolerancing of individual dimensions Specification of Fits – Preparation of production drawings and reading of part and assembly drawings, basic principles of geometric dimensioning & tolerancing.

INTRODUCTION TO 2D DRAFTING ϖ Drawing, Editing, Dimensioning, Layering, Hatching, Block, Array, Detailing, Detailed drawing. ϖ Bearings - Bush bearing, Plummer block ϖ Valves – Safety and non-return valves.

3D GEOMETRIC MODELING AND ASSEMBLY Sketcher - Datum planes – Protrusion – Holes - Part modeling – Extrusion – Revolve – Sweep – Loft – Blend – Fillet - Pattern – Chamfer - Round - Mirror – Section – Assembly ϖ Couplings – Flange, Universal, Oldham's, Muff, Gear couplings ϖ Joints – Knuckle, Gib & cotter, strap, sleeve & cotter joints ϖ Engine parts – Piston, connecting rod, cross-head (vertical and horizontal), stuffing box, multi-plate clutch ϖ Miscellaneous machine components – Screw jack, machine vice, tail stock, chuck, vane and gear pump

The above tasks can be performed manually and using standard commercial 2D / 3D CAD software

OUTCOMES: Upon the completion of this course the students will be able to

CO1 Follow the drawing standards, Fits and Tolerances

CO2 Re-create part drawings, sectional views and assembly drawings as per standards

TEXT BOOK:

1. Gopalakrishna K.R., "Machine Drawing", 22nd Edition, Subhas Stores Books Corner, Bangalore, 2013

REFERENCES:

1. N. D. Bhatt and V.M. Panchal, "Machine Drawing", 48th Edition, Charotar Publishers,2013

2. Junnarkar, N.D., "Machine Drawing", 1st Edition, Pearson Education, 2004

3. N. Siddeshwar, P. Kanniah, V.V.S. Sastri, "Machine Drawing" , published by Tata Mc GrawHill,2006 4. S. Trymbaka Murthy, "A Text Book of Computer Aided Machine Drawing", CBS Publishers, New Delhi, 2007

CH -2209 ENVIRONMENTAL SCIENCE

Course Objectives:

- The aim of this course is to make the students better understand the changes in the environment and be given a greater voice and planning conservation through an interdisciplinary environmental science curriculum that is design to enhance scientific enquiry and to strengthen competence.

Course Outcomes:

At the end of the course, the student will be able to

- Understand various types of pollution regulations and their scientific bases.
- Apply knowledge for the protection and improvement of the environment.
- Recognize the major concepts in environmental science and demonstrating in-depth of the environment

SYLLABUS

Introduction: Definition, scope and importance, measuring and defining environmental development – indicators.

Ecosystems: Introduction, types, characteristic features, structure and functions of ecosystems – forest, grassland, desert, aquatic (lakes, rivers and estuaries).

Environmental and Natural Resources Management: Land resources- land as a resource, common property resources, land degradation, soil erosion and desertification, effects of modern agriculture, fertilizer-pesticide problems.

Forest Resources: use and over-exploitation, mining and dams –their effects on forest and tribal people,

Water Resources: use and over utilization of surface and ground water, floods, droughts, water logging and salinity, dams-benefits and costs, conflicts over water,

Energy Resources: Energy needs, renewable and non-renewable energy sources, use of alternate energy sources, impact of energy use on environment,

Bio-diversity and its Conservation: Value of bio-diversity- consumptive and productive use, social, ethical, aesthetic and option values, bio-geographical classification of India - India as a

mega diversity nation, threats to biodiversity, hot spots, habitat loss, poaching of wild life, loss of species, seeds etc., conservation of biodiversity - in-situ and ex-situ conservation,

Environmental pollution- local and global issues: Causes, effects and control measures of air pollution, indoor air pollution, water pollution, soil pollution, marine pollution, noise pollution, solid waste management, composting, vermiculture, urban and industrial wastes, recycling and re-use, nature of thermal pollution and nuclear hazards, global warming, acid rain , ozone depletion,

Environmental problems in India: Drinking water, sanitation and public health, effects of activities on the quality of environment, urbanization, transportation, industrialization, green revolution, water scarcity and ground water depletion, controversies on major dams – resettlement and rehabilitation of people: problems and concerns, rain water harvesting, cloud seeding and watershed management,

Economy and environment: The economy and environment interaction, economics of development, preservation and conservation, sustainability: theory and practice, limits to growth, equitable use of resources for sustainable lifestyles, environmental impact assessment,

Social issues and the environment: Population growth and environment, environmental education, environment movements, environment versus development,

Institutions and governance: Regulation by Government, monitoring and enforcement of environmental regulation, environmental Acts, water (prevention and control of pollution) act, air (prevention and control of pollution) act, environment .protection act, wild life protection act, forest conservation act, coastal zone regulations, institutions and policies relating to India, environmental governance,

International conventions: Stockholm conference-1972, Earth summit-1992, World commission for environmental development (WCED),

Case studies: Chipko movement, Narmada bachao andolan, Silent valley project, Madhura refinery and Taj mahal, Industrialization of Pattancheru, Nuclear reactor at Nagarjuna sagar, Tehri dam, Ralegaon siddhi (Anna Hazare), Kolleru lake-aquaculture, Fluorosis in Andhra Pradesh,

Field work: Visit to a local area to document and mapping environmental assets – river/forest/grass land / hill/ mountain, study of local environment-common plants, insects, birds,

study of simple ecosystems – pond, river hill, slopes etc, visits to industries- water treatment plants, effluent treatment plants.

Text Book: Environmental Studies by Anubha Kaushik & C.P. Kaushik, Second Edition, New Age International (P) Limited.

CH-3101 PROCESS INSTRUMENTATION AND CONTROL

Course Objectives:

In studying this course Chemical Engineering students will come to know the measurement of various process variables and acquire the knowledge of the operation of various process control systems effectively. The students learn

- How physical quantities are measured and how they are converted to electrical or other forms.
- To use various types of instruments.
- Represent the processes in terms of mathematical equations
- The concept of stability and know how to operate a control system in a stable way.
- To deal with various controllers and their functions and applications.
-

Course Outcomes:

At the end of the course, the student will be able to

- Recommend suitable instrument for the measurement temperature
- Select a method of measurement for pressure,composition, flow and level
- Develop transfer functions for the processes
- Examine the stability of various control systems
- Apply advanced control schemes for processes and identify the characteristics of control valves

SYLLABUS

Qualities of Measurement: The elements of instruments, static and dynamic characteristics, dynamic response of first order and second order instruments.

Expansion Thermometers: Temperature scales, constant-volume gas thermometer, bimetallic thermometer, pressure spring thermometer, theory of volumetric and pressure thermometers, static accuracy of thermometer, comparison of pressure-spring thermometers.

Thermoelectric Temperature Measurement: Thermoelectricity, industrial thermocouples, thermocouple lead wires, thermal wells, response of thermocouples, the mill voltmeter.

Resistance Thermometers: Thermal coefficient of resistance, industrial resistance thermometer bulbs, resistance thermometer circuits, null-bridge resistance thermometers, deflectional resistance thermometers.

Radiation Temperature Measurement: Introduction, blackbody devices and radiation receiving elements, radiation pyrometers, photoelectric pyrometers and optical pyrometers.

Methods of Composition Analysis: Spectroscopic analysis, absorption, Emission and Mass spectroscopy- IR, UV absorption and mass spectrometers, Gas analysis by thermal conductivity, analysis of moisture in gases (humidity), psychrometer method, hygrometer method, dew-point method for moisture analysis in gases, measurement of moisture in paper, textile and lumber.

Measurement of Pressure and Vacuum: Pressure, vacuum and head, liquid column manometers, measuring elements for gauge pressure and vacuum, indicating elements for pressure gauges, measurement of absolute pressure, measurement of pressure in corrosive fluids, static accuracy of pressure gauges.

Measurement of Head and Level: Density and specific gravity, direct measurement of liquid level, pressure(level) measurement in open vessels, level measurement in pressure vessels, density measurement, level measurement by weighing.

Introduction to Process Dynamics and Control: Response of First Order Systems - Physical examples of first order systems.

Response of first order systems in series, higher order systems: Second order and transportation lag.

Control systems: Controllers and final control elements, Block diagram of a chemical rector control system Closed loop transfer functions, Transient response of simple control systems.

Stability Criterion: Routh Test, Root locus. Transient response from root locus, Application of root locus to control systems Introduction to frequency response, Control systems design by frequency response.

Advanced control strategies: Cascade control, Feed forward control, ratio control, Smith predictor, dead time compensation, internal model control. Controller tuning and process identification. Control valves.

Text Books:

1. Donald P Eckman. Industrial Instrumentation, CBS Publishers, New Delhi, 2004.
2. D.R. Coughanowr. Process Systems Analysis and Control, Mc Graw Hill, 1991

Reference Books:

1. Hand Book of Instrumentation and control, Considine.
2. Chemical Process Control, G. Stephanopolous, Prentice Hall, 1984.

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CH-3102 MASS TRANSFER –I

Course Objectives:

- To explain the students with the basic principles of mass transfer operations and other separation processes with examples.
- To impart knowledge on how certain substances undergo the physical change with diffusion/mass transfer of components from one phase to other phases.
- To describe the students with equipment used in operations involving mass transfer and other separation processes and their advantages and disadvantages.
- To focus on absorption and distillation operations and the process design aspects of the same operations.
- To provide the knowledge on humidification and dehumidification operations and their applications in real situations

Course Outcomes:

At the end of the course, the student will be able to

- Identify diffusion phenomena in various chemical processes
- Determine diffusivity coefficient in gases and liquids.
- Calculate mass transfer coefficients at interfaces of multiphase mass transfer systems
- Understand the VLE concepts and application to different distillations
- Understand the importance of humidification and dehumidification processes and their industrial applications
- Design equipment for gas-liquid mass transfer operations

SYLLABUS

Introduction: Mass transfer Operations.

Molecular Diffusion in Fluids: Binary solutions, Fick's law, equation of continuity, Steady state equimolal counter current diffusion, Stefan's diffusion, estimation of diffusivity of gases and liquids, application of molecular diffusion.

Mass Transfer Coefficients: Mass transfer coefficients in turbulent flow, theories of mass transfer, analogy between momentum, heat and mass transfer in laminar and turbulent flow, correlations for mass transfer coefficients in simple situations, diffusion in solids.

Interphase Mass Transfer: Concept of equilibrium, diffusion between phases, two resistance theory, material balances in steady state co-current and counter-current stage processes, Murphy stage efficiency.

Equipment for Gas-liquid Operations: Sparged vessels, mechanically agitated vessels for single phase liquids and gas-liquid mixtures, tray towers, sieve tray for absorption and distillation, venturi scrubbers, spray towers and spray chambers, packed towers for absorption and distillation, tray towers versus packed towers.

Humidification operations: Definition of fundamental terms, Psychrometric charts, theory of adiabatic saturation and wet bulb temperature, Lewis relation, gas-liquid contact operations, water cooling with air, dehumidification of air-water-vapor mixture, cooling towers, evaporative cooling.

Absorption: Solubility's of gases in liquids, two component systems, multi-component systems, ideal and non-ideal solutions, choice of solvent for absorption, single component absorption material balances, counter current multistage operations, dilute gas mixtures, on-isothermal operation, tray efficiency, continuous contact equipment, HETP, HTU, NTU concepts for single operation absorption with chemical reaction.

Distillation: Principles of VLE for binary systems, phase diagrams, relative volatility, ideal solutions, azeotropes, enthalpy concentration diagrams, flash vaporization, partial condensation, differential distillation, steam distillation, continuous distillation, McCabe-Thiele method, Ponchon-Savarit method, tray efficiencies, introduction to multi-component distillation, azeotropic and extractive distillations.

Text Book:

Mass transfer Operations, Robert E. Treybal, 3rd edition, McGraw-Hill Book Co.,

Reference Books:

1. "Unit Operations in Chemical Engineering" by McCabe,W.L.,Smith,J.C.and Harriot,P., 5th Edition, McGraw-Hill Book Co.,
2. "Chemical Engineering Hand Book" by J.H. Perry.

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CH-3103 CHEMICAL REACTION ENGINEERING – I

Course Objectives:

- To learn principles of rate law and stoichiometry. Isothermal reactors- Batch, plug flow reactor and mixed flow reactor. Design of single and multiple reactors.
- To endow with the knowledge on thermal characteristics of various reactions

Course Outcomes:

At the end of the course, the student will be able to

- Derive the rate law for non-elementary chemical reactions and determine the kinetics of chemical reaction using integral, differential and fractional life methods.
- Design reactors for homogenous reactions under isothermal conditions for single and multiple reactions
- Select optimal sequence in multiple reactor systems

SYLLABUS:

Introduction and overview of chemical reaction engineering – Variables affecting a chemical reaction – Kinetics of homogeneous reactions – Concentration dependent term of rate equation – Elementary and nonelementary reactions – Temperature dependent term – Arrhenius law, activation energy, collision theory, transition state theory Searching for a mechanism.

Interpretation of batch reactor data – Methods of analysis, integral, differential and half life methods – Analysis of different types of reactions, irreversible and reversible – Variable volume reactor.

Ideal reactors for a single reaction – Performance equations for batch, mixed flow and plug flow reactors – Space time, space velocity and mean residence time.

Design for single reactions – Size comparison of reactors – Multiple reactor systems – Recycle reactor.

Design for parallel reactions – Qualitative and quantitative discussion about product distribution.

Design for series reactions – Qualitative and quantitative discussion about product distribution.

Text Book:

"Chemical Reaction Engineering"., Levenspiel, O. 3rd Edition, John Wiley and Sons.

