M.TECH.

(INDUSTRIAL POLLUTION CONTROL ENGINEERING)

(Effective from the admitted batch of 2021-22)

Scheme and Syllabi

DEPARTMENT OF CHEMICAL ENGINEERING
AU COLLEGE OF ENGINEERING
ANDHRA UNIVERSITY
VISAKHAPATNAM

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DEPARTMENT OF CHEMICAL ENGINEERING
AU COLLEGE OF ENGINEERING
ANDHRA UNIVERSITY
VISAKHAPATNAM

SCHEME OF INSTRUCTION & EXAMINATION
1/2 M.TECH (INDUSTRIAL POLLUTION CONTROL ENGINEERING) FIRST SEMESTER
(WITH EFFECT FROM 2021-22 ADMITTED BATCH ONWARDS)
UNDER CHOICE BASED CREDIT SYSTEM

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
IPCE 1.1.1	Chemical Reaction Engineering	3	3	1	--	4	30	70	100
IPCE 1.1.2	Transport phenomena	3	3	1	--	4	30	70	100
IPCE 1.1.3	Elective-I	3	4	--	--	4	30	70	100
IPCE 1.1.4	Elective-II	3	4	--	--	4	30	70	100
IPCE 1.1.5	Research Methodology & IPR	2	4	--	--	4	30	70	100
IPCE 1.1.6	Audit Course–1*	0	2	-	--	2	--	--	--
IPCE 1.1.7	Elective lab	2	--	--	3	3	50	50**	100
IPCE 1.1.8	Seminar	2	--	--	3	3	100	--	100
	TOTAL	18	20	2	6	28	400	400	800

*To be included as 'Qualified' or 'Not Qualified' in the marks list
**Only internal evaluation.

Elective-I: 1. Management and control of Industrial waste water and Solids
2 Petroleum Refinery Engineering-I
3. Electrochemical Engineering - I

Elective-II: 1. Corrosion Engineering-I
2. Energy Engineering-I
3. Reaction Engineering-I

Audit Course 1 : 1. Yoga for working professionals
2. Organizational Behaviour

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UNDER CHOICE BASED CREDIT SYSTEM

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
IPCE 1.2.1	Air pollution and control	3	3	1	--	4	30	70	100
IPCE 1.2.2	Process Dynamic and Control	3	3	1	--	4	30	70	100
IPCE 1.2.3	Analytical Techniques	3	3	1	--	4	30	70	100
IPCE 1.2.4	Elective-III	3	4	--	--	4	30	70	100
IPCE 1.2.5	Elective-IV	3	4	--	--	4	30	70	100
IPCE 1.2.6	Audit Course–2*	0	2	-	--	2	--	--	--
IPCE 1.2.7	Elective lab	2	--	--	3	3	50	50	100
IPCE 1.2.8	Seminar	2	--	--	3	3	100	--	100
	TOTAL	19	19	3	6	28	300	400	700

*To be included as 'Qualified' or 'Not Qualified' in the marks list

Elective-III: 1. Industrial Hazards, Safety Measures & Environmental Impact Assessment
2. Petroleum Refinery Engineering-I
3. Electrochemical Engineering - I

Elective-IV: 1. Corrosion Engineering-II
2. Energy Engineering-II
3. Reaction Engineering-II

Audit Course 2 : 1. Disaster Management
2. Entrepreneurship

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(WITH EFFECT FROM 2021-22 ADMITTED BATCH ONWARDS)
UNDER CHOICE BASED CREDIT SYSTEM

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
IPCE 2.1.1	Elective-V	3	4	--	--	4	30	70	100
IPCE 2.1.2	Elective-VI (Open Elective)	3	4	--	--	4	30	70	100
IPCE 2.1.3	Dissertation (preliminary)	9	--	--	--	--	100	--	100
	TOTAL	15	8	--	--	8	160	140	300

Note: The dissertation shall be evaluated through Viva-voce examination by a committee with HOD, Chairman, Board of Studies and Research guide as members. The marks shall be awarded in the ratio of 30,30 and 40 percent by the members Respectively

Elective-V: 1. Environmental Biotechnology
2. Waste to Energy
3. Process modelling & simulation

Elective-VI (Open elective): 1. Nano Technology
2. Pollution Control
3. Corrosion Engineering

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UNDER CHOICE BASED CREDIT SYSTEM

Code No.	Course	Credits	Theory	Tutorial	Lab	Total	Sessional marks	Exam marks	Total marks
IPCE 2.2.1	Dissertation	16	--	--	--	--	--	100	100
	TOTAL	16	--	--	--	--	--	100	100

Note: The dissertation shall be evaluated through Viva-voce examination by a committee with an external member nominated by University, HOD, Chairman, Board of Studies and Research guide as members. The marks shall be awarded in the ratio of 20, 20, 20 and 40 percent by the members respectively

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M.Tech. Industrial Pollution Control Engineering

Program Outcomes

PO1 Develop an ability to independently carry out research /investigation and development work to solve practical problems

PO2 Develop an ability to write and present a substantial technical report/document

PO3 Acquire a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4 Acquire in-depth knowledge about various environmental processes, analyze and design solutions for complex problems related to environmental and public health.

PO5 Evaluate critically environmental sustainability and sensitize communities through effective communications and assess alternative solutions for adequate decision making for overall environmental management.

PO6 Acquire professional and intellectual integrity and ethics to produce socially responsible and competent environmental scientists and engineers

Program Specific Outcomes

PSO1 Identify, formulate and solve pollution problems of the industry using professional ethics, social responsibility and in-depth knowledge of industrial pollution their ability of critical thinking and management skill

PSO2 Apply the technical knowledge to solve the pollution problems of industries and society.

SYLLABUS
M.TECH. I SEMESTER
IPCE-1.1.1: Chemical Réaction Engineering
(Common for Chemical, MPE, CACE & IPCE)

Objectives:

- To focus on the thermal characteristics of various reactions and the design aspects of non isothermal and adiabatic reactors
- To focus on Heterogeneous data analysis and design
- To focus on CVD reactors
- To study the design aspects of heterogeneous catalytic systems
- To impart the knowledge on mass transfer with reaction in process catalysts

Outcome:

- Enables the students to understand the design aspects of non isothermal and adiabatic reactors
- Enables the students to on heterogeneous data analysis and design aspects of heterogeneous catalytic systems
- Able to derive the rate laws for CVD
- Able to develop the rate laws for heterogeneous fluid solid catalyzed reactions under rate limiting situations.