Reference Books:

1. "Chemical Engineering Kinetics" Smith, J.M, 3rd Edition. McGraw Hill Inc.
2. "Elements of Chemical Reaction Engineering"., Fogler, H.S, 3rd Edition, Prentice Hall India Ltd.

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CH-3106 MASS TRANSFER-I LABORATORY

Course Objectives:

- The student will be made familiarised with distillation process and will be able to determine liquid and vapour diffusion coefficient. The student will be able to calculate VLE, HTU, HETP and rate of evaporation by conducting experiments.

Course Outcomes:

At the end of the course, the student will be able to

- Determine separation performance of batch distillation, steam distillation, sieve plate and packed bed distillation
- Estimate the diffusion coefficient of vapour in gas
- Estimate the diffusion coefficient of liquid
- Determine the rate of evaporation

List of Experiments:

1. Steam distillation
2. Differential distillation
3. Height equivalent to a theoretical plate
4. Vapor-liquid equilibria
5. Determination of liquid diffusion coefficient
6. Determination of vapor diffusion coefficient
7. Surface evaporation
8. Height of a transfer unit

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CH-3107 PROCESS INSTRUMENTATION & CONTROL LABORATORY

Course Objectives:

- To understand the dynamic behavior of the systems.
- To evaluate response of fist and higher order characteristics.
- Study the installed characteristics of the valve.
- Study if there is a hysteresis in the control valve and sensor.
- Evaluate the tuning of a PID control via manual and automatic tuning.

Course Outcomes:

At the end of the course, the student will be able to

- Identify the dynamics of first order, second order, interacting and non-interacting processes.
- Determine control valve characteristics.
- Evaluate the hysteresis characteristics of Bourdon pressure gauge.
- Implement PID controller on a level control, temperature control and pressure control process.
- Demonstrate PID control trainer.

List of experiments:

1. Response of mercury-in glass thermometer.
2. Response of mercury-in glass thermometer with thermal well.
3. Calibration & response of resistance thermometer.
4. Response of manometer.
5. Calibration of thermocouples.
6. Response of single-tank liquid level system.
7. Response of two-tank non-interacting liquid level system.
8. Response of two tank interacting liquid level system.
9. Study of on-off control – Control let off position.
10. Valve characteristics of equal % control valve.
11. Valve characteristics of linear control valve.
12. On-off control – controller on position.
13. Studies on hysteresis characteristics of Bourdon pressure gauze.
14. Hysteresis characteristics of equal % control valve.
15. Studies on hysteresis characteristics of linear control valve.
16. Response studies for different types of controller (P, PI, PID) using PID control trainer.
17. Level control trainer.
18. Pressure control trainer.
19. Temperature control trainer.

CH-3108 ANALYTICAL TECHNIQUES

Course Objects:

- To give hands on training to the student to analyze different industrial products using various instruments.

Course Outcomes:

At the end of the course the student will be able to

- Conduct titrations using conductivity meter, potentiometer and pH meter.
- Estimate amount of metal present in the given solution
- Determine analytically different analytes like metal ions, highly conjugated organic compound and biological macromolecules using UV-Spectroscopy.
- Analyze industrial product like fertilizers, cement, pesticides, steel plate.

List of Experiments:

1. Conductivity meter
2. pH meter
3. UV Spectrophotometer
4. Potentiometer
5. Electro gravimetric analysis
6. Thin Layer Chromatography (TLC)
7. Cement analysis
8. Fertilizer analysis
9. Pesticide analysis

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CH-3109 SUMMER INTERNSHIP PROGRAM (Evaluation)

Evaluation of Summer Internship / Community Service in the industries / nearby villages which was carried out after 2nd year 2 semester during summer vacation.

Course objectives:

- To sensitize the students to the living conditions of the people who are around them,
  - To help students to realize the stark realities of the society.
  - To bring about an attitudinal change in the students and help them to develop societal consciousness, sensibility, responsibility and accountability
  - To make students aware of their inner strength and help them to find new /out of box solutions to the social problems.
  - To make students socially responsible citizens who are sensitive to the needs of the disadvantaged sections.
  - To help students to initiate developmental activities in the community in coordination with public and government authorities.
  - To develop a holistic life perspective among the students by making them study culture, traditions, habits, lifestyles, resource utilization, wastages and its management, social problems, public administration system and the roles and responsibilities of different persons across different social systems.

Course outcomes: At the end of the course, the student will be able to

- Learn service as a graduate attribute
- Reduced stereotypes and greater inter-cultural understanding
- Improve social responsibility and citizenship skills
- Involve in community service after graduation

- **CH-3201 MASS TRANSFER –II**

Course Objectives:

- To explore about different mass transfer operations and its applications in industrial scale.

Course Outcomes:

At the end of the course, the student will be able to

- Analyze VLE, LLE, and SLE data
- Select a suitable mass transfer operation for a given separation
- Determine number of stages in distillation, extraction and adsorption operations
- Estimate the height of packed column in distillation, extraction and adsorption operations
- Calculate drying rates and moisture content for batch and continuous drying operations

SYLLABUS

Liquid-liquid operations: Extraction: Introduction, liquid-liquid equilibria, analytical and graphical solutions for single and multistage operations, continuous counter current operation without and with reflux, fractional extraction, equipment for liquid-liquid contacting operations, single stage, multistage and continuous contacting equipment,

Leaching: Preparation of solid, steady and unsteady state operation, equipment, analytical methods both theoretical and problematic approaches for single and multistage operations,

Adsorption: Theory of adsorption, Industrial adsorbents, adsorption equilibria, Freundlich equation, single and multistage operations, unsteady state adsorption, equipment for single stage and continuous contact, ion-exchange,

Drying: Equilibria, drying rate curve, batch and continuous drying, time of drying and calculations, mechanism of batch drying, equipment's for batch and continuous drying operations,

Crystallization: Equipment and analytical methods, factors governing nucleation and crystal growth rates, controlled rate of crystals, incorporation of principles into the design of the equipment,

Less conventional operations: Dialysis, thermal diffusion, mass diffusion,

Membrane separation processes: Separation of gases, separation of liquids, dialysis, membranes for liquid extraction, pervaporation, reverse osmosis.

Text Book:

'Mass Transfer Operations', by Robert E.Treybal, III Edition, McGraw-Hill Book Co.

Reference Books:

1. 'Unit Operations in Chemical Engineering' by McCabe,W.L., Smith, J.C. and Harriot, P., 5th Edition, McGraw-Hill Book Co.
2. 'Chemical Engineering Hand Book' by J.H.Perry

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CH-3202 CHEMICAL REACTION ENGINEERING-II

Course Objectives:

- To endow with the knowledge on thermal characteristics of various reactions
- To accomplish knowledge on non-ideal reactors
- To impart the knowledge on heterogeneous reacting systems
- To study the design aspects of heterogeneous catalytic systems
- To impart the knowledge on mass transfer with reaction situations

Course Outcomes:

At the end of the course, the student will be able to

- Explain the thermal characteristics and design of adiabatic reactors for single and multiple reactions
- Apply the non-ideality concepts in the reacting system for better understanding the deviations from ideality
- Apply the tanks-in-series model, and the dispersion (single parameter) models for a first-order reaction, to account for the non ideality
- Develop the progressive conversion model and shrinking core model for explaining the fluid particle reaction
- Understand the principles and mechanism involved in heterogeneous catalysis and analyze the data of heterogeneous catalytic reactions.
- Understand the rate controlling mechanisms in heterogeneous catalysis and their rate determinations

SYLLABUS

Temperature and pressure effects – Heats of reaction and temperature – Equilibrium constants from thermodynamics – Equilibrium conversion – General graphical design procedure – Optimum temperature progression – Adiabatic operations.

Non ideal flow – Basics – C,E and F curves – Conversion in non ideal flow reactors – Dispersion model – Tanks-in-series model.

Heterogeneous catalysis – Physical adsorption – Chemisorption – Catalytic properties – Estimation of surface area, pore volume and porosity – Catalyst preparation – Catalyst poisons – Catalytic deactivation.

Solid catalysed reactions – Rate equations – Pore diffusion combined with surface kinetics – Thiele modulus – Effectiveness factor – Performance equations for reactions containing porous catalyst particles – Experimental methods for finding rates – Determining controlling resistances. Noncatalytic systems – Design of fluid-fluid reactors – Factors to consider in selecting a contractor – Various contractors and contacting patterns for G/L reactions.

Design of fluid particle reactions – Progressive Conversion Model (PCM), Shrinking Core Model (SCM) – Comparison – Controlling mechanisms – Determination of rate controlling step.

Text Book:

'Chemical Reaction Engineering' Levenspiel O, 3rd Edition, John Wiley & Sons.

Reference Books:

1. "Chemical Engineering Kinetics' by Smith, J.M. 3rd Edition, McGraw Hill Inc.
2. "Elements of Chemical Reaction Engineering" by Fogler, H.S, 3rd Edition, Printice Hall India Ltd.

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CH-3203 Financial Management for Engineers

Objectives of this Course:

1) To provide awareness and understanding of the ways finance helps in reaching business objectives.
2) To familiarise with the form, content and analysis of financial statements and the accounting principles and techniques.
3) To Identify signals pointing to deterioration in financial conditionand analyse the reasons for variances between the actual and budgeted results
4) To facilitate in the improvement of organizations' performance by pointing out the importance of cost control, breakeven and variance analysis.

To equip with the ability to communicate comfortably with Financial Executives and discuss the financial performance of the organization effectively.

Outcomes of the Course:

1) Ability to Analyse financial statements
2) Understanding costs and methods to reduce them
3) Taking decisions regarding the price of the products services, or both
4) Skill to practice different Budgeting Systems in organisations

UNIT-I

Accounting concepts and systems - Elements of Financial Statements - Trading, Profit & Loss Statement- Cash Flow Statements - Notes to Accounts - Profits vs. Cash Flows

UNIT-II

Analysis of Financial Statements - Financial Analysis - Financial Ratios and their Interpretations covering: Profitability Ratios; Liquidity Ratios; Return on Capital Ratios; - Management of WorkingCapital: Capital and Its Components - Working Capital Cycle - Working Capital Financing.

UNIT-III

Management Decision Making: Cost concepts and its application in Decision Making - Types of cost – Direct& Indirect, Fixed&Variable - Cost Sheet - Cost VolumeProfit Analysis - Understanding Cost behaviour – Cost concepts and its application in Decision Making - Relevance of Activity Based Costing - Marginal Costing - Make or Buy - Shut down or continue - Sell or process further - Domesticvs. Export Sales

UNIT-IV

Budgets and Budgetary Control: Differenttypesof Budgets (Departmental,Functionbased, Cash, Master) - Budgeting systems (ABC / ZBB / Rolling/ Incremental / Planning) - Variance Analysis - Capital Budgeting and Investment Appraisals - Meaning of Capital Budgeting - Relevance of Capital Budgeting - Techniques of Capital Budgeting - Payback Period - AccountingRate of Return - NetPresent Value - Internal Rate of Return - Discounted Payback Period

UNIT-V

Means of Finance: Financial Instruments - Shares, Debentures, Derivatives - Share Capital Vs. Term Loans - Leasing - Financial Markets - Capital Markets - Stock Exchanges

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Suggested Books:

1. Finance for Non-Finance People by Sandeep Goal (2017), Publisher: Taylor and Francis.
2. Finance for Non-Finance Managers by B.K. Chatterjee (1988), Jaico Publishing House, Sold by Amazon
3. Finance for Nonfinancial Managers: Finance for Small Business, Basic Finance Concepts (Accounts and Finance) by MurugesanRamaswamy (2021), Repro Books-On-Demand

*****

CH-3206 MASS TRANSFER-II LABORATORY

Course Objectives:

- The student will learn about the LLE, dynamics and mass transfer in spray tower, packed tower and sieve tray tower.
- The students will learn the drying characteristics of the given solid material.

Course Outcomes:

At the end of the course, the student will be able to

- Determine the LLE
- Determine the critical moisture content in drying
- Determine separation performance and mass transfer coefficients of sieve plate
- Identify the axial mixing characteristics in packed bed
- Evaluate the dynamics of liquid drops

List of experiments:

1. Ternary liquid equillibria (Binodal curve)
2. Liquid-liquid equilibria.
3. Limiting flow rates in spray tower
4. Hydrodynamics of perforated plate tower
5. Volumetric mass transfer coefficients in perforated plate tower
6. Dynamics of liquid drops (Single drop extraction tower)
7. Studies of axial mixing characteristics in a packed bed
8. Gas-liquid mass transfer in packed tower
9. Drying characteristics of a given material

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CH-3207 CHEMICAL REACTION ENGINEERING LABORATORY

Course Objectives:

- To familiarize students with main type of chemical reactors
- To analyze the experimental data to obtain the reaction rate expression (reaction order and specific reaction rate constant)
- To compare the conversion of reactants for a specific reaction in various types of reactor.
- To understand the concept of residence time distribution in reactor systems.
- To determine mass transfer coefficient of systems with chemical reaction

Course Outcomes:

At the end of the course, the student will be able to

- Determine the kinetics of a reaction in a batch reactor, CSTR, & PFR
- Determine the mass transfer coefficient (solid-liquid reacting system)
- Determine the kinetics by fractional conversion method
- Determine the temperature dependency of a reaction
- Evaluate the performance of reactors through RTD studies
- Compare the performance of single reactor with combination of reactors

List of experiments:

1. Determination of the order of a reaction using a batch reactor and analyzing the data by
   (a) differential method and (b) integral method
2. Determination of the activation energy of a reaction using a batch reactor
3. To determine the effect of residence time on conversion and to determine the rate constant using a CSTR
4. To determine the specific reaction rate constant of a reaction of a known order using a batch reaction.
5. To determine the order of the reaction and the rate constant using a tubular reactor
6. Determination of RTD and dispersion number in a tubular reactor using a tracer
7. Mass transfer with chemical reaction (solid-liquid system) – Determination of mass transfer coefficient

8. Axial mixing in a packed bed - Determination of RTD and the dispersion number for a packed bed using tracer
9. Langmuir adsorption isotherm - Determination of surface area of activated charcoal.
10. Performance of reactors in series: (i) A plug flow reactor followed by a CSTR and (ii) A CSTR followed by a plug flow reactor.