Syllabus:

Review of Fundamentals Rate laws and stiochiometry, reactions with phase change (Scope: Chapter 3 of Fogler) Least squares Analysis of rate data: differential reactors: Laboratory reactors (Scope: sections 5.4 to 5.6 of Fogler) Multiple reactions (Scope: Chapter 9 of Fogler).

Isothermal reactor design (Scope: Chapter 4 of Fogler) Batch reactor, PFR, CSTR design. Pressure drop in reactors, Reversible reactions, unsteady state operation of reactors, Simultaneous reaction and separation

Catalysis and catalytic reactors (Scope: Chapter 6 of Fogler) Steps in catalytic reaction: derivation of rate laws, design for gas-solid reactions, heterogeneous data analysis and design; Chemical vapour deposition, catalyst reactivation, moving bed reactions.

Diffusion and reaction in process catalysts (Scope: Chapter 11 of Fogler).

Diffusion and reaction in spherical catalyst.

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Internal effectiveness factor, falsified kinetics; estimation of diffusion and reaction limited regimes. Mass transfer and reaction in packed bed. Determination of limiting situations from reaction data, CVD reactors.

Non-isothermal reactor design (Scope: Chapter 8 of Fogler), Energy Balance, equilibrium conversion under adiabatic conditions unsteady state operation, multiple steady states.

Learning outcomes:

- Express important concepts in reaction kinetics and classify reactions according to different properties.
- Calculate the reaction rate constant and reaction activation energy using Least squares Analysis of rate data
- Explain
- Explain the criteria used to evaluate the laboratory reactors and solve problems related to multiple reactions
- develop performance equations for different types of reactors using mass balances
- Design different reactors and explains the Simultaneous reaction and separation.
- Develop the rate laws for heterogeneous fluid solid catalyzed reactions under rate limiting situations.
- Develop the expression for concentration profile and effectiveness factor for first order reaction in a spherical pore of a catalyst.
- Explain different mechanisms postulated for adsorption and surface reaction in catalytic reactions.
- Explain the mass transfer and reaction in a packed bed.
- Do design calculations for non isothermal and adiabatic reactors
- Investigate the effect of temperature on reactor design and reaction parameters.
- Calculates the multiple steady states for MFR type reactors

Textbook:

Fogler. H.S: Elements for Chemical Reaction Engineering 2nd Edition, Prentice Hall, New Delhi, 1992.

Reference:

Smith J.M: 'Chemical Engineering Kinetics' 3rd Edition, McGraw Hill, 1981.

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IPCE -1.1.2: Transport Phenomena
(Common for Chemical, MPE, CACE & IPCE)

Objectives:

- To be able to analyze various transport processes with understanding of solution approximation methods and their limitations.

Outcomes:

- Ability to understand the chemical and physical transport processes and their mechanism.
- Ability to do heat, mass and momentum transfer analysis.
- Ability to analyze industrial problems along with relevant approximations and boundary conditions.
- Ability to develop steady and time dependent solutions along with their limitations.

Syllabus:

Unit 1: Momentum Transport

1.1 The Equations of change for isothermal systems.
1.2 Velocity distributions with more than one independent variable.
1.3 Velocity distributions in turbulent flow.
1.4 Inter phase transport in isothermal systems.

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

- Perform momentum balance for a given system at microscopic scale.
- Solve the governing equations to obtain velocity profile.
- Solve the unsteady state momentum equation to obtain velocity profiles
- Understand the momentum transport under turbulent conditions and can be able to find out the friction factor or drag coefficient for a fluid flow system

Unit 2: Energy Transport

1.1 The Equations of change for non – isothermal systems.
1.2 Temperature distributions with more than one independent variable.
1.3 Temperature distributions in turbulent flow

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1.4 Inter phase transport in non isothermal systems.

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

- Perform energy balance for a given system at microscopic scale.
- Solve the governing equations to obtain temperature profiles at steady state and unsteady state condition.
- Understand the energy transport under turbulent flow conditions and can be able to find out the heat transfer coefficient.

Unit 3: Mass Transport

1.1 The Equations of Change for multi component systems.
1.2 Concentration distribution with more than one independent variable.
1.3 Concentration distribution in turbulent flow.

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

- Perform the mass balance for a given system at microscopic scale and can be able to solve the governing equation to obtain concentration profiles.
- Solve the unsteady state mass balanceequation to obtain concentration profiles
- Understand the mass transport phenomena under turbulent flow conditions.

Textbook:

"Transport phenomena" R. Byron Bird, Warren E. Stewart and E.N. Light foot, Wiley & Sons, Inc., New York.

Reference Books:

1."Fundamentals of Momentum, Heat and Mass Transfer" James R. Welty, Charles E. Wicks and Robert E. Wilson, John Wiley & Sons, Inc., New York.
2. "Boundary – Layer Theory", Dr.H.Sehlichting, McGraw – Hill Book Company, New York.

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IPCE-1.1.3: Elective – I

IPCE- 1.1.3 A - Elective-I (Management and control of industrial wastewater and solids)

Course objective:

The course is designed as tailor-made approach to know the fundamental concepts and various technologies of industrial wastes and solid waste management helpful the students in brightening chances for getting wide range of employability both in industrial and community organizations

Course outcome:

- On completion of the subject course, the students will have the scope to learn various theoretical and technical aspects of industries waste water treatment and solid waste management methods which are very significant in industrial sector
- The course will add the design approach of Effluent Treatment Plants and solid waste recovery and recycling techniques and the students can brighten their chances of job opportunity in corporate companies engaged in design of pollution control equipments
- Sludge treatment aspects of the course will be helpful to students for further enhancing their skills when they take up practical assignments
- The course will lay down a basic platform to persue further research in the specific fields the interest of students
- Enhance the knowledge of latest practices being adopted in the field of wastewater treatment and solid waste management and helpful the students who take up their career in academic line

Syllabus:

Unit – I

Source of Industrial wastewater: Types, permissible limits, **sources and pollutants** - BOD, COD, TOC, sampling and analysis of industrial wastewater, **impacts on** - soil, irrigation, animal husbandry, plants, ecosystems and public health aspects

Learning outcome

- The student will learn various types of industrial wastewaters and its permissible limits as per the statutory stipulations
- The student will have knowledge on sources of pollutants, sampling & analysis techniques pertaining to water pollution measures. And also, the aspects like of impacts on soil, irrigation, animal husbandry, plants, eco-systems and public health aspects