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CH-3208 CHEMICAL PROCESS EQUIPMENT DESIGN LABORATORY

(Open book practical examination)

Course Objectives:

- The objective of the course is to design the heat exchangers and to check the suitability of the given heat exchanger and to learn how to formulate problems involving use of "new" and "old" equipment. The students will solve problems mass transfer equipments and chemical reactors

Course Outcomes:

At the end of the course, the student will be able to

- Design double pipe heat exchanger and shell and tube heat exchanger with/ without phase change
- Evaluate the suitability of given heat exchanger for the process
- Design the plate column absorption/ distillation tower
- Evaluate the performance and design of continuous/batch reactors

SYLLABUS

The following equipment are to be designed in detail:

1. Double pipe Heat Exchangers
2. Sensible heat exchangers (1-2 or 2-4),
3. Condenser and reboiler,
4. Multiple effect evaporator
5. Fractionating / Absorption column-Plate and packed columns,
6. Packed bed absorber,
7. Continuous and Batch reactors (homogeneous and heterogeneous)

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CH-3209 SOFT SKILLS

Course Objectives:

- To develop skills to communicate clearly.
- To aid students in building interpersonal skills.
- To enhance team building and time management skills.
- To inculcate active listening and responding skills.

Course Outcomes:

- Make use of techniques for self-awareness and self-development.
- Apply the conceptual understanding of communication into everyday practice.
- Understand the importance of teamwork and group discussions skills.
- Develop time management and stress management.

Learning Outcomes:

- Acquisition of etiquette and skills that an engineer requires.
- Students will develop the acumen for self-awareness and self-development.
- Students will be able to communicate unmistakably.
- Students will be able to tackle real-life challenges.

Unit-I

Introduction to Soft Skills: Communication – Verbal and Non Verbal Communication - Personal grooming (Etiquette, Attitude, Body Language), Posture, Gestures, Facial Expressions, Eye Contact, Space Distancing, Presentation Skills, Public Speaking, Just a Minute (JAM) sessions, Adaptability.

Unit-II

Goal Setting and Time Management: Immediate, Short term, Long term, Smart Goals, Strategies to Achieve goals, Types of Time, Identifying Time Wasters, Time Management Skills, Stress Busters.

Unit-III

Leadership and Team Management: Qualities of a Good Leader, Team Dynamics, Leadership Styles, Decision Making, Problem Solving, Negotiation Skills.

Unit-IV

Group Discussions: Purpose (Intellectual ability, Creativity, Approach to a problem, Tolerance), Group Behaviour, Analysing Performance.

Unit-V

Job Interviews: Identifying job openings, Covering Letter and CVs / Resumes, Interview (Opening, Body-Answer Q, Close-Ask Q), Telephone Interviews, Types of Questions.

Reference Books:

1. Krannich, Caryl, and Krannich, Ronald L. Nail the Resume! Great Tips for Creating Dynamite Resumes. United States, Impact Publications, 2005.
2. Hasson, Gill. Brilliant Communication Skills. Great Britain: Pearson Education, 2012.
3. Prasad, H. M. How to Prepare for Group Discussion and Interview. New Delhi: Tata McGraw-Hill Education, 2001.
4. Pease, Allan. Body Language. Delhi: Sudha Publications, 1998.
5. Rizvi, Ashraf M. Effective Technical Communication: India, McGraw-Hill Education. 2010.
6. Thorpe, Edgar & Showick Thorpe. Winning at Interviews. 2nd Edition. Delhi: Dorling Kindersley, 2006.

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CH-4106 INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP

Course Objectives:

- To familiarise the students with the concepts of Management.
- To relate the concepts of Management with Industrial Organisations.
- To explain the factors affecting productivity and how productivity can be increased with effective utilization of inputs in an industrial undertaking.
- To set forth a basic framework for understanding Entrepreneurship.

Course Outcomes:

- An engineer with his/her fundamental knowledge of Industrial Management, will be in position to take appropriate decisions in the corporate environment. The concepts of Entrepreneurship acts as a motivating factor to launch new enterprises and translate one's dream into realty.

SYLLABUS

Basic Concepts of Management:
Management **:-** Definition, Nature and Importance ; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management;

Forms of Business Organizations:Introduction, Types of Business organizations:
Private Sector- Individual Ownership , Partnership, Joint stock companies and Co-Operative organizations**;** Public sector- Departmental Organizations, Public Corporations and Government Companies; The Joint sector Management.

Production and operations Management: Plant location- Factors to be considered in the selection of Plant location; Break - even analysis- Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance.

Entrepreneurship : Definition, Characteristics and Skills , Types of Entrepreneurs, Entrepreneur vs. Professional Managers, , Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

Entrepreneurial Development and Project Management: Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques;, Stages in Project formulation ; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

Text Books:

1. Sharma,S.C, and Banga, T.R., Industrial Organization & Engineering Economics, Khanna Publishers, Delhi, 2000.
2. Vasant Desai, The Dynamics of Entrepreneurial Development and Management(Planning for future Sustainable growth), HImalayan Publishing House, 2018.

Reference Books:

1. Aryasri , A.R., Management Science**,** McGraw HIll Education (India Private Limited , New Delhi 2014.
2. Sheela, P. , and Jagadeswara Rao, K., Entrepreneurship, Shree Publishing House, Guntur, Andhra Pradesh, 2017.

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CH-4107 ASPEN PLUS (Process Design)

Course Objectives:

- To familiarize students with basic programming skills required for solving chemical engineering problems.
- To analyze the data obtained from simulation with theoritcal concepts.
- To compare different thermodynamic property estimation methods and analysing the results.
- To familiarize students with fundamental applications of chemical engineering in ASPEN PLUS.

Course Outcomes:

At the end of the course, the student will be able to

- Carry out thermodynamic property estimations using Aspen
- Simulate Mixer, splitter, pumps, compressors and flash units
- Apply sensitivity, design specification and case study tools in Aspen
- Design heat exchangers, reactors and distillation columns
- Optimize process flowsheets using sequential modular and equation oriented approaches.

SYLLABUS

Solve the following steady state simulation exercises using Aspen:

1. Physical property estimations.
2. Simulation of individual units like, mixers, splitters, heat exchangers, flash columns and reactors
3. Design and rating of heat exchangers
4. Design and rating of distillation columns.
5. Mass and Energy balances.
6. Handling user specifications on output streams – Sensitivity and design Spec tools.
7. Simulation of a flowsheet
8. Simulation exercises using calculator block
9. Optimization Exercises
10. Simulation using equation oriented approach

Text Books:

1. Lab manuals / Exercise sheets
2. A.K.Jana, Chemical Process Modelling and Computer Simulation, Prentice Hall India, 3rd Edition, 2018.

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CH-4108 INDUSTRIAL / RESEARCH INTERNSHIP EVALUATION

Evaluation of Summer Internship in the industries / Research Institutions which was carried out after 3rd year 2 semester during summer vacation.

Course Objectives

The main objective of industrial training is to provide top –notch knowledge and upgrade relevant skill sets. Education only provides knowledge but to develop relevant skills, industrial training plays a crucial role.

Course outcomes: At the end of the course the student will be able to

- Participate in the projects in industries during his or her industrial training
- Describe use of advanced tools and techniques encountered during industrial training/ Visit
- Interact with industrial personnel and follow engineering practices and discipline prescribed in industry
- Develop awareness about general workplace behavior and build interpersonal and team skills.
- Prepare professional work reports and presentations.
- Adopt effectively to changing conditions

CH-4201 PROJECT WORK, SEMINAR AND INTERNSHIP IN INDUSTRY

(Project Work/ Internship shall be carried out in the Industry/ Institutions)

Course Objectives:

- To apply and adapt a variety of problem-solving strategies tosolve problems;
- To improve thinking skills;
- To promote effective mathematical communication
- To develop mathematical knowledge through problem solving in a way that increases students' interest and confidence;
- To use the language of mathematics to express mathematical ideas precisely;
- To provide learning environment that stimulates and enhances effective learning
- To develop positive attitude towards mathematics

Course Outcomes:

At the end of the course, the student will be able to

- Carry out literature review
- Formulate the problem involving manufacture of a chemical product/ experimentation/modeling/simulation/optimization/design
- Carry out the project involving manufacture of a chemical product/ experimentation/ modeling/simulation/optimization/design/industrial problem
- Discuss the results
- Communicate results orally to audience
- Present the detailed written report

PROFESSIONAL ELECTIVES

1. TRANSPORT PHENOMENA

Course Objectives:

- To make students understand the use of basic laws of mass, momentum and energy transport in the engineering analysis.
- Momentum transport deals with evaluation of velocity distributions in steady and unsteady laminar flow problems in simple geometries of Newtonian and non-newtonian fluids.
- Energy transport deal with the evaluation of steady/ unsteady temperature distributions in solids and in laminar flow.
- Mass transport deals with the evaluation of steady state concentration profiles with or without chemical (Homogeneous/ heterogeneous) reaction.

Course Outcomes:

At the end of the course, the student will be able to

- Identify the transport properties of solids, liquids and gases
- Formulate a mathematical representation of flow / heat / mass transfer phenomena
- Solve steady state flow/heat/mass transfer problems for simple geometries analytically
- Solve unsteady flow/ heat problems for simple geometries

SYLLABUS

PART-A

Momentum Transport: Viscosity and the mechanism of momentum transport- i). Newton's law of viscosity, ii). Non-Newtonian fluids and iii). pressure and temperature dependence of viscosity,

Velocity Distributions in Laminar Flow: i). Shell momentum balances boundary conditions, ii). flow of a falling film, iii). flow through a circular tube and iv). flow through an annulus,

The Equations of Change for Isothermal Systems: i). The equations of continuity, motion and mechanical energy in rectangular and curvilinear coordinates, ii). use of the equations of change to set up steady flow problems and iii). dimensional analysis of the equations of change,

Velocity Distributions with more than one independent variable and unsteady viscous flow,

PART-B

Energy Transport: Thermal conductivity and the mechanism of energy transport- i). Fourier's law of heat conduction and ii). temperature and pressure dependence of thermal conductivity in gases and liquids,

Temperature Distributions in Solids and in Laminar Flow: i) Shell energy balances-boundary conditions, ii). heat conduction with an electrical heat source, iii). heat conduction with a viscous heat source, iv). heat conduction through composite walls, v). forced convection and vi). free convection,

The Equations of Change for Non-Isothermal Systems: i). The equation of energy in rectangular and curvilinear coordinates, ii). the equations of motion for forced and free convection in non-isothermal flow, iii). use of the equations of change to set up steady state heat transfer problems and iv). dimensional analysis of the equations of change,

Temperature Distribution with More Than One Independent Variable: Unsteady state heat conduction in solids,

PART-C

Mass Transport: Diffusivity and mechanism of mass transport- i). Definitions of concentrations, velocities and mass fluxes, ii). Fick's law of diffusion and iii). temperature and pressure dependence of mass diffusivity,

Concentration Distribution in solids and in laminar flow: i). Shell mass balances – boundary conditions, ii). diffusion through a stagnant gas film, iii). diffusion with heterogeneous chemical reaction, iv). diffusion with homogeneous chemical reaction and v). diffusion into a falling liquid film,

The Equations of Change for Multi-Component Systems: i). The equations of continuity for a binary mixture, ii). the equations of continuity of A in curvilinear coordinates and iii). dimensional analysis of the equations of change for a binary isothermal fluid mixture,

Text Book:

'Transport Phenomena' by R. Byron Bird, W.E. Steward and Edwin N. Lightfoot, John Wiley& Sons Inc., New York

Reference Books:

1. Transport phenomena' by Robert S. Brodkey & Haryr C. Hershey, McGraw Hills Company, New York
2. Transport Phenomena-for engineers' byLouis Theodore, International Book Compnay, London
3. 'Transport Phenomena' by W.J.Book and K.M.K.Multzall, JW&Sons Ltd.
4. 'Fundamentals of Momentum, Heat and Mass Transfer' by Mames R Welty, Charlese Wicks and Robert E Wilson, J W & Sons Inc., New York

   Fluid Dynamics and Heat Transfer' by James G. Knudsen and Donald L.Katz., McGraw Hills Company Inc., New York

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2. FUEL CELL TECHNOLOGY

Course Objectives:

- To provide deeper knowledge, a wider scope and improved understanding of theory, analysis, performance, design and the operational principles of various fuel cell components and systems.
- To provide the design and analysis emphasis on the thermodynamics and heat transfer for all thermal systems of a fuel cell stack.

Course Outcomes:

At the end of the course, the student will be able to

- Understand fuel cell fundamentals.
- Analyze the performance of a fuel cell and stack.
- Demonstrate the operation of fuel cell stack and fuel cell system
- Apply the modeling techniques for fuel cell systems

SYLLABUS

Introduction – fuel cell; brief history of fuel cells, types of fuel cells and fuel cell applications.
Thermodynamics and Electrochemical kinetics – Engineering thermodynamics, conversion efficiencies of heat engines and fuel cells, chemical reactions, chemical thermodynamics and electrochemical kinetics.

Fuel cell components and their impact on performance – General design features, fuel cell performance: the MEA and the current/voltage curve, MEA components and the fuel cell stack.
Stack design – Sizing of a fuel cell stack, stack configuration, uniform distribution of reactants inside each cell, heat removal from a fuel stack and stack clamping.