Unit – II

Primary and secondary treatment methods: screening, sedimentation, flotation and neutralization, bacterial and bacterial growth curve, aerobic processes, suspended processes, activated sludge processes, extended growth processes, contact stabilization, aerated lagoons and stabilization ponds, attached growth processes, trickling filters, rotary disk contractors, fluidized bed contractors, anaerobic processes

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Learning outcome:

- On completion of the course, the student will have the scope to learn various theoretical & technical aspects of industrial wastewater treatment and management methods
- As the aspects related to biological treatment process of the effluents, the student will enhance the skills to design the treatment systems

Unit – III

Tertiary treatment techniques: carbon adsorption, ion-exchange, reverse osmosis, ultra filtration, ozonation, sonozone processes, chlorination

Learning outcome:

- Student will learn the advanced treatment procedures of effluents and expected to gain knowledge in optimizing the operating parameters of the tertiary treatment systems
- The course will laid on a basic platform to pursue further research and the specific fields of the interest of the students in advanced treatment systems

Unit – IV

Sludge treatment and disposal: overview, mass volume relationships, secondary clarification and gravity thickness, aerobic & anaerobic digestion, cake filtration, composting, sludge disposal

Learning outcome:

- This module will give a overview of sludge treatment and disposal systems being practiced in the industries
- The sludge treatment aspects of the course will be helpful to the students for further enhancing their skills when they take-up practical assignments

Unit – V

Solid waste Management: Terminology – liquid waste, solid waste, refuse, garbage & food waste, rubbish, white goods, rubble. **Solid waste characteristics** – generation rates, components, moisture content, density, proximate and ultimate analysis and energy content, **solid waste collection & transportation** – haul – container system, stationary container system, layout of collection routes, transfer stations, **solid waste processing and recovery** – recovery of materials for recycling, manufacturing of solid waste products, energy recovery, **disposal of solid wastes** – land filling methods, aspects of landfill implementation, sanitary landfill equipment

Learning outcome:

- This module will help the student to learn about broad classification of solid waste and its characteristics like moisture content, density, proximate and ultimate analysis etc.

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- It is expected to learn various methodologies adopted in solid waste management including handling, transportation and treatment. And also, the principles of reduce, recycle & reuse (3R) will be well-known to the students

Textbooks:

1. "Industrial Pollution Control" by C.S.Rao
2. "Environmental Engineering – A design approach" by Arcadio P. Sincero and Gregoria A. Sincero

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IPCE - 1.1.3 B - Elective-I (Petroleum Refinery Engineering-I)

Objective: The objective of this course is to provide with:

Basic concepts of petroleum refinery engineering, refinery process, products, specifications, test methods and design of equipment.

Outcomes: The student will be able to:

- Understand the formation and composition of petroleum and classify important refinery products and their properties.
- Analyze the fractionation of petroleum, treatment techniques, thermal and catalytic process and design of distillation towers.

Syllabus:

Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits of world, Indian petroleum industry, Composition of petroleum.

Petroleum processing data: Evaluation of petroleum, thermal properties of petroleum fractions, important products and properties, test methods.

Learning outcomes:

- Understand the origin and composition of petroleum, deposits of world.
- Classify the petroleum products and test methods.

Fractionation of petroleum: Dehydration and desalting of crudes, heating of crude-pipe still heaters, distillation of petroleum, blending of gasoline.

Learning outcomes:

- Explain the dehydration and desalting of crudes.
- Analyzing crude pipe still heaters and blending of gasoline.

Treatment techniques: Treatment of gasoline, kerosine, lubes, and wax purification.

Learning outcomes:

- Discuss the treatment of gasoline, kerosine and lubes.
- Explain the wax purification.

Thermal and catalytic processes: Cracking, catalytic cracking, catalytic reforming, coking, alkylation process.

Learning outcomes:

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- Explain the catalytic cracking and catalytic reforming process.
- Explain the coking and alkylation process.

Design of atmospheric distillation and vacuum distillation towers.

Learning outcomes:

- Design of atmospheric distillation column.
- Design of vacuum distillation column.

Text book: Petroleum refinery engineering by Nelson.
Reference Books: 1.Modern petroleum refining process by B.K.Bhaskara Rao.
2.Petroleum refining technology by Dr.Ram Prasad.

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IPCE - 1.1.3 C - Elective-I (Electrochemical Engineering-I)

OBJECTIVES:

- To enable the basic principles of electrochemistry, electrochemical devices, electro active materials used in such devices, and case studies of batteries.

- To enable the clean energy needs and demands especially in the electrochemical power generation sector; and to become educators, practicing engineers, and national leaders in electrochemical energy conversion and storage.

- To enable the integrated skills in fundamentals of electrochemistry (e.g.; chemistry, physics, mathematics, thermodynamics, and chemical kinetics) and electrochemical engineering applications (batteries, solar, flow and fuel cells, electrochemical synthesis and corrosion) to ensure successful career opportunities and growth within electrochemical power generation industries and academia.

- To enable the students in energy related programs such as clean power generation and future green technologies.

OUTCOMES:

- The student would know how to solve the problems relating to the production, storage, distribution and utilization of electrochemical energy and the associated environmental issues. And he would know integration of electrochemical principles and materials science for application in modern electrochemical devices.

- The student would know design and conduct experiments, acquire data, analyze, interpret data, solve practical and complex problems on a variety of electrochemical devices such as batteries, solar cells, flow and fuel cells and integrate the professional, ethical, social and environmental factors in electrochemical engineering and understand the impact of these factors on global energy issues.

Syllabus:

Introduction:

Unit I : Basic Concept: Mechanism of Electrolysis, Laws of Electrolysis, Curent and Voltage Efficiency - Electrolytic dissociation, Coulometers, Ionic conduction. Electrolytic conductivity, Absolute ionic velocities, ionic mobilities, Transference Nos. Modern Ionic

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Theory, Ionic activity Degree of dissociation. Ionic Atmosphere Time of relaxation and relaxation effect, Electrophoretic effect - Debye - Huckel Onsager equation of conductance (Derivation is not required) and its validity.

- Able to understand the concept and applications of Laws of Electrolysis.
- Able to understand the importance and construction of Coulometers.
- Able to understand about Transference Nos.
- Able to understand Degree of dissociation.

Unit II: Thermodynamics I: Chemical Potential and Free Energy changes. Cell and Electrode potentials. Thermodynamics of Electrode potentials - Nernst Equation. Equilibrium Constant, Arbitrary Zero of potential, EMF series and their limitations Activity Coefficient of and their evaluation, Liquid Junction potentials, Concentration Cells - Reference Electrodes.

- Able to understand the concept of Chemical Potential and Free Energy changes.
- Able to understand how to calculate cell electrode potential.
- Able to understand the application of Nernst Equation.
- Able to understand how to measure Junction potential.

Unit III : Thermodynamics II : Electrode Kinetics, Role of Interface, Electric Double Layer and its capacitance - Irreversible Electrode processes - Irreversibility, Tates of Electrode Processes. Electrode Kinetics Model, Cathodic Hydrogen evolution, Depolarisation - Overpotential, Tafel Equation, Ohmic or resistance Over potential, Concentration overpotential, Oxygen Evolution reaction and Decompostion potential, Ionic Transport by Migration, Diffusion and Convection - Mass transfer.

- Able to understand Electric Double Layer theory.
- Able to understand the concepts of Depolarisation and Overpotential.
- Able to understand importance of Tafel Equation.

Unit IV : Kenetics of Corrosion Processes and Evans Diagrams : Electrokinetic phenomenon - Straming potential, zeta potential and Electro - Osmosis, Electrophoresis, Dorn Effect.

Measurements and Systems Analysis : Conductivity measurements - Conductometric analysis - Titrations, Measurements of pH, potential - potentiometric titrations, Polarography Electrogravimetry, Coulometry. Current Distribution in a cell. Rotating Disc Electrode, Rotating Cylinder electrode, Rough Surface Electrode Limiting Current Technique.

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- Able to understand the importance of Evans Diagrams.
- Able to understand the concepts of Osmosis and Electrophoresis.
- Able to understand the importance of Conductometric analysis – Titrations.
- Able to understand about potentiometric titrations.

Unit-V: Potential relations in corrosion cells potentials, pH diagrams in corrosion.

Corrosion theory : Manifestation of corrosion, bases of electrochemical corrosion, amount and intensity of corrosion, Eight forms of corrosion : Uniform attack, Galavanic corrosion, crevice corrosion,Pitting, inter granular corrosion. Selective leaching, stress corrosion cracking. Conditions leading to pitting attack., environmental factors, hydrogen damage. Corrosion inhibition and prevention : Domestic water supplies, recirculating water systems, corrosion inhibitors, Inhibitors for acid pickling, vapor phase inhibitors. Coatings and paits: Phosphating, Protective metal coatings; cathodic protection and corrosion of buried structures.

- Able to understand the different forms of corrosion.
- Able to understand the preventive techniques of corrosion.
- Able to understand the concepts of Protective metal coatings.
- Able to understand the application of cathodic protection of buried structures.

Textbooks:

1. An Introduction to Electrochemistry by Samuel Glasstone, D. Van Nostrand Company Inc princeton, Affiliated East-West press Pvt. Ltd.
2. Electrochemistry - Principles and Applications by Edmund C. Fotter Oliver Hume Press Ltd., London.

Reference Books:

1. Electrochemical Engineering, Principles, by Geofferey Prentice, The Johns Hopkins University, Prentice Hall, Englewood Cliffs, New Jersy, 07632.
2. Electrochemistry - Bookris and A.K.Reddy.
3. Electrochemical Engineering by C.L.Mantell.
4. Principles of Electrochemical Engineering by L.W.Shemilt.
5. Chemical Engineering Development Centre, Indian Institute of Technology, Madras 600 036.
6. Fontanna and Grene ‘Corrosion Engineering’.

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IPCE -1.1.4: Elective –II

IPCE -1.1.4 A - Elective-II (Corrosion Engineering-I)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives : The main objectives are to provide:

1. Basic aspects of electrochemistry relevant to corrosion phenomena,
2. Importance and forms of corrosion.
3. Knowledge on corrosion rate expressions and measurement techniques.
4. Knowledge on factors influencing corrosion of iron and steel exposed to atmospheric, soil and aqueous medium.
5. Basic knowledge on remedial measures for corrosion.

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

1. Acquires knowledge on basic principles of electrochemistry, importance of corrosion.
2. Predict whether corrosion will occur for a particular environment.
3. Estimate corrosion rates and analyze.
4. Identify the type of corrosion and propose viable remedial measures.

Syllabus:

Basic Concepts and Outlines of Electrochemistry: Fundamentals of Electrochemical reactions, Faraday's Laws Electrolytic and ionic conductance, ionic mobility's, Transport Nos. Galvanic Cell and Electrolytic cells.

Definition and importance of corrosion, Dry cell, analogy, Corrosion Cells, Types of Corrosion Cells- a) Dissimilar electrode cells b) Concentration cells such as a salt concentration cells, differential aeration cells c) differential Temperature cells. Corrosion Rate Expresions - mdd, ipy, cpy, mpy, etc.

LO1: Choose a specific cell for a given situation
LO2: Identify the type of corrosion cell that will form in that particular environment

Corrosion Tendency and Electrode Potentials: Free Energy changes, Development of Nernst Equation for calculation of Half-cell potentials, Hydrogen electrode, Spontaneity of a reaction, Reversible cells and potentials – convention of Sign and calculations of EMF from standard Equilibrium potentials., EMF Series and Galvanic series, Reference Half Cells – Calomel, Silver-Silver Chloride and Saturated Copper-Copper Sulphate Half Cells. Pourbaix Diagram for Iron, Aluminum and magnesium, limitations of pourbaix diagrams.

LO3: Predict the tendency of corrosion to occur
LO4: Identify the corrosion zones based on pH of media

Polarization and Corrosion Rates: Polarization and a Polarized Cell, Causes of Polarization – Concentration Polarization, Activation Polarization and IR drop. Hydrogen Over potentials, combined

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polarization and Mixed potential theory. Tafel Slopes and Tafel Equation. Graphical method of expressing Corrosion Reactions (Polarization diagrams/Evans diagrams), Derivation of Stern-Geary Equation, Influence of Polarization on Corrosion rates.

LO5: Derive the equations for estimating corrosion rates
LO6: Evaluate and Analyze data for corrosion rates

Passivity: Characteristics of Passivation, Flade potential, behavior of passivators, transpasivity, Theories on Passivity.

Forms of Corrosion: Uniform attack, Galvanic Corrosion, Crevice Corrosion, Pitting, Intergranular Corrosion, Selective Leaching, Erosion Corrosion and Stress Corrosion. Hydrogen damage. Factors influencing, mechanisms and prevention techniques for all forms of corrosion. Calculation of Corrosion rates using weight lost method and Polarization data. Electrochemical Impedance Spectroscopy.