Fuel cell modeling – Theory and governing equations, modeling domains and modeling examples.

Fuel cell system design – Hydrogen-air system, fuel cell systems with fuel processor, electrical subsystems and system efficiency.
Fuel cell applications – Transportation applications, stationary power, backup power and fuel cells for small portable power.

Text Books:

1. For chapters 1 to 3: Fuel Cell Technology Hand Book, Edited by Gregor Hoogers, CRC Press.
2. For Chapters 4 to 7: PEM Fuel Cells: Theory and practice By Frano, Elsevier Academic Press

Reference Books:

1. Fuel cells principles and applications by B.Viswanathan and M. Aulice Scibioh, Universal Press. (India) Private Limited, Hyderabad.
2. Fuel Cell Systems Explained, second edition, by James Larminie and Andrew Dicks, John Wiley & Sons Ltd.

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3. PETROCHEMICALS

Course Objectives:

To make a thorough understanding of the availability of petroleum resources, technical and financial constrains of all the elementary problems. To know the development of petrochemical industries and methodolically furnishes the conversion of petroleum feedstock's to chemical and intermediates.

Course Outcome:

- Able to know Petrochemical industry-Feedstock, various important Chemicals produced from ethylene and C_3, C_4 and higher carbon atoms.
- Able to know the structure of Polymer, methods of polymerization, high pressure polyethylene (LDPE), low pressure polyethylene (HDPE),
- Able to know Petroleum aromatics, synthetic fibers, Synthetic rubber, Plastics and Synthetic detergents.
- Able to understand all the production processes and will get an awareness on accidents that are occurring in industries during handling, storage, and manufacturing of chemicals, remedial measures to arrest the accidents immediately.

SYLLABUS

Petrochemical industry-Feedstocks: Petrochemical industry in India, feed stocks for petrochemicals.

Chemicals from ethylene: Vinyl chloride monomer, vinylacetate monomer, ethylene oxide, ethylene glycol, acetaldehyde.

Chemicals from C_3,C_4 and higher carbon atoms: Isopropylalcohol, acrylonitrile, acrylic acid, phenol, bisphenol-A, iso and n-butanol, methyltertbutylether, methacrylic acid, malic anhydride.

Polymers of olefins: Polymer structure, methods of polymerization, high pressure polyethylene (LDPE), low pressure polyethylene (HDPE), polypropylene, polyvinylchloride, polystyrene.

Petroleum aromatics: Benzoic acid, caprolactum, terephthalic acid, phthalic anhydride,

Synthetic fibres: Production techniques of synthetic fibres, production of polyester, nylon-6,6, nylon-6, acrylic fibers.

Synthetic rubber: Styrene butadiene rubber (SBR), butyl rubber, synthesis of polyurethane.

Plastics: Phenol formaldehyde resins, urea formaldehyde resins, polycarbonates.

Synthetic detergents: Classification of detergents, general manufacture of sulphonates, keryl benzene sulphonate (Surf).

Text Book:

`A Text on Petrochemicals' by B.K.Bhaskara Rao, 3rd Edition, Khanna Publishers, NewDelhi.

Reference Text Books:

1. `Petrochemical processes', Vol.2, 2nd edition, by A.Chanvel and G. Lefebvre, Gulf publishing company.
2. `Shreve's chemical process industries', 5th edition, by George T. Austin, Mc Graw Hill Publishers

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4. CHEMICAL PROCESS EQUIPMENT DESIGN

Course Objectives:

- This subject introduces the student to the science and art of chemical engineering design. By applying all the knowledge acquired so far, the student will be trained to develop project reports and to carryout design calculations of various process equipment. Finally the student will be able to come out the investment needed for a particular process and also finds out the returns on investment.

Course Outcomes:

At the end of the course, the student will be able to

- Develop process design
- Enumerate general design consideration
- Design incompressible/compressible flow systems and estimate cost of filters
- Select high and low pressure vessels
- Design of distillation column, heat exchangers and evaporators

SYLLABUS

Introduction of Plant Design and Costs, Process Design Development: Design project procedure, design information from the literature and other sources of information, flow diagrams, preliminary design, comparison of different processes, firm process design, equipment design and specialization, scale up in design, safety factors specifications, materials of construction,

General Design Considerations: Health and safety hazards, fire and explosion hazards, personnel safety, loss prevention, thermal pollution control, noise pollution and control, plant location, plant layout, plant operation and control, utilities, structural design, storage, materials handling, materials and fabrication selection.

Material Transfer, Handling and Treatment Equipment Design and Costs: Pumps and piping, frictional effects due to end losses, fittings, orifices and other installations, piping standards, pumps, tanks, pressure vessels and storage equipment, filters.

Mechanical Design of Process Equipment: Design and selection of storage vessels and low pressure vessels, design of roofs, bottom plates, formed heads, flat plate and conical closures, tall vertical columns, supports to process vessels, distillation columns, heat exchanges, evaporators.

Heat Transfer Equipment Design and Costs: Basic theory of heat transfer, consideration in selection of heat transfer equipment, General methods for process design of heat exchangers, evaporators.

Mass Transfer Equipment Design: Finite stage and continuous contactors, plate and column efficiencies, other design factors for finite stage contactors, packed towers, relative merits of plate and packed towers, mass transfer equipment costs, reactors.

Text Books:

1. 'Plant design & Economics for Chemical Engineers', 4th edition, M.S.Peters&K.D.Timmerhaus, McGraw Hills Publishing Company
2. 'Process Equipment Design', 3rd Edition, M.V.Joshi, MacMillan India Ltd 1981

Reference Books:

1. 'Process-Plant-Design' by J.R.Backhurst&J.H.Harker, Heieman Education London
2. 'Chemical Engineering' Volume-VI (An introduction to Chemical Engineering Design) by J.M.Coulson & J.F.Richardson

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5. PROCESS MODELING & SIMULATION

Course Objectives:

- To introduce different types of models along with examples related to chemical engineering
- To instruct how to develop empirical models using different tools and the use of numerical methods for solution of Non- Linear Algebraic equations
- To disseminate the use of different numerical techniques for carrying out numerical integration and differentiation.
- To impart knowledge on modelling of various equipment and their simulation using different numerical techniques.
- To guide selection of the solution method based on the computational requirements of various solution options.
- To elucidate process simulation using modular and equation based solving approaches.

Course Outcomes:

At the end of the course, student will be able to:

- Classify different types of mathematical models
- Develop mathematical model for the given chemical engineering problem from basic engineering principles.
- Identify the appropriate numerical method for solving a given model.
- Solve ODEs and PDEs using different numerical methods.
- Simulate binary distillation column, gravity flow tank, batch reactor, Non-isothermal CSTR, and counter-current heat exchanger.
- Compare and contrast modular approaches with equation oriented approach

SYLLABUS

Mathematical Models for Chemical Engineering Systems: classification of mathematical models- steady state vs dynamic models, lumped vs distributed parameter models, deterministic vs stochastic models.

Examples of Mathematical Models: Two heated tanks, batch reactor, constant volume CSTRs, non-isothermal CSTR, reactor with mass transfer, ideal binary distillation column, batch distillation with holdup.

Empirical Model Building- method of least squares, linear, polynomial and multiple regression, non-Linear regression.

Solution of Non- Linear Algebraic Equations- bisection, false position, Quasi Newton and Newton- Raphson methods.

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Numerical Integration- Trapezoidal rule, Simpson's rule and Newton– Cotes formula.

Numerical Solution of Differential Equations- Euler's method, Runge- Kutta methods, predictor corrector methods.

Numerical Solution of Partial Differential Equations- elliptic, parabolic and hyperbolic equations, finite difference methods, Leibman's method, Crank Nicholson method. Applications to steady state and Unsteady state heat conduction and temperature distribution problems.

Process Simulation Examples: VLE dew point and bubble point calculations, binary distillation column, gravity flow tank, batch reactor, Non- isothermal CSTR, countercurrent heat exchanger.

Process Simulation using Modular and Equation Based Solving Approaches: Developing a simulation model, a simple flow sheet, Sequential modular approach, Simultaneous modular approach, Equation solving approach.

Textbooks:

1. Process modelling, Simulation and Control for Chemical Engineers, 2nd ed., W. L. Luyben, McGraw-Hill, New York, 1990.
2. Numerical Methods for Engineers, S.K. Gupta, Wiley Eastern, New Delhi, 1995.

Reference Books:

1. Numerical Methods for Engineers and Scientists, S.S. Rao
2. Introduction to Numerical Methods in Chemical Engineering, P. Ahuja, PHI learning Pvt. Ltd., New Delhi, 2010
3. Process Modelling and Simulation, Amiya K. Jana, 2012.

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6. PETROLEUM REFINERY ENGINEERING

Course Objectives:

- To introduce the basics of refinery engineering subject for petroleum specialization students to gain knowledge of the overall refinery operations, refinery products and its test methods.
- To learn various primary and secondary cracking process available to produce normal and value added products.
- Further, to learn the treatment process available to remove the impurities in the crude and finished products and its test methods for quality check.

Course Outcomes:

At the end of the course, the student will be able to

- Compare various theories on origin and formation of petroleum, to explain and summarize the composition of crude oil, to prepare a report on the world wide scenario of reserves and deposits and the Indian petroleum refining industry scenario.
- Describe and summarize various petroleum products, to know various analytical tests available for estimating various physico chemical properties and classify the crude into different classes.
- Classify the crude processing methods and describe the treatment process i.e. Desalting and Dehydration and infer the preliminary process i.e. Atmospheric Distillation and Vacuum Distillation Units.
- Summarize and infer various secondary cracking process to produce value added products and to design the equipment in the refining industry.

SYLLABUS

Origin and formation of Petroleum. Reserves and deposits of the world, Composition of crudes, Refinery introduction and Indian petroleum refining industry scenario.

Refinery products and test methods, Evaluation of crudes, Crude pretreatment-Dehydration and desalting, Pipe still heater. Atmospheric and Vacuum distillation of crude oil.
Thermal Conversion Process- Vis Breaking, Delayed Coking.

Catalytic Conversion Process- Fluid Catalytic Cracking, Hydrocracking, Hydrotreating, Alkylation, Isomerization, Polymerization and Reforming.

Lube Oil Process – Solvent deasphalting, solvent Extraction, Solvent Dewaxing and Hydro finishing.

Treatment of kerosene, additives, blending of gasoline, Asphalt and air blown asphalt.

Textbooks:

1. Petroleum Refining Technology by Dr. Ram Prasad
2. Modern Petroleum Refinery Engineering by B K Bhaskar Rao
3. Gary, J.H., Handwerk, G.E. and Kaiser, M.J. (2007) Petroleum Refining: Technology and Economics. 5th Edition, CRC Press, Boca Raton, 488 p.
4. Petroleum Refining. Vol. 3 Conversion Processes, Pierre Leprince (Editor).

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7. MULTI COMPONENT SEPARATION PROCESSES

Course Objectives:

- Provide an introduction to design methods of equilibrium and non-equilibrium multi-component mass transport processes
- The student will learn how to solve different shortcut and rigorous models
- The student will make use of conceptual design methods in designing and troubleshooting industrial mass transport processes

Course Outcomes:

At the end of the course, the student will be able to

- Predict multi component VLE data from the model constants of constituent binaries
- Determine high pressure equilibria
- Understand flash vapourization and multicomponent differential distillation
- Interpret the design considerations of fractionating process
- Design of distillation column for azeotropic and extractive distillation
- Differentiate tray design and operation versus packing design and operation

SYLLABUS

Multi Component Vapor –Liquid Equilibria: Ideal mixtures at low pressures, non-ideal mixtures, activity coefficient models - Wilson, NRTL, UNIQUAC and UNIFAC equations, evaluation of model constants from binary experimental data, prediction of multicomponenet VLE from the model constants of the constituent binaries,

High Pressure Equilibria: Vaporization constants, K, Thermodynamic method for K, graphical charts, chao-Seader correlation,

Equilibrium and Simple Distillation: Multicomponent equilibrium, flash vaporization(EFV), multicomponent differential distillation,

Design Considerations in Fractionating Process: Quantitative relationships, temary and multicomponent system fractionation, key fractionation concepts, selecton of key components, column pressure, material balance, rigorous and approximate minimum reflux calculations,

recommended short-cut methods for minimum reflux minimum plates at total reflux, FUG methods, Smith Brinkley method,

Multicomponent Fractionation Rigorous Design Procedures: Sorel method, Lewi Metheson method, Thiele-Geddes method and its versions in distillation column design, techniques of separating azeotropic and close boiling mixtures by fractional distillation, azeotropic and extractive distillation, selection of solvents, design considerations, pseudo binary methods, solvent recovery,

Tray Design and Operation: The common tray types, tray capacity limits, tray hydraulics parameters, flow regies on trays, column sizing, tray efficiency, fundamentals, tray efficiency prediction,

Packing Design and Operation: Packing types, packing hydraulics, comparing packings and trays, packing efficiency and scale-up.

Text Books:

1. 'Distillation' by M.Van Winkle, McGraw Hill Book Company
2. 'Phase Equilibria in Chemical Engineering' by S.M.Wales, Butterworth publishers, 1985
3. 'Distillation Design' by Henery Z Kister, McGraw Hill Book Company

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8. CHEMICAL ENGINEERING MATHEMATICS

Course Objectives:

- To learn various computational techniques for analyzing and solving chemical engineering problems.