Effect of Dissolved Oxygen (Air saturated Water, High Partial Pressure of Oxygen and Anaerobic bacteria), Temperature, pH, Galvanic coupling, velocity, dissolved salts concentration. Wet and dry corrosion.

LO7: Identify the type of corrosion
LO8: Recommend proper remedial measures

Textbooks :

1. Corrosion and Corrosion Control by Herbert, H. Uhlig John Wiley and Sons Inc., New York.
2. Corrosion Engineering by Mars F Fontana, McGraw Hill.
3. An Introduction to Electrochemistry by Samuel Glass stone, Affiliated East West Press Pvt. Ltd.,

Reference Books :

1. Corrrosion Volumes 1 & 2 by L.L. Shrier, Newnes - Butter-worths, London.

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IPCE - 1.1.4 B - Elective-II (Energy Engineering-I)
Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives:

To lean overview of solar radiation and it's potential for collection to meet the energy needs of mankind and potential for solar energy option. To learn measuring techniques of solar radiation and its compilation.

To learn various design and operational aspects of solar energy collection and storage.

To learn the design and operation of solar energy appliances like liquid flat plate collectors, Solar Air Heaters, Thermal energy storage, Thermal energy storage, Solar Pond, Solar thermal power generation.

To learn theory and application of Photovoltaic cells

Outcome:

The student learns collection and design of various kinds of equipment operated on solar energy. The student learns principles and practice of Photo voltaic cells.

Syllabus:

The Solar Energy option

Thermal conversion – collection and storage Thermal applications – photovoltaic conversion – wind energy – Energy from Bio – mass – ocean thermal energy conversion.

Solar Radiation

Solar Radiation outside the earths – atmosphere Solar radiation at the Earth's surface – Instruments for measuring Solar Radiation – Solar Radiation data – Solar Radiation Geometry Empirical equations for predicting the availability of Solar Radiation – Solar radiation on tilted surface.

Liquid flat – Plate Collectors

Components of liquid flat plate – various types of collectors – Performance Analysis – Transmissivity – Absorptivity product – Overall loss coefficients and heat Transfer correlations – Collector efficiency heat removal factors – effect of various parameters on performance. Transient Analysis – Testing procedures.

Solar Air Heaters

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Various types of solar Heaters – Performance Analysis of a conventional Air Heater – Testing procedures – Concentrating collectors – various types of concentrating collectors cylindrical and parabolic collectors – General receiver collectors.

Thermal energy storage

Sensible heat storage – Latent heat storage – Thermochemical storage

Solar Pond

Description – Performance analysis – Experimental studies – Operational problems.

Solar Air Conditioning and Refrigeration

Heat pump cycle – Coefficient of performance of the heat pumps – solar air-conditioning with absorption – Refrigeration system (Ammonia water and lithium bromide – water systems).

Solar thermal power generation

Thermal and direct electricity generation – Major sub-stations of a solar thermal power plant, Examples of installed systems – Concentration ratio. Temperature and efficiency concepts – Solar farm and tower – Economics.

Photovoltaic Energy Conversion

Photovoltaic Energy Conversion Fundamentals – band theory of solids – Physical processes in a solar cell – Solar cell with light incidence – Solar cell module – Silicon Solar Cells – Copper Sulphate / Cadmium sulphide Solar Cells.(Banasal et at.,chapters 9;Taylor, chapters 6, pages 256-298.

Text Books:

1. Solar Energy: Principles of thermal collection and storage by S.P. Sukhatme, Tata McGraw Hill, New Delhi 1984 (Chapters 2 to 8)
2. Renewable energy sources and conversion technology by N. K. Bansal, M. Kleemann, Michael Mcliss, 1990 (Chapters 2 – 9).

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IPCE - 1.1.4 C - Elective-II (Reaction Engineering-I)
Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Unit I : (Scope : J.M. Smith : Chapter 7): Heterogeneous Processes, catalysis, and absorption: Global Rates of Reaction - Types of Heterogeneous Reactions - The nature of catalytic Reactions - The Mechanism of catalytic Reactions - Surface Chemistry and Absorption - Absorption Isotherms - Rates of Absorption.

Unit II (Scope : J. M. Smith: Chapter 8 : Solid Catalysts: Determination of surface area - Void Volume and solid density - Fore volume distribution - Theories of Heterogeneous Catalysis - Classification of catalysts - Catalyst Preparation - Promoters and Inhibitors Catalyst Deactivation (Poisoning).

Unit III: (Scope: J.M. Smith : Chapter 9): Rate equations for fluid - Solid Catalytic Reactions: Rates of adsorption, Desorption, Surface Reaction - Rate equations in terms of Fluid phase concentrations at the catalyst surface - Qualitative analysis of rate equation - Quantitative inter pretation of Kinetic data - Redox Rate equations.

Unit IV: (Scope : Octave Levenspiel : Chapter 15) : Deactivating Catalysts : Mechanism of Catalyst Deactivation - The ratre of equation - The rate of equation from experiment - Batch - solids: Determining the rate for Independent Deactivation Batch - solids : Determining the rate of parellel, series or side - by - side Deactivation - Flowing solids experimental Reactors - Finding the Mechanism of Decay from experiment Design.

Unit V: (Scope : J. M. Smith : Chapter 10) : External transport Processes in Heterogeneous Reactions: Fixed bed reactors - The effect of physical processes on observed rate of reaction - Mass and Heat transfer coefficients (fluid particle) in packed beds - Quantitative treatment of external transport effects - Stable operating conditions - Effect of external transport Processes on selectivity.

Fluidised bed reactors - Particle - fluid Mass and Heat transfer Slurry Reactors - Mass transfer coefficients: Gas bubble to liquid (K_1) - Mass transfer coefficients: Liquid to particle (K_c) - The effect of mass - transfer on observed rates Trickle - Bed reactors - mass transfer coefficients: Gas to liquid ($K_1 a_g$) - Liquid to particle ($k_c a_c$) - Calculation of global rate.

Text Books:

1. Smith. J.M., " Chemical Engineering Kinetics", McGraw Hill book Company, New Delhi (Third Edition) 1981.
2. Octave Levenspiel, " Chemical Reaction Engineering" , Wiley Eastern Limited - Second Edition - 1972.

Reference Books :

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1. Thomas, J.M. And Thomas, W.J. " Introduction to the Principles of Heterogeneous Catalysis". Academic Press Inc., New York 1967.
2. Carbnerry, James, J., " Chemical and Catalytjic Reaction - Engineering", McGraw - Hill, Engineering Series.