Course Outcomes:

At the end of the course, the student will be able to

- Understand the fundamental mathematics and to solve problems of algebraic and differential equations, simultaneous equations and partial differential equations.
- Evaluate problem solving strategies to procedural algorithms and to write program structures.
- Solve engineering problems using computational techniques

SYLLABUS

Mathematical Formulation of the Physical Problems: i). Application of the law of conservation of mass, salt accumulation in stirred tank, starting an equilibrium still, solvent extraction in N stages, diffusion with chemical reaction and ii). application of the law of conservation of energy, radial heat transfer through a cylindrical conductor, heating a closed kettle, flow of heat from fin,

Analytical (Explicit) Solution of Ordinary Differential Equations Encountered in Chemical Engineering Problems: i). First order differential equations, method of separation of variables, equations solved by integration factors, certain examples involving mass and energy balances and reaction kinetics and ii). second order differential equations, non-linear equations, linear equations, simultaneous diffusion and chemical reaction in a tubular reactor, continuous hydrolysis of tallow in a spray column,

Partial Differential Equations: i). Formulation of partial differential equations, unsteady-state heat conduction in one dimension, mass transfer with axial symmetry, continuity equation, ii). boundary conditions- function specified, derivative specified and mixed conditions and iii). particular solutions of partial differential equation- compounding the independent variable into

one variable, superposition of solutions, the method of images and particular solution suggested by the boundary conditions,

Finite Differences: i). The difference operator, properties of the difference operator, difference tables, other difference operators, ii). linear finite difference equation, complementary solution, particular solution, simultaneous linear difference equations and iii). non-linear finite difference equations, analytical solutions,

Solutions for the following Type of Problems by Finite Difference Method: a). Calculation of the number of plates required for an absorption column, b). calculation of the number of theoretical plates required for distillation column and c). calculation of number of stages required for a counter current extraction and leaching operation,

Application of Statistical Methods: i). Propagation of errors of experimental data, ii). parameter estimation of algebraic equations encountered in heat and mass transfer, kinetics and thermodynamics by method of averages, linear least squares and weighted linear least squares methods and iii). design of experiments - factorial and fractional factorial methods.

Text Book:

'Mathematical Methods in Chemical Engineering' by V.G.Jenson and G.V.Jeffreys, Academic Press, London

Reference Books:

1. 'Applied Mathematics in Chemical Engineering' by Harold S. Mickley, Thomas S. Sherwood and Charles E. Reed, Tata McGraw Hill Publications.
2. 'Introductory Methods of Numerical Analysis' By S.S. Sastry, Prentice Hall of India Private Limited, New Delhi.

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9. FERTILIZER TECHNOLOGY

Course Objectives:

- To introduce various nutrients and their role in growth of a plant
- To introduce different types of the nitrogenous, phosphatic, potassic and compound fertilizers
- To introduce different fertilizer production methods

Course Outcomes:

At the end of the course, the student will be able to

- understand different raw material availability
- Explain the beneficiation of rock phosphate
- Discuss the production of all types of fertilizers
- Formulate different fertilizer mixtures

SYLLABUS

Details about Indigenous Fertilizer Production – raw materials, details of various nutrients with their importance, sources of nitrogen and hydrogen, steam reforming of hydrocarbons, partial oxidation of fuel cells with gas purification including high and low temperature shift conversion, carbondioxide removal processes and methanation.

Coal Gasification, ammonia synthesis, thermodynamic principles associated with ammonia synthesis, ammonia reactors, nitric acid and sulfuric acid.

Urea – total recycle and stripping processes, process details of ammonium sulfate, ammonium chloride, ammonium nitrate, calcium ammonium nitrate.

Phosphate Rock – availability and beneficiation methods for upgrading, bone meal, basic slag, single super phosphate, triple super phosphate, phosphoric acid by wet process and furnace process, AMI process with hydrochloric acid, complex fertilizers like mono and di-ammonium phosphates, urea ammonium phosphate.

Text Book:

‘Hand Book of Fertilizers’ published by fertilizer Association of India, New Delhi

Reference Books:

1. ‘Chemistry and Technology of Fertilizers’ by V. Sauchelli, Reinhold Publications.
2. ‘Fertilizers Manual, a UNIDO Publication from International Fertilizer Development Centre, Alabama, USA.
3. ‘Chemical Technology-II’ published by IIT, Madras.

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10. COMPUTER AIDED DESIGN

Course Objectives:

- To revise the basic concepts in Fluid Mechanics, Heat Transfer, Mass Transfer and Chemical Reaction Engineering and apply the numerical methods with the aid of computer in designing such systems.

Course Outcomes:

At the end of the course, the student will be able to

- Elaborate the need of computer aided design and advantages of simulation
- Design the size of the pipe for a given pressure drop for Newtonian and non-newtonian fluids
- Evaluate pressure drop in compressible fluid flow, pipe line networks and two phase flow
- Develop the rating and design calculations in heat exchangers, distillation columns, extraction cascades, plate/packed bed absorbers and isothermal flash.
- Design ideal reactors, packed bed and fluidized bed reactors
- Estimate rate of extent of reaction vector for simultaneous reactions

SYLLABUS

CAD of Fluid Flow System:
Flow of Newtonian fluids in pipes
Pressure drop in compressible flow
Flow of Non-Newtonian fluids in pipes
Pipe network calculations
Two phase flow system,

CAD of Heat Transfer Equipment: Shell and tube exchangers without phase change, Condensers, Reboilers, Furnaces,

CAD of Mass Transfer Equipment: Distillation, Gas absorption ,Liquid extraction,

CAD of Chemical Reactors: Chemical reaction equilibrium ,Analysis of rate data, Ideal reactor models, Non-ideality in chemical reaction, Performance analysis using residence time

distribution, Temperature effects in homogeneous reactors, Heterogeneous systems, Fluidized bed reactors.

Text Book:

Chemical Process Computations by Raghu Raman. Elsevier Scientific Publishers, London, 1987

Reference Books:

1. Fundamentals and Modelling of Separation process by C D Holland, rentice Hall Inc. New Jercey, 1975
2. Catalytic Reactor Design by Orhan, Tarhan, Mc Graw Hill, 1983
3. Chemical Engineering, Vol 6 by Sinnot, Pergamon Press, 1993

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11. PROCESS ENGINEERING & ECONOMICS

Course Objectives:

- To introduce types of interests, annuity, perpetuity, bond, debenture
- To introduce depreciation and cost accounting methods
- To introduce cash flow tree diagram, methods of cost estimation.
- To introduce profitability, profitability evaluation
- To introduce optimization in industries
- To introduce economic balance of various operations.

Course Outcomes:

At the end of the course the student will be able to

- Determine costs involved in process plants.
- Estimate depreciation costs and various ratios to tell about financial status of the company
- Perform economic analysis and optimum design of the processes
- Evaluate project profitability.

SYLLABUS

Value of Money - Equivalence: Value of money, equations for economic studies, equivalence, types of interest- discrete and continuous, annuities - relation between ordinary annuity and the periodic payments, continuous cash flow and interest compounding, present worth of an annuity, perpetuities and capitalized costs, bonds and debentures, value of a bond and yield rate,

Depreciation: Types and various methods of calculating depreciations, depreciation accounting,

Cost Accounting: Basic relationship in accounting, balance sheet and income statement, various ratios to study the balance sheet and income statements,

Cost Estimation: Cash flow for industrial operations, factors affecting investments and production costs, estimation of capital investment, cost indices, cost factors in capital investment, methods of estimating capital investment, estimation of total product cost- manufacturing costs and general expenses,

Profitability: Alternate investments and replacements. mathematical methods for profitability evaluation, economic production charts for plants operating below 100%, above 100% and under dumping conditions, general procedure for determining optimum conditions, break even chart for production schedule and its significance for optimum analysis,

Economic Balance in fluid flow, heat transfer and mass transfer operations; optimum economic pipe diameter in fluid dynamics, optimum flow rate of cooling water in condenser in heat transfer and optimum reflux ratio in distillation operation,

Economic Balance in cyclic operations and semi continuous cyclic operations, economic balance in yield and recovery, economic balance in chemical reactors, batch and flow reactors.

Text Books

`Plant Design and Economics for Engineers' by Max S. Peters and K.D.Timmerhans, McGraw Hill Book Company,

`Process Engineering Economics' by Herbest E. Schweyer, McGraw Hill Book Company.

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12. PROCESS OPTIMIZATION

Course Objectives:

- Optimization of Chemical Process is an important of subject for Chemical Engineers. It deals with various optimization techniques in reducing cost of production ,energy consumption, maximum throughput and minimum labour cost etc. Onstudying the course one can understand how to write a model of the process optimize the process using the model

Course Outcomes:

At the end of the course, the student will be able to

- Understand the definition of Optimization and how to write an Objective function
- Understand various types of Objective functions like Concave and Convex functions and its properties
- Study the Optimization of uni & multi dimensional search problems
- Solve the Optimization problems by Linear and Non-Linear Programming methods

SYLLABUS

Definition of optimization Applications of optimization optimal insulation thickness Requirements for an optimization technique, Writing an objective function Production schedule ,material balance requirements , six steps of solving an optimization problem.

Basic concepts of optimization continuous and discontinuous , unimodal and multi modal functions concave and convex functions, Finding the optimal point, definition of maximum, minimum and saddle points with examples.

Unconstrained unidimensional search , Newton method Quasi Newton method and Secant method, Speed of iterations linear ,order p and super linear, Quadratic interpolation, cubic interpolation, Region elimination method, Fabonacci and Golden section method.

Multivariable unconstrained optimization ,direct methods Powell method,Conjugate searchdirection, Gradient and conjugate Gradient, Fletcher Reeves method , Positive definite of Hessian matrix Marquadt method.

Linear programming ,definition , solving the refinery schedule problem by linear programming method using graph, Simplex method and definition.

Non linear programming , Lagrange multiplier method, Iterative linearization and Quadratic programming method, Necessary and sufficient condition for a minimum value ,Kuhn-tucker conditions.

Text Books:

1. Optimization of Chemical Process by Edgar and Himmelblau, 2nd edition, Mc GrawHill Publications.
2. Optimization Theory and Applications by S.S. Rao, 2nd Edition, Wiley Eastern Limited.
3. Formulation and optimization of Mathematical Models by C.L.Smith, R.W. Pike and P.W.Mur.

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13. RESERVOIR ENGINEERING

Course Objectives:

- To know the fundamental concepts of reservoir engineering, basic properties of reservoir rocks, various types of reservoirs and driving mechanisms for the production of Oil and gas from an oil reservoir.

Course Outcomes:

At the end of the course, the student will be able to

- Identify the type of oil reservoirs by knowing the characteristics and mechanisms.
- Predict the reservoir performance by knowing the past performance history of the oil reservoir.

SYLLABUS

Fundamental Concepts of Reservoir Engineering: Porosity, fluid saturation, permeability, flow through layered beds, flow through series beds, Klinkenberg effect, effective permeability data, phase behavior.

Oil Reservoirs: Reservoir driving mechanisms, basic equation and tools, volatile oil reservoirs, identification of volatile oil reservoirs, ultimate recovery, predicting reservoirs behavior, performance, mechanics of reservoir performance, prediction procedure, limitations of predictions, relating reservoir performance to time, factors affecting ultimate recovery, analysis of gas oil ratio history.

Depletion Drive Reservoirs: Producing characteristics and methods of identification, detailed procedure for predicting reservoir performance, limitations of predictions, factors affecting ultimate recovery.

Water Drive Reservoirs: Effect of free gas saturation on recovery, predicting reservoirs performance, calculating water influx, use of the unsteady state equation in predicting reservoir performance, validity of performance prediction, limitations in predicting reservoir performance, the material balance equation as a straight line.

Gravity Drainage Reservoirs: Permeability in the direction dip, dip of the reservoir, reservoir producing rates, oil viscosity, relative permeability characteristics, fundamental recovery process, predicting reservoir performance, apparent relative permeability, oil saturation method.

Combination of Drive Reservoirs: Index of drives, equations used, material balance equations, instantaneous gas- oil ratio equation.

Pressure Maintenance: Pressure maintenance by gas injection, condensing gas drive, predicting performance by gas injected gas drive index, pressure maintenance by water injection, predicting performance by water injection, index of injected water drive, control of the gas cap, typical water injection pressure maintenance operations.

Improving Oil Recovery: Improving oil recovery by fluid immiscible gas–water, miscible fluid injection thermal oil recovery, predicting recovery from fluid injection products, Stiles's method of water flood prediction, derivation of water cut and recovery equations, frontal advance techniques for prediction result of either water or gas injection, well arrangements, peripheral water flooding, predicting behavior of peripheral water floods, special consideration involved in water flooding, water flood case history, predicting the results of water flooding.

Text Book:

'Reservoir Engineering Manual' – 2nd Edition by Frank W. Cole, Gulf Publishing Company, Houstan, Texas, 1969.

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14. PAPER TECHNOLOGY

Course Objectives:

- To understand the growth prospects of Indian paper mills, history of paper industry, different types, composition and uses of paper, raw materials for paper making, preparation of raw materials, classification of fibers, recovery of cooking chemicals from spent cooking liquors, Pulping processes, manufacture of paper and Testing of different properties of pulp and paper and the types of pollutants from paper industry and their treatment.

Course Outcomes:

At the end of the course, the student will be able to

- Understand the history of development of paper industry in India and Importance of paper industry, historical background of paper making.
- Explain growth prospects of Indian Paper mills.
- Design the equipment used for the manufacture of paper.
- Explain how to reduce the paper wastes
- Maximize the production rate and recovery of useful chemicals.

SYLLABUS

History: Importance of paper industry, historical background of paper making, development of paper industry in India.

Different types and uses of paper: Different types and uses of papers and paper boards, composition, method of making different types of papers and boards.

Raw materials for paper making: Classification of fibres, characteristics and composition of some important vegetable fibers (hard woods, softwoods, bagasse, straws, rags and paper stock)

Preparation of raw materials: Wood preparation – pulp wood measurement, barking, chipping, screening and conveying of chips).

Pulping processes: Mechanical pulping, alkaline pulping (Soda and Kraft), sulfite pulping, semi-chemical pulping, recovery of cooking chemicals from spent cooking liquors.

Pulp bleaching: Bleaching agents, bleaching methods – single stage and multi stage bleaching, **Stock preparation**: Beating and refining, sizing and loading (filling).

Manufacture of paper: Paper machines (Fourdrinier and Cylinder), making of paper – forming section, press section, dryer section, calendaring section.

Testing of different properties of pulp and paper: Testing and evaluation of pulp, various properties of pulp and paper and their testing.

Text Books:

1. 'Handbook of Pulp and Paper Technology' by Kenneth W.Britt, Vols.I&II
2. 'Modern Pulp and Paper Making' edited by John B.Calkin
3. `Pulp and Paper: Science and Technology - Vols.I&II' by E.Libby, McGraw Hill Books Co.
4. 'Pulp and Paper Manufacture- Vols. I & II' by R.C.McDonald & Others, McGraw Hill Books Company.

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15. COMPUTER APPLICATIONS IN CHEMICAL ENGINEERING

Course Objectives:

The objective of this course is to provide student with

- a sufficient background regarding the applications of computers in Chemical Engineering problems.
- The Knowledge of numerical integration, numerical differentiation, function approximations, solution of linear equations using matrix methods, solution of ordinary differential equations, initial value problems, boundary value problems and solution of partial differential equations by solving number of problems.

Course Outcome:

At the end of the course the student will be able to

- Learn the applications of computers in solving chemical Engineering problems
- Solve /write programs for Chemical Engineering problems

SYLLABUS

Roots of Algebraic and Transcendental Equations: Iteration methods, Regula-Falsi method, Newton Rapson method, roots of simultaneous sets of transcendental and algebraic equations,

System of linear equations and their solution by different techniques, numerical differential and integration, regression analysis, least squares and orthogonal polynomial approximation,

Numerical solution of ordinary differential equations,

Numerical solution of partial differential equations (simple case studies),

Application of the above Techniques to Problems of Interest in Chemical Engineering.

Text Book:

'Digital computation for chemical engineers' by Leaon Lapidus, McGraw Hill Book Company

Reference Books:

1. 'Applied Numerical Methods' by Camehanet, McGraw Hill Book Co.
2. 'Applied Numerical Methods with Personal Computers, by Constantinides, McGraw Hill Book Co, New York

OPEN ELECTIVES

1. CORROSION ENGINEERING

Course Objectives:

- Basic aspects of electrochemistry relevant to corrosion phenomena,
- Importance and forms of corrosion.
- Knowledge on corrosion rate expressions and measurement techniques.
- Basic knowledge on remedial measures for corrosion.

Course Outcomes:

At the end of the course, the student will be able to

- Identify various forms of corrosion.
- Determine corrosion rates for metals from their polarization curves
- Analyze corrosion rate characteristics from electrochemical impedance spectroscopy
- Select suitable corrosion resistant coatings, oxide layers for various applications

SYLLABUS

Introduction and Scope: Corrosion definition, wet and dry corrosion, mechanism, electro-chemical principles and aspects of corrosion, Faradays laws, resistance, specific resistance, conductance, specific conductance, transport numbers, ionic mobility, corrosion rate expressions, calculation of corrosion rates, thermodynamic aspects of corrosion, equilibrium potential, Nernst equation for electrode potential, EMF series, over voltage, application of Nernst equation to corrosion reactions,

Polarisation and Corrosion Potentials: References electrodes for corrosion measurements, types of polarisation, concentration, activation and resistance polarizations, Tafel constant, Evans diagrams, anodic control, cathodic control, mixed control, Pourbaix-diagram for Fe-H_2O system,

Various forms of Corrosion: Uniform attack, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, selective leaching (dezincification), cavitation damage, fretting corrosion, erosion corrosion, and stress corrosion and remedial measures,

Prevention Techniques: Modification of the material by alloying, appropriate heat treatment, chemical and mechanical methods of surface treatment, metallic, non-metallic linings, inhibitors, passivity, Cathodic protection and anodic protection.

Text Books:

1. 'Corrosion Engineering' by Mars G. Fontana, Tata McGraw Hill Publishing Company, New Delhi
2. 'Corosion and Corrosion Control' by H.H.Uhllg, John Wiley & Sons Inc., America

Reference Books:

1. 'Electrochemistry' by Samuel Glasstone, Litton Educational Publishing Company
2. 'Electrochemistry, Principles & Applications' by Edmond C.Potter, Cleaver Hume Press Limited**.**

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2. ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

SYLLABUS

Introduction to Artificial Intelligence: Definitions of Artificial Intelligence, Artificial Intelligence Problems, Topics of Artificial Intelligence, Timelines of Artificial Intelligence, Production Systems, State Space Representation, Branches of Artificial Intelligence, Applications of Artificial Intelligence. Heuristic Search Techniques-Generate-and-test, Hill Climbing, Search Techniques, Problem Reduction, Constraints Satisfaction, Means-ends Analysis.

Knowledge Representation Structures: First- order Logic- Basic Predicate Representations, Conversion of WFF to Clause Form, Resolution, Resolution Examples, Issues with Resolution, Frames, Conceptual Dependency, Scripts, and Semantic Network.

Reasoning:Types of Reasoning, Non- monotonic Inference Methods, Non- monotonic Reasoning, Truth Maintenance Systems, Reasoning with Fuzzy Logic, Rule- based Reasoning, Diagnosis Reasoning. Expert Systems-Characteristics of Expert System, Components of an Expert System, Expert System Development, Knowledge Engineering, Applications of Expert System, Case studies.

Learning: Types of Learning, Machine Learning, Intelligent Agents. Clustering- k-Means Clustering, Fuzzy Clustering, Hierarchical Clustering, Cluster Similarity, Case Studies.

Supervised Learning: Support Vector Machines, Case-based Reasoning, Decision Trees- C4.5 Algorithm, ID3 Algorithm, Random Forest, Ensemble Classifiers, and Nearest Neighbourhood. Artificial Neural Nets – ANN Basics, ANN- Learning Process, Types of Networks, Perceptron, RBF Networks, ANN Summary, Case Studies.

Text Book:

1. Artificial Intelligence and Machine Learning, by Vinod Chandra S.S and AnandHareendran S, PHI publishers.

Reference books:

1. Artificial Intelligence by Elaine Rich, Kevin Knight, McGraw-Hill publishers.
2. Machine Learning: The Art and Science of Algorithms that Make Sense of Data by Peter Flach, Cambridge University Press.

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3. DATA SCIENCE WITH APPLICATIONS

COURSE OBJECTIVES: From the course the student will learn

1. knowledge and expertise to become a data scientist.
2. Essential concepts of statistics and machine learning that are vital for data science;
3. significance of exploratory data analysis (EDA) in data science.
4. Critically evaluate data visualizations presented on the dashboards
5. Suitability and limitations of tools and techniques related to data science process

COURSE OUTCOMES: At the end of the course, student will be able to

1. Describe the steps involved in Data Science process and the technologies needed for a data scientist.
2. IdentifysuitableML techniques for data modellingand apply them for decision support.
3. handle large datasets with distributed storage and processing system
4. use appropriate tools for data collection, EDA and model building for specific types of data
5. can build a prototype application of Data Science as a case study.

UNIT I

Introduction to Data science, benefits and uses, facets of data, data science process in brief, big data ecosystem and data science

Data Science process: Overview, defining goals and creating project charter, retrieving data, cleansing, integrating and transforming data, exploratory analysis, model building, presenting findings and building applications on top of them

Unit II

Applications of machine learning in Data science, role of ML in DS, Python tools like sklearn, modelling process for feature engineering, model selection, validation and prediction, types of ML, semi-supervised learning

Handling large data: problems and general techniques for handling large data, programming tips for dealing large data, case studies on DS projects for predicting malicious URLs, for building recommender systems

UNIT III

NoSQL movement for handling Bigdata: Distributing data storage and processing with Hadoop framework, case study on risk assessment for loan sanctioning, ACID principle of relational databases, CAP theorem, base principle of NoSQL databases, types of NoSQL databases, case study on disease diagnosis and profiling

UNIT IV

Tools and Applications of Data Science: Introducing Neo4jfor dealing with graph databases, graph query language Cypher, Applications graph databases, Python libraries like nltk and SQLite for handling Text mining and analytics, case study on classifying Reddit posts

UNIT V

Data Visualization and Prototype Application Development: Data Visualization options, Crossfilter, the JavaScript MapReduce library, Creating an interactive dashboard with dc.js, Dashboard development tools,

Applying the DS process for respective engineering problem solving scenarios as a detailed case study.

Textbook:

1) Davy Cielen, Arno D.B.Meysman, and Mohamed Ali, “Introducing to Data Science using Python tools”, Manning Publications Co, Dreamtech press, 2016
2) Prateek Gupta, “Data Science with Jupyter” BPB publishers, 2019 for basics

Reference Books:

1) Joel Grus, “Data Science From Scratch”, OReilly, 2019

2)Doing Data Science: Straight Talk From The Frontline, 1 st Edition, Cathy O’Neil and Rachel Schutt, O’Reilly, 2013

4. NANO SCIENCE & TECHNOLOGY

Course Objectives:

- To give foundational knowledge of the Nano scienceand related fields.
- To make the students acquire an understanding the Nano science and Applications
- To help the students understand in broad outline of Nanoscience and Nanotechnology.

Course Outcomes:

At the end of the course, the student will be able to

- Understand the properties of nanomaterials and their applications
- Synthesize nanoparticles
- Characterize nanomaterials
- Scale up the production of nanoparticles
- Understand applications of nanoparticles in nanobiology and nanomedicine

SYLLABUS

General Introduction: Basics of quantum mechanics, harmonic oscillator, magnetic phenomena, band structure in solids, Mossbauer and Spectroscopy, optical phenomena bonding in solids, anisotropy,

Silicon Carbide: Application of silicon carbide, nano materials preparation, sintering of SiC, X-ray diffraction data, electron microscopy sintering of nano particles, nano particles of alumina and zirconia, nano materials preparation, characterization, wear materials and nano composites,

Mechanical Properties: Strength of nano crystalline SiC, preparation for strength measurements, mechanical properties, magnetic properties,

Electrical Properties: Switching glasses with nanoparticles, electronic conduction with nano particles,

Optical Properties: Optical properties, special properties and the coloured glasses

Process of Synthesis of Nano Powders, electro deposition, important nano materials

Investigaing and Manipulating materials in the nanoscale: Electron microscope, scanning probe microscope, optical microscope for nano science and technology, X-ray diffraction

Nanobiology: Interaction between bimolecules and naoparticle surface, different types of inorganic materials used for the synthesis of hybrid nano-bio assemblies, application of nano in biology, naoprobes for analytical applications - a new methodology in medical diagnostics and biotechnology, current status of nano biotechnology, future perspectives of nanobiology, nanosensors,

NanoMedicines: Developing of nano-medicines, nanosytems in use, protocols for nanodrug administration, nanotechnology in diagnostics applications, materials for used in diagnostics and therapeutic applications, molecular nanomechanics, molecular devices, nanotribology, studying tribology at nanoscale, nanotribology applications.

Text Books:

1. 'Nano Materials' by A.K.Bandyopadhyay, New Age Publishers
2. 'Nano Essentials'by T.Pradeep, TMH.

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5. INDUSTRIAL SAFETY & MANAGEMENT

Course Objectives:

- To know about Industrial safety programs and toxicology, Industrial laws , regulations and source models
- To understand about fire and explosion, preventive methods, relief and its sizing methods
- To analyse industrial hazards and its risk assessment.

Course Outcomes:

At the end of the course, the student will be able to

- Analyze the effects of release of toxic substances
- Select the methods of prevention of fires and explosions
- Understand the methods of hazard identification and prevention.
- Assess the risks using fault tree diagram
- Explain safety management in general and in industry specific
- Plan emergency preparedness and understand the occupational health hazards

SYLLABUS

Introduction : Industrial Safety, Incident, accident, near miss, hazard, risk, emergency, disasters, risk criteria, Safety at work.

Pediction and Evaluation of Unsafe Conditions:
Identification of unsafe areas, unsafe acts, manifestation of unsafe conditions to emergency situation, lessons from accidents and disasters, safety audit and its elements, safety in plant layout, equipment design. Construction, erection, commissioning, material handling.

Hazards – chemical hazards, thermodynamic hazards, electrical & electromagnetic hazards, mechanical hazards.

Risk – Definition, causes, potential and adverse effects.

Hazard Analysis – incident scenarios, residual risk, Concept Hazard Analysis (CHA), Preliminary Process Hazard Analysis PPHA, HAZOP, Fault Tree Analysis (FTA), Event Tree Analysis (ETA).

Risk Assessment – Risk criteria, causes of death/damage, individual risk, societal risk, criteria for acceptable risk tolerable risk, application of risk assessment, computation of fatality rates, severity rates, vulnerability analysis, introduction to computerized risk assessment techniques.

Safety Management (General) – safety policy perceptions, safety organization, safety audit techniques, project and **Construction Safety** – welding & cutting operations, fabrication, material handling, equipment spacing, safe plant layout procedures, storage tanks, erection & commissioning works, housekeeping methods, maintenance of storage yards, erection & maintenance of electrical panels and MCC rooms, electrical & mechanical safe guarding.

Emergency Preparedness – onsite & offsite emergency preparedness, emergency preparedness plans, site specific action plans and contingency plans, emergency facilities, rehabilitation & rescue operations, post emergency actions.