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IPCE 1.1.5: RESEARCH METHODOLOGY AND IPR

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2: Effective literature studies approaches, analysis, Plagiarism, Research ethics,

Unit 3: Effective technical writing, how to write report, Paper, Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science
2. & engineering students'"
3. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
4. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
5. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
6. Mayall , "Industrial Design", McGraw Hill, 1992.
7. Niebel , "Product Design", McGraw Hill, 1974.
8. Asimov , "Introduction to Design", Prentice Hall, 1962.
9. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New
10. Technological Age", 2016.
11. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

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IPCE 1.1.6 A: Audit Course-1 (YOGA FOR WORKING PROFESSIONALS)

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Course objectives:

1. To make the student understand various practices of yoga and yoga diet.
2. To make the student be familiar with various asanas and other associated practices.
3. To make the student appraise the holistic benefits of yoga
4. To make the student identify a therapeutic solution for common health issues.
5. To make the student experience the pranahuti aided meditation.

Course outcomes:

1. The students will discover the importance of yoga for leading a disciplined way of life.
2. The students would improve their wellness by adapting various yogic practices in their day to day life.
3. The students would perceive the holistic benefits of yoga
4. The students can judge the causes of common diseases and can recommend therapeutic solutions based on yogic practices
5. The student can compare the placebo meditation and meditation with pranhuti.

Unit-I: Introduction to Yoga

The Origins of Yoga – Definitions - Concepts - Aims and objectives of Yoga - Yoga is a Science and Art - Ideal Practice of Yoga in the new millennium. Streams of Yoga - Karma Yoga - Bhakti Yoga -Jnana Yoga - Raja Yoga (Astanga Yoga) - Hatha Yoga - Yoga and Diet - - Yoga Disciplined way of life. Difference between Yogasanas and Physical Exercises.

Learning outcomes:

1. After completing this unit, the students will be able to recognize the differences between yogic practices and physical exercises.
2. At the end of this unit, the students will be able assess the relevance of yogic practices for holistic wellness in the contemporary times.

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Unit-II: Yogasanas with practical

Loosening the joints- Joint freeing series, Suryanamaskar, Tadasana, Trikonasana, Artha chandrasana, Danurasana, Utkatasana, Dandasana, Pavanamuktasana, Hamsasana, Arthakati chakrasana, Artha chakrasana, Janusirasasana, Vajrasana, Makarasana, Padmasana, Sukhasana, Natrajasana, Savasana. Introduction to Kriyas, Pranayamas, Bandhas and Mudras.

Learning outcomes:

1. The students will be able to demonstrate some selective yogasanas.
2. The students will be able to appraise the importance of allied yogic practices such as pranayama, mudras, bandhas and kriyas.

Unit-III: Physiological benefits of Yoga

Physiological Benefits of Asanas and Pranayama – Chest Cage – Regulation of Breathing – Types of Breathing. Physiological Benefits of Bandhas – Mudras – Kriyas - Meditation – Nadis – Chakras – Kundalini shakti – Psycho-neuro Immunology. Role of Yoga on Psychological Qualities and Psychological Disorders.

Learning outcomes:

1. By studying this unit, the students will be able to value the physiological benefits of yoga practices.
2. The students will be able to support the role of yoga in the treatment of psychological disorders at the end of this chapter.

Unit-IV: Introduction to Yoga Therapy

Essence and Principles of Yoga therapy- Physiology and Pathology in the yoga – Shatra- koshas – doshas- Granthis – Pancha prana – Application of Yoga and its types- Methodology in Yoga Therapy – Factors (Heyam, Hetu, Hanam and Upayam) - Methods (Darsanam, Sparsanam, Prasnam, Nadi, Pariksa) Examination of Vertebra, joints, Muscles, Abdomen and Nervous system and therapeutic applications – Modification of yogic practices for Human Systems- Yogic diet.

Learning outcomes:

1. At the end of the unit, the students become familiar in assessing the health of an individual.
2. After completing this unit, the students can recommend appropriate yoga therapy for health problems faced by an individual.

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Unit-V: Meditation

(The student has to maintain a diary to record his observations during meditation. This diary will help him to understand the extent of his progress)

Meaning and Concept of Meditation – Need of meditation- techniques of meditation-Tools of meditation-Advantages of Meditation- Experience of meditation- Obstacles. Sahaj Marg Meditation, Heartfulness movement. Elements of sahaj marg meditation: Prayer, cleaning, sitting, satsang, universal prayer and suggestions. Ten maxims of sahaj marg.

Learning outcomes:

1. The student will be well versed in the benefits of meditation at the end of the unit.
2. The student can experience the difference in normal situation and meditative condition after experiencing pranahuti aided meditation.

Reference books

1. George Feuerstein: The Yoga Tradition (Its history, literature, philosophy and practice).
2. Georg Feuerstein. The Psychology of Yoga: Integrating Eastern and Western Approaches for Understanding the Mind.
3. Swamy Satyananda Saraswathi: Asana, Pranayama, Mudra, Bandha (India: Yoga Publications Trust, Munger, Bihar).
4. Swami Sivananda **:** Practice of Yoga (The Divine Life Society, Shivananda Nagar.P.O.,U.P. Himalayas, India).
5. Krishna Raman: A Matter of Health (Integration of Yoga and western medicine for prevention and cure) (Chennai East West Books(Madras) Pvt. Ltd.,1998.
6. Bhavanani, A.B. (2011): Application of Yoga Concept in the Health Improvement. In: P.Nikic, ed.
7. Ram Chandra, Complete works or Ram Chandra (Babuji) Vol. I, Sri Ram Chandra Misssion, SPHT, Calcutta.

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IPCE 1.1.6 B- Audit Course -I Organizational Behavior

Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

UNIT-I: Organizational Behavior: Concept of Organization - Concept of Organizational Behavior - Nature of Organizational Behavior - Role of Organizational behavior - Disciplines contributing to Organizational Behavior.

UNIT-II: Motivation: Definition - Nature of Motivation - Role of Motivation - Theories of Motivation: Maslow's Need Hierarchy Theory, Herzberg's Motivation Hygiene Theory and McGregor's Theory X and Theory Y.

UNIT –III: Group Dynamics: Meaning - Concept of Group - Types of groups -Formal and Informal groups - Group development - Group cohesiveness and factors affecting group cohesiveness.

UNIT-IV: Leadership: Concept of Leadership - Difference between Leadership and Management - Importance of Leadership - Leadership styles: Autocratic leadership, Participative leadership and Free Rein leadership.

UNIT-V: Communication: Meaning - Communication Process - Forms of communication: Oral, Written and Non- Verbal communication - Direction of communication: Downward, Upward and Horizontal communication.

UNIT-VI: Organizational conflicts: Concept of conflict - Reasons for conflict - Types of Conflict: Intrapersonal conflict, Interpersonal conflict, Intragroup conflict, Intergroup conflict, Inter organizational conflict - Conflict management.

UNIT –VII: Organizational Change: Nature - Factors in Organizational change -Planned change: Process of planned change - Resistance to change: Factors in resistance to change - Overcoming resistance to change.

Text Books.

1.L.M.Prasad: Organizational Behavior, Sultan Chand & Sons, New Delhi -110002

2.K. Aswathappa: Organizational Behavior, Himalaya Publishing House, New Delhi

Reference Books.

1. Stephen Robbins: Organizational Behavior, Pearsons Education, New Delhi.

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II SEMESTER

IPCE-1.2.1 : AIR POLLUTION CONTROL IN INDUSTRY

The objectives of this course are to provide the student with:

- a basic understanding of the fundamentals of air pollution with a background on historical perspective on air pollution
- knowledge of major air pollutants; their sources and effects (environmental, economic and health), Sampling of air pollutants and their analysis
- Insight into the dispersion of air pollution in the atmosphere
- knowledge of air pollution control equipment and their design aspects
- knowledge of various techniques to reduce the concentration of pollutants like sulphur dioxide, nitrogen oxide, organic vapors etc
- Knowledge of air pollution legislation and role of citizens in air pollution control

Outcome:

(a) Enables student to gain knowledge about the nature, origin of air pollution and impact of the air pollution on human beings, plants and materials
(b) Enables the student to learn the sampling and analysis of pollutants (Monitoring of air pollutants)
(c) Enables the student to understand the updated engineering technologies to control air pollution and air pollution legislation.
(d) Enables student to gain knowledge about various technologies available to control of specific air pollutants like So_2, No_x , organic vapors etc.

Syllabus:

Sources, nature and type of pollutants, emission factors, meteorological factors in pollution, plume behavior and characteristics, chill index, equivalent ambient temperature, chimney design considerations, plume rise, effective stack height, element of air pollution modeling, acid rain problem,

Health effects of pollution, effect of plants, animals and materials, problems of air pollution in India, global problems, air pollution measurements, Ringleman's chart.,

Air pollution technology-I: Sampling and analysis of particulate matter and gaseous pollutants, removal of particulate matters, principles and design of settling chambers, solid traps, cyclone separators, fabric filters and fiber filters, scrubbers and electro-static precipitators,

Air pollution technology-II: General methods of control and removal of sulfur-dioxide, oxides of nitrogen and organic vapors from gaseous effluents, air pollution legislation, role of citizens in air pollution control,

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Case Studies: Madhura refinery and it's impact on Taj Mahal, Bhopal gas tragedy, Chernobyl disaster and HPCL Visakha refinery, changes in raw materials, alternative technology for minimization of pollutants.

Reference books:

1. 'Design of Pollution Control Equipment' by Gregory Sincero and Adam Sincero
2. 'Air Pollution' by H.V.N. Rao, Mc Graw Hill Publications, 1998.

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IPCE-1.2.2: Process Dynamics & Control
(Common for MPE, CACE & IPCE)

Objectives :

The main purpose of teaching Process Dynamics & Control for first year postgraduate students is to take the student from basic mathematics to a variety of design applications in a clear, concise manner. This course is focused on the use of the digital computer in complex problem solving and in process control instrumentation. For chemical engineering problem solving students need more advanced mathematical preparation like partial differential equations, linear algebra and Fourier series all are introduced in this course.

Outcome:

- Able to know the sampled data control systems consists of sampling and advanced mathematical model Z- transforms.
- Able to describe the process in which the flow of the signals is interrupted periodically like in chromatograph.
- Able to calculate the open loop response of a sampled data system and can develop a pulse transfer function that is the counterpart of the transfer function for continuous systems.
- Able to know the sophisticated instruments used for the analysis of water and air pollutants, The student should have knowledge to design the equipment used for the abatement of these pollutants.
- In a position to modernize the solid waste management and the student must be in a position to get awareness on accidents that are occurring in industries during handling, storage, and manufacturing of chemicals, remedial measures to arrest the accidents immediately.

Syllabus:

Unit-1

Review of time domain, Laplace domain and frequency domain dynamics of process and control system.

Learning outcomes

- Able to know the sampled data control systems consists of sampling and
- Able to solve the problems related to Laplace domain and frequency domain dynamics of process and control system.

Unit-2

Sampled data control system – sampling and Z–Transforms , open loop and closed loop response, Stability.

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Learning outcomes

- Able to solve the problems related toSampled data control system – sampling and Z–Transforms ,
- Able to calculate the open loop response of a sampled data system and stability

Unit-3

State space methods – representation of physical systems – transfer function matrix – Multivariable systems – Analysis and control.

Learning outcomes

- Able to solve the problems related toState space methods – representation of physical systems and Student can develop a pulse transfer function that is the counterpart of the transfer function for continuous systems.
- Able to solve the Design Multivariable control systems – Analysis and control.The student should have knowledge to design the equipment used for the abatement of these process control systems.

Unit-4

Non linear control –examples of non linear systems – Methods of phase plane analysis.

Learning outcomes

- Able to solve the problems related toNon linear control systems
- Able to solve the problems related toexamples of non linear systems and also develops Methods of phase plane analysis.

Unit-5

Control of heat exchangers, distillation columns and Chemical Reactors.

Learning outcomes

- Able to solve the problems related toControl of heat exchangers, distillation columns and
- Able to solve the problems related toChemical Reactors.

Textbooks:

1. Process system Analysis and control, 2nd edition, Donald R Coughanower and Koppel.
2. Automatic process Control by Peter Harriot.
3. Process Modeling, Simulation and control for Chemical Engineers by W.L. Luyben.

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IPCE-1.2.3 - ANALYTICAL TECHNIQUES

Objective:

To understand the different types of analysis methods used in chemical industries. The course consists of both chemical and instrumental methods and also both qualitative and quantitative methods of analysis. In this course, the chemical methods of quantitative analysis include all the aspects such as: selection and sampling of materials, preparation of solutions, and analysis of various chemical raw materials and products. In instrumental methods colorimetric, spectrophotometric, spectrographic, flame emission, photo meter have been discussed.