Safety Management (Industry Specific)- Chemical Manufacturing Plants, Fertilisers, Steel Plants, Petrochemical Plants, Metallurgical Plants, Mineral Process Industries, Sugar plants, semiconductor industry, Polymer manufacturing plans, Paper industry, Pharmaceutical and bulk drug industries, Vessel manufacturing industry, LPG bottling plants, Power Plants, tanneries and textiles.

Statutory Framework – key provisions of Factories Act, Environmental Protection Act, Manufacture, Storage and Import of Hazardous Chemical rules, Static and Mobile Pressure Vessels rules, NFPA specifications, OSHA regulations.

Occupational Health Management – occupational health perspectives, pre-employment & periodical medical examinations, diseases, causes, consequences,

Occupational Health Hazards in Various Industries – aluminium industry, asbestos, battery manufacturing, sugar, cement, coke ovens, cotton ginning, dairy, electro plating, fish canning, poultries, irrigation, lead smelting, mining, pesticides, power plants, refineries, pulp & paper industry, PVC processing, steel plants, fertilizers, sulphuric acid plants, tanneries and textiles.

International Standards – British council's five star rating systems, International Safety Rating Systems (ISRS), ISO 14001 EMS, ISO 18001 OHSAS, BIS 14489 Code of Conduct for conducting safety audits.

Text Books:

1. "Hazards in Chemical industries, 3rd edition" – Authored by Frank P.Lees
2. "Hazard identification and risk assessment" – Authored by Geoff Wells; Published by Institution of Chemical Engineers, Davis Building, 165-189 Railway Terrace, Rugby, Warwickshire CV21 3HQ, UK.

Reference Books:

1. "Safety Management 5th edition" – Authored by John V. Grimaldi and Rollin H. Simonds; Published by A.I.T.B.S. Publishers & Distributors, J-5/6, Krishna Nagar, Delhi – 110051.
2. "Environmental Health and Safety Management" – Authored by Nicholas P. Cheremisinoff and Madelyn L. Graffia; Published by Jaico Publishing House, Hyderabad.

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6. FUELS, REFRACTORIES AND FURNACES

Course Objectives:

- The main objective of this course is to study the different minerals used for the manufacturing of different types of refractories and its large scale applications in industries**.**

Course Outcomes:

At the end of the course, the students will be able to

- Understand the importance, types of refractories, properties, design and installation and different types of coatings on refractories.
- Explain about special refractories
- Describe refractories for iron & steel industry, Glass industry and cement & nonferrous industry

SYLLABUS

Introduction of Refractories: Production, demand and growth of refractories in India – layout of modern refractory plant – fundamental properties of refractories – Indian and international standards – factors for selection and use of refractories – test and quality control procedures.

Silica Refractories: Raw materials and composition – manufacturing process steps – quality of raw materials and process parameter on quartz inversion – glassy phase and other micro structural features – porosity, strength, RUL dependence on micro structure – specifications of silica refractories.

Alumina – Silica Refractories: Al_2O_3 – SiO_2 phase diagram – clay, pyrophyllite, sillimanite, grog, bauxite and diaspore as raw materials – manufacturing processes – micro structure and properties.

Basic Properties: Magnesite, forsterite, dolomite and chrome based refractories – raw materials and composition – manufacturing processes – micro structure and properties.

Special Refractories: Oxide based, carbide based and nitride based refractories – cordierite – zirconia – carbon – fusion cast refractories, slide gate, purging refractories, and continuous casting refractories – ceramic fibres.

Refractories for Iron and Steel Industry: Coke oven, blast furnace, twin hearth, LD converter – continuous casting – electric arc furnace, induction furnaces – reheating furnaces – slide plate

system – nozzle, shroud/ SDN – ladle and tundish lining practices – monolithic - gunning techniques – refractor, slag and metal interactions.

Refractories for Cement and Non Ferrous Industry : Wet/ dry process for cement making – preheater and pre calcinatory and zone lining – alkali and wear resistance – refractory requirement and use in copper, aluminum and hydro carbon industry – use of monolithic.

Refractories for Glass Industry : Design of glass tank for container, sheet, lamp, float glasses, refractory practices in side wall, throat, forehearth, and roof of glass tanks – regenerator systems – alumina and AZS fused cast refractories – glass corrosion resistance, oxidation, seed potential tests – glass defects and analysis – feeder expendables.

Refractories for Ceramic Industry: Kiln furniture – types – properties of requirement - silicon carbide, mullite, corderite, alumina, zirconia – mullite, zirconia types – kiln design – LTM concept – fast firing technology.

Refractories for Energy Conservation: Insulation refractories – types- ceramic fiber product – design and installation – ceramic coatings – case studies in ceramic fiber usage.

Textbook:

B. M. Coop and E. M Piekson, Raw Materials for the refractory industries and industry materials and consumer survey, 1981.

Reference Books:

1. J. H. Eheslers Refracrtories: production and Properties. Iron and Steel Institute, London, 1972.
2. Akira Nistrikawa, Technology of monolithic refractories, Plibrico japan co. Tokyo 1984
3. D.N. Nandi, Hand Book Refractory's, Tata Mc Graw hill publishing Co. New Delhi 1991
4. K.Shaw, Refractories and thick uses ADP sciences publisher U K 1972
5. Keishi GOTON, Powder Technology Hand Book, Marcel Dekker Inc. 1997
6. Chester J.H., Steel Plant Refractories, 2nd Edition, 1973, United Steel Companies Limited, Sheffield UK
7. Advances in Refractory Technology, Ed. Robert E Fisher, Ceramic Transaction Vol 4., American Ceramic society, 1990, Westerville, Ohio, USA.

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7. BIOCHEMICAL ENGINEERING

Course Objectives:

- To apply the chemical engineering principles in biological systems.

Course Outcomes

At the end of the course, the student will be able to

- Understand cell and enzyme kinetics
- Discuss methods of immobilization
- Calculate volume of a fermentor
- State sterilization methods
- Select downstream process to separate the products
- Estimation using various Bioanlytical techniques

SYLLABUS

Introduction to Biochemical Engineering and Biotechnology: Overall view of biotechnology since its practice–to date, enzyme kinetics, derivation of M.M. equation of single as well as multiple substrates, enzyme inhibition, determination of M.M. parameters, industrial applications of enzymes,

Cell Cultivation & Kinetics: Microbial, animal and plant cell cultivation, cell immobilization, batch growth of cells, yield coefficient, monod growth kinetics,

Analysis and Design of Fermenters: Batch fermenter, mixed flow fermenter (chemostat), plug flow fermenter, mixed flow fermenters in series, and cell recycling,

Genetic Engineering: DNA and RNA, cloning of genes, stability of recombinant microorganisms, gene manipulation,

Sterilization: Sterilization of media and air, thermal death kinetics, design criterion, continuous sterilization methods,

Aeration and Agitation in Fermenters: Correlations of mass transfer coefficient, measurement of interfacial area and gas holdup, power consumption, scale up concepts,

Bioanalytical Techniques: Gas chromatography, thin layer and paper chromatography, HPLC, affinity, gel, adsorption and ion exchange chromatography.

Text Book:

'Biochemical Engineering Fundamentals' 2nd edition by J.E.Bailey and D.F.Ollis, McGraw-Hill Publishers, Newyork, 1986

Reference Books:

1. 'Chemical Engineering' volume-3, 3rd Edition by J.F Richardson and D.G. peacock, (Chapter-5: Biochemical Reaction Engineering), Pergomon Press, U.K, 1994
2. 'Bioprocess Engineering: Basic Concepts' 2nd edition by M.L.Shuler and F.Kargi, Prentice Hall India, New Delhi, 2003
3. 'Biochemical engineering' by D.G. Rao, Tata McGraw-Hill Publishers, New Delhi,
4. 'Biochemical Engineering' by J.M. Lee, Prentice Hall, Englewood Clifts, 1992.

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8. INDUSTRIAL POLLUTION CONTROL ENGINEERING

Course Objectives:

- To understand the types of emissions from chemical industries and their effects on environment, remedial measures.
- To enable the students to design water treatment system & to acquire knowledge on proper management of solid wastes.
- To provide a general idea about safety in chemical industries.

Course Outcomes:

At the end of the course, the student will be able to

- Analyze the effects of pollutants on the environment
- Distinguish air pollution control methods
- Assess treatment technologies for wastewater
- Identify treatment technologies for solid waste
- Identify and manage industrial hazards

SYLLABUS

Types of Emission from chemical industries and their effects on environment, Environmental legislation, noise pollution, occupational health hazards, meteriological factors in pollution dispersion (ALP and ELP), plume behaviour and characteristics, chimney design considerations: Plume raise, effective stack height,

Methods of Analysis of Air Pollutants, particulate matter, SO_x, NO_x, CO_x analysis, removal of particulate matters: principles and design of setting chambers, solid traps, cyclone separators, fabric and design of fibre filters, scrubbers and electrostatic precipitators,

General Methods of Control and removal of sulphur dioxide, oxides of nitrogen, organic vapors from gaseous effluents with design aspects, sources of waste waters, effluent guidelines and standards, characterization of effluent streams, oxygen demanding wastes, oxygen sag curve, BOD curve, analysis of water pollutants,

Methods of Primary Treatment: Screening, sedimentation, floatation and neutralization, biological treatment, bacteria and bacterial growth curve, aerobic processes suspended growth processes, activated sludge process, extended aeration, contact stabilization, aerated lagoons and stabilization ponds, attached growth process with design aspects, trickling filters, rotary drum filters, fluidized bed contactors, anaerobic processes,

Methods of Tertiary Treatment: Carbon adsorption, ion exchange, reverse osmosis, ultra filtration, chlorination, ozonation & sonozone process, sludge treatment and disposal,

Solid Waste Management: solid waste collection, transportation, solid waste processing and recovery, hazards in waste management, risk assessment and safety measures, types of hazardous wastes, health effects, safety measures, risk assessment response measures, case studies or pollutants removal and safety measures in fertilizer, petrochemical, paper, pharmaceutical industries and petroleum refinery,

Industrial Safety: Why safety, accidents, causes and remedial measures, safety aspects of site selection, plant layout and unit plot planning, hazards of commercial chemical operations and reactions, safety aspects of process design, instrumentation for safe operations, safety aspects in design and inspection of pressure vessels, effect of toxic agents, toxicity vs hazards, respiratory hazards, safe experimentation and testing of reactions, materials for safety,

Flamable Materials: Fire extinguishing agents and their applications, eye safety in chemical processing, personnel protective equipment, permit systems, hazard evaluation techniques, modern safety management systems, safety effectiveness.

Text Books:

1. 'Environmental Pollution Control', by C.S. Rao, Wiley Eastern Limited
2. 'Safety and Accident Prevention in Chemical Operations' by Fawcett and Wood

Reference Books:

1. 'Environmental Engineering' by Arcdio P.Sincero and Geogoria Sincero
2. 'Loss Prevention in Chemical Industries' by Frank P.Lees

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9. INTERNET OF THINGS

Course Objectives:

- Understand IoT conceptual framework and design standardisation of IoT/M2M architectural layers and domains
- Learning the usage of messaging protocols between connected devices and the web
- Identify the functions and usage of data analytics and cloud services for IoT applications and business processes.
- Elucidate sensor technology for sensing the real world using analog and digitalsensors
- Develop the codes, design and test the embedded devices for IoT and M2M using IDEs and development platforms

Course Outcomes (COs):

At the end of the course, student will be able to

- Understand the IoT Standards and design principles.
- Understand various web-communication protocols and their practical usage.
- Able to use IoT cloud-based services using the Xively, Nimbits.
- Able to learn various types of sensors and actuators, interfacing and use in IoT environment.
- Able to use number of device platforms of IDEs, such as Arduino, Intel Galileo, RPi, BBand mBed, provide development tools, libraries and framework, and are used for the development of embedded Software.

SYLLABUS

The Internet of Things: An Overview of Internet of things, Internet of Things Conceptual Frame work, IoT architectural View, Technology behind IoT, Sources of IoT, M2M Communication, Examples of IoTs, Design Principles for Connected Devices Internet Connectivity: IoT/M2M System Layers and Design Standardization.

Design for Web Connectivity.: Web communication protocols for connected devices, Message Communication protocols for connected devices, Web Connectivity for Connected- Devices Network using Gateway, SOAP, REST, HTTP RESTFUL, and Web Sockets, Principles, Internet connectivity, Application Layer Protocols: HTTP, HTTPS, FTP, Telnet.

Data Acquiring, Organizing, Processing and Analytics: Data Acquiring and Storage, Organizing the Data, Transactions, Business Processes, Integration and Enterprise Systems. Analytics, Knowledge acquiring, managing and storing process.

Data Collection, Storage and Computing Using a Cloud Platform: Cloud Computing Paradigm for Data Collection, Storage and Computing. Everything as a service and Cloud Service Models, IOT cloud-based services using the Xively, Nimbits and other platforms.

Sensor, Participatory Sensing, RFID, Wireless Sensor Networks: Sensors Technology, Participatory Sensing, Actuator, Sensor Data Communication Protocols, RFID, WSN.

Prototyping and Designing the Software for IoT Applications: Prototyping embedded device Software, Devices, Gateways, Internet and Web/Cloud Services Software Development, Prototyping Online Component APIs and WebAPIs.

IoT Case Studies:
Design Layers, Design Complexity and Designing Using Cloud PaaS. IoT Applications forSmart Homes, Cities, Environmental Monitoring and Agriculture. Connected Car and Its applications.