Outcome:

- The student should be able to know the theory of sampling, selection and preparation of the sample.
- The student should be able to know the sophisticated instruments used for the analysis of mineral ores and chemical samples. The student should have knowledge of analysis for the ores and chemical samples.
- The student should be in a position to understand the operation of instruments like X-Ray, flame emission spectroscopy.
- The student can determine the traces of elements in the metals and alloys required for specific application.

Syllabus:

Unit-1

Theory of sampling, sampling of ores, minerals and coals, proximate and ultimate analysis of coal; coking index, calorific value of coal, its determination and calculation, analysis of ash,

Learning outcomes

- The student should be able to know the theory of sampling
- Selection and preparation of the sample. And coal

Unit-2

Wet assaying of ores of iron, copper, lead, zinc and manganese, dry assaying process, fire saving methods for gold and silver,

Learning outcomes

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- The student should be able to know the theory of sampling**Wet assaying** of ores of iron, copper, lead, zinc and manganese able to determine the metals and alloys required for specific application

- The student can determine the traces of elements and also The student should be able to know the theory of dry assaying process, fire saving methods for gold and silver,

Unit-3

Instrumental methods of mineral investigation: Theory and techniques of colorimetry and absorptiometry, photometer, spectrophotometers, atomic absorption spectrophotometer,

Learning outcomes

- The student should be able to know the sophisticated instruments used for the analysis of mineral ores and chemical samples Theory and techniques of colorimetry
- The student should be able to know the sophisticated instruments used for the analysis of mineral ores and chemical samples Theory and techniques of photometer, spectrophotometers, atomic absorption spectrophotometer

Unit-4

Electrochemical methods of analysis, Electrogravimetry methods, potentiometric titration, polarography, DTA,

Learning outcomes

- The student should be able to know the sophisticated instruments used for the analysis Electrochemical methods of analysis,

- The student should be able to know the sophisticated instruments used for the analysis Electrogravimetry methods, potentiometric titration, polarography. And The student should have knowledge of analysis for the ores and chemical samples.

Unit-5

X-ray techniques, emission of X-rays, X-rays instrumentation, X-ray diffraction, flame emission spectroscope - source, equipment and application of emission spectroscopy.

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Learning outcomes

- The student should be able to know the sophisticated instruments used for the analysis X-ray techniques, emission of X-rays, X-rays instrumentation, X-ray diffraction,
- The student should be able to know the sophisticated instruments used for the analysis flame emission spectroscope - source, equipment and application of emission spectroscopy

Reference books:

1. 'An Introduction to Metallurgical Analysis: Chemical & Instrumental' by S.K. Jain, Vikas Publishing House
2. A Text Book of Metallurgical Analysis' by B.C.Agarwal & S.P.Jain, Khanna Publications.
3. A Text Book of Quantitative Inorganic Analysis' by A.I.Vogel, ELBS Edition.

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IPCE-1.2.4 - Elective-III

IPCE-1.2.4 A-ELECTIVE-III (Industrial Hazards, Safety Measures & Environmental Impact Assessment)

Course objective:

This course is designed to promote the knowledge on various important aspects of hazard analysis and EIA techniques which are mandatory for implementation by the industries. The objective include an intention that the student will get fair opportunities for obtaining employment as this particular course is having lot of demand in India and abroad.

Course Outcome:

- Now a day's industrial & occupational safety gained paramount importance for loss prevention in order to achieve considerable profit in process industries. This course significantly help the students to learn the concepts of safety, hazards, risk, occupational safety management
- This course include an approach of conducting environmental impact assessment study and preparing reports which is mandatory for all the process industries being setup
- The course also describes various methodologies for identification and assessment of hazards involved in handling and processing of various harmful chemicals in industries
- Emergency preparedness plans are included in this course which enlighten the learners various aspects of planning, emergency resources, action teams and rescue operations in case of real emergencies in industries
- The students will be knowing various statutory regulations pertaining to factories act, environmental protection act, static and mobile pressure vessel rules and other regulatory amendments to comply which can help them when they are employed in industrial sectors
- This course may help the students for getting opportunities abroad because of huge demand of HSE engineers especially in gulf oil companies and basic chemicals manufacturing companies
- Further learning in this field may provide self employability by way of freelanced consultancy to the industries
- This course will provide the basis for taking up further research work in inventing new technologies for effective management of industrial hazards and occupational health

Syllabus:

Unit - I

Introduction: Hazards – chemical hazards, thermodynamic hazards, electrical & electromagnetic hazards, mechanical hazards & health hazards, **Risk** – definition, causes, potential & adverse effects, **statutory framework** – key provisions of factories act, environmental protection act, manufacture, storage & import of hazardous chemical rules, static & mobile pressure vessels rules, NFPA specifications, OSHA regulations

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Learning outcomes:

- The definitions like Hazard, Risk, Incident, Accident, Near-miss will give basic understanding about the terminology used in Industrial Safety
- Some of the key provisions of Factories Act, Environmental Protection Act, SMPV Rules, NFPC specifications, OSHA regulations will enhance the knowledge of various national & international standards

Unit – II

Hazard Analysis: Incident scenarios, residual risk, concept hazard analysis, preliminary process hazard analysis, HAZOP, Fault Tree Analysis (FTA), Event Tree Analysis (ETA), sneak analysis, Failure Mode and Effect Analysis (FMEA), Human Reliability Analysis (HRA), Cause Consequence Analysis (CCA)

Learning outcomes:

- The course also describes various methodologies for identification and assessment of hazards, involved in handling and process in of various harmful chemicals in industries
- The concepts like residual & societal risk will help the student to understand to implement acceptable risk methodologies in process operations

Unit – III

Safety Management Systems: Safety policy perceptions, safety organization, safety audit techniques, **project and construction safety** – welding and cutting operations, fabrication, material handling, equipment spacing, safe plant layout procedures, storage tanks, erection and commissioning works, housekeeping methods, maintenance of storage yards, erection and maintenance of electrical panels and MCC rooms, electrical & mechanical safe guarding, **process safety management** – elements, methods of management, equipment reliability, preventive maintenance schedules, work permits, **emergency preparedness** – onsite & offsite emergency preparedness, emergency preparedness plans, site specific action plans & contingency plans, emergency facilities, rehabilitation & rescue operations, post emergency actions

Learning outcomes:

- The overview of BIS:14489 "Code of Conduct of Occupational Health & Safety Audit" will enhance the students capabilities in conducting safety audit for the hazardous industries
- Emergency preparedness plans are included in this course which enlighten the learners various aspects of planning, emergency resources, action teams and rescue operations in case of real emergencies in industries

Unit – IV

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Occupational Safety 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 & textiles