Text Books:

1. Internet of Things: Architecture, Design Principles And Applications, Rajkamal, McGrawHill Higher Education
2. Internet of Things, A.Bahgya and V.Madisetti, Univesity Press,2015

Reference Books:

1. Designing the Internet of Things, Adrian McEwen and Hakim Cassimally,Wiley
2. Getting Started with the Internet of Things,CunoPfister , Oreilly

10. DESIGN OF EXPERIMENTS

Course Objectives:

The student will be able to learn

- The basic guidelines of designing experiments
- Parametric estimation
- Fitting first/second order models
- Optimization of the given problem

Course Outcomes:

At the end of the course, the student will be able to

- Design experiments for a critical comparison of outputs
- Propose hypothesis from experimental data
- Implement factorial and randomized sampling from experiments
- Estimate parameters by multi- dimensional optimization

SYLLABUS

Introduction: Strategy of experimentation, basic principles, guidelines for designing experiments. Simple Comparative Experiments: Basic statistical concepts, sampling and sampling distribution, inferences about the differences in means: Hypothesis testing, Choiceof samples size, Confidence intervals, Randomized and paired comparison design.

Experiments with Single Factor: An example, The analysis of variance, Analysis of thefixed effect model, Model adequacy checking, Practical interpretation of results, Sample computer output, Determining sample size, Discovering dispersion effect, The regression approach to the analysis of variance, Non-parametric methods in the analysis of variance, Problems.

Design of Experiments: Introduction,Basicprinciples:Randomization,Replication,Blocking, Degrees of freedom, Confounding, Design resolution, Metrology considerations for industrial designed experiments, Selection of quality characteristics for industrial experiments. Parameter Estimation.

Response Surface Methods: Introduction, The methods of steepest ascent, Analysis of a second- order response surface, Experimental designs for fitting response surfaces: Designs

forfittingthefirst-ordermodel,Designsforfittingthesecond-ordermodel,Blockinginresponse surface designs, Computer-generated (Optimal) designs, Mixture experiments, Evolutionary operation, Robust design, Problems

Design and Analysis: Introduction, Preliminary examination of subject of research,Screeningexperiments: Preliminary ranking of the factors, active screening experiment- method of random balance, active screening experiment Plackett-Burman designs, Completelyrandomizedblockdesign,Latinsquares,Graeco-LatinSquare,YoudensSquares, Basic experiment-mathematical modelling, Statistical Analysis, Experimental optimization of research subject: Problem of optimization, Gradient optimization methods, Nongradient methods of optimization, Simplex sum rotatable design, Canonical analysis of the response surface, Examples of complex optimizations.

Text Books:

1. LazicZ.R.,DesignofExperimentsinChemicalEngineering,APracticalGuide,Wiley, 2005.
2. AntonyJ.,DesignofExperimentsforEngineersandScientists,ButterworthHeinemann, 2004.
3. MontgomeryD.C.,DesignandAnalysisofExperiments,Wiley,5thEdition, 2010.
4. Doebelin E. O., Engineering Experimentation: Planning, Execution, Reporting,McGraw- Hill, 1995.

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11. RENEWABLE ENERGY SOURCES

Course Objectives:

The student will be able to learn

- Various sources of energy
- Direct/indirect utilization of solar energy
- Wind energy conversion and types of wind machines
- OTEC systems and application of Geothermal energy

Course Outcomes:

At the end of the course, the student will be able to

- Identifythechallengesandproblemsassociatedwiththeuseofenergysources.
- Illustrate the renewable energy technologies.
- Distinguishconversiontechnologiesforsolar,wind,biomassandhydrogen energies
- Evaluate the performance of energy conversion technologies

SYLLABUS

Sources of Energy: Energy sources and their availability, renewable energy sources. Energy from Biomass: Introduction, Biomass as a source of energy, Biomass conversion technologies, Biogas generation, classification of biogas plants, Biomass gasification.

Solar Energy: Sun and solar energy, solar radiation and its measurement, solar energy collectors, solar energy storage, Photovoltaic systems, Application of solar energy

Wind Energy: Wind as an Energy source, Basic principles of wind energy conversion, Types of Wind machines, Components of wind energy conversion system, Performance of wind machines, application of wind energy.

Geothermal Energy: Introduction, Origin and distribution of geothermal energy, types of geothermal resources, Hybrid geothermal power plant, Application of geothermal

Energy Hydrogen Energy: Introduction, Hydrogen production, Hydrogen storage, Hydrogen transportation Energy from the Oceans: Introduction, Ocean Thermal Electric Conversion (OTEC), Energy from Tides, Ocean Waves Chemical Energy Sources. Introduction to Fuel cells, and Batteries.

Text Books:

1. Non-ConventionalEnergySources,Rai,G.D,KhannaPublishers,NewDelhi,2010.
2. Non-conventional Energy Sources, RajeshKumarPrasad, T.P.Ojha, Jain Brothers, 2012.
3. Solar energy–Thermal Collection and storage, SukhatmeS. PandJ. Nayak, Tata McGraw Hill Education Pvt. Ltd., 2008, 3rdEdition.
4. Power Plant Technology, MM. EIWakil, Tata McGraw Hill, NewYork,1999

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12.ENERGY TECHNOLOGIES

Course Objectives:

The student will be able to learn

- Conventional and non conventional energy sources
- Direct solar energy conversion using photovoltaic cells
- Recovery streams of heat from the product streams using waste heat boilers
- Energy conversion and management

Course Outcomes:

At the end of the course, the student will be able to

- Identify the Energy sources and its exploration
- Design process equipment for alternative energy sources
- Explain the principles of solar cells and fuel cells
- Analysis for energy accounting & auditing

SYLLABUS

Conventional Energy Sources: Formation of fossil fuels &resources. Energy sources: Coal; Oil; Natural gas; Hydropower. Coal Gasification & Liquefaction; Synthetic fuels; Hydrogen; Methods & applications of Cogeneration; Fluidized-bed combustion, combined cycle plants. Role of coal in energy crisis.

Non-conventional Energy Sources: Study of power plants using energy sources like solar, wind, geothermal, ocean thermal, tide. Design of Biogas plant; Biomass energy; Alternative fuels from biomass.

Direct Energy Conversion: Solar cells; Photovoltaic cells; Theory of junction-type cells & construction details. Fuel cells: types; practical considerations; construction & working details. Principles of MHD power generation. Nuclear energy: Nuclear fuels; Fission-type reactor.

Waste Heat Recovery: Heat pump; Demand of energy & Forecasting; Principles of energy accounting & auditing; economics; Principles of energy management; Technology assessment with reference to case studies.

Energy Conservation & Management: EnergyScenariointheWorldandIndiain21st century. Exploration of energy resources based on combustion.

Text Books:

1. EnergyTechnology–Nonconventional,Renewable&conventional,S.Rao,Khanna Publishers, New Delhi.
2. AnIntroductiontoPowerPlantTechnology,G.D.Rai,KhannaPublishers,NewDelhi.
3. Non-conventional Energy Sources, G.D.Rai, Khanna Publishers ,New Delhi

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HSS ELECTIVES

1. INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP

Course Objectives:

- To familiarize the students with the concepts of Management.
- To relate the concepts of Management with industrial organizations.
- To explain the factors affecting productivity and how productivity can be increased in an Industrial undertaking.
- To set forth a basic framework for understanding Entrepreneurship.

Course Outcomes:

- On completion of the course, the students will be able to:
- Understand the roles, skills and functions of management.
- Distinguish the different types of business organizations.
- Identify the factors involved in Production Operations Management.
- Diagnose organizational problems and take suitable decisions.
- Establish good Human Resource Management practices.
- Acquire necessary knowledge and skills required for organizing and carrying out entrepreneurial activities.

SYLLABUS

Basic Concepts of Management:

Management :- Definition, Nature and Importance ; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management;

Forms of Business Organizations: Introduction, Types of Business organizations: Private Sector- Individual Ownership, Partnership, Joint stock companies and Co-Operative organizations; Public sector- Departmental Organizations, Public Corporations and Government Companies; The Joint sector Management.

Production and Operations Management: Plant location- Factors to be considered in the selection of Plant location; Break - even analysis- Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance.

Entrepreneurship: Definition, Characteristics and Skills , Types of Entrepreneurs, Entrepreneur vs. Professional Managers, , Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

Entrepreneurial Development and Project Management: Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques;, Stages in Project formulation ; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

Text Books:

1. Industrial Organization & Engineering Economics by Sharma,S.C, and Banga, T.R., , Khanna Publishers, Delhi, 2000.
2. The Dynamics of Entrepreneurial Development and Management (Planning for future Sustainable growth) by Vasant Desai**,** HImalayan Publishing House, 2018.

Reference Books:

1. Management Science**,** by Aryasri , A.R., McGraw HIll Education (India Private Limited , New Delhi 2014.
2. Entrepreneurship by Sheela, P. and Jagadeswara Rao, K., Shree Publishing House, Guntur, Andhra Pradesh, 2017.

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2. ORGANIZATIONAL BEHAVIOUR

Course Objectives:

- To understand the basic concepts of organisational behaviour, its foundations and importance.
- To enable students to have a basic perspective of Motivation and Motivation theories.
- To acquaint the students about group behaviour in organizations, including communication, leadership conflicts and organizational change and how these are linked to and impact organizational performance.

Course Outcomes:

- Indentifying fundamental aspects of organizational dynamics.
- Evaluate main theories of motivation and formulating suitable motivational strategies.
- Analyze the behaviour of individuals and groups in organizations.
- Understanding of Leadership theories and Leadership behaviour.
- Apply relevant theories, concepts to address important Organizational Behaviour questions.

SYLLABUS

Organizational Behaviour : Concept of Organisation - Concept of Organisational Behaviour - Nature of Organisational Behaviour - Role of Organisational behaviour - Disciplines contributing to Organisational Behaviour.

Motivation: Définition - Nature of Motivation - Role of Motivation - Théories of Motivation : Maslow's Need Hierarchy Theory, Herzberg's Motivation Hygiene Theory and Mc Gregor's Theory X and Theory Y.

Group Dynamics: Meaning - Concept of Group - Types of groups -Formal and Informal groups - Group development - Group cohesiveness and factors affecting group cohesiveness.

Leadership: Concept of Leadership - Difference between Leadership and Management - Importance of Leadership - Leadership styles: Autocratic leadership, Participative leadership and Free Rein leadership.

Communication: Meaning - Communication Process - Forms of communication: Oral, Written and Non-Verbal communication - Direction of communication : Down Ward, Up Ward and Horizontal communication.

Organisational Conflicts: Concept of Conflict - Reasons for conflict - Types of Conflict: Intrapersonal conflict, Interpersonal conflict, Intra group conflict, Inter group conflict, Inter Organizational conflict - Conflict management.

Organizational Change: Nature - Factors in Organizational change -Planned change: Process of Planned change - Resistance to change: Factors in résistance to change – Over coming résistance to change.

Text Books :

1. Organizational Behaviour by L.M.Prasad: Sultan Chand & Sons, New Delhi -110002
2. Organisational Behaviour by K. Aswathappa:, Himalaya Publishing House, New Delhi

Référence Book :

Organizational Behaviour by Stephen Robbins:, Pearsons Education, New Delhi.

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3. OPERATIONS RESEARCH

Course Objectives:

- Formulate a real world problem as a mathematical programming model.
- Provide knowledge of optimization techniques and approaches.
- Understand and study inventory problems.
- Know the network models.
- Put on knowledge in solving replacement problems and different queuing models

Course Outcomes:

- Learned to translate a real-world problem into a mathematical formulation.
- Formulate and Solve Transportation, Assignment and sequencing problems.
- Resolve inventory problems.
- Able to solve maximum flow and shortest path problems.
- Capable to solve replacement problems and analyze queuing models.

SYLLABUS

Introduction: Definitions of Operations Research; Phases of Operations Research; Types of Operations Research models; applications, merits and demerits of Operations Research.

Allocation: Linear Programming problem formulation; Basic assumptions; Graphical solution; Simplex method; Artificial variable technique; Two phase method; Big M method; Duality principle; Primal and Dual relation.

Transportation: Formulation; Solution methods; Unbalanced transportation problems - North west corner rule; Least cost entry method; Vogel's approximation method; Optimal solution; degeneracy.

Assignment: Formulation; Variations in Assignment problem; Travelling salesman problem.

Sequencing: Sequencing of - *n* jobs through two machines; *n* jobs through three machines; *n* jobs through *m* machines; 2 jobs through *m* machines.

Inventory Control: Introduction; Types of Inventory; Inventory costs; Deterministic models - Economic order quantity (EOQ) and Economic Production Quantity (EPQ) with and without shortages; Quantity discounts; P system; Q system; Inventory control Techniques.

Network Analysis: Network definitions; Time estimates in network analysis; Labeling using Fulkerson's rule; Forward pass computations; Backward pass computations; Project management using Critical Path Method(CPM) and Programme Evaluation and Review Technique(PERT).

Replacement: Introduction, Replacement of items that deteriorate with time - Value of money unchanging and changing, Replacement of items that fail completely.

Queuing Models: Introduction; Single channel poisson arrivals; Exponential service times; Unrestricted queuewith infinite population and finite population models; Multi channel poisson arrivals; Exponential service times with infinite population and restricted queue.

Text Books:

1. Operations Research- An Introduction" by Hamdy A Taha, TAHA , Prentice Hall, 2009.
2. "Introduction To Operations Research by F.S. Hiller, G.J. Liberman,B. Nag and P.Basu Mc Graw Hill Education(India), 2012.
3. "Operations Research" by S.D.Sharma Kedarnadh Ramnadh & Co.,2017

Reference Books:

1. "Operations Research" by R. Pannerselvam, PHI..
2. "Operations Research" by Richard Bronson, Schaum's Series, Mc Graw Hill
3. "Operations Research- Theory and Practice" by N.V.S.Raju, BS publications.
4. "Operations Research" by V.K. Kapoor, Sultan Chand & Sons.

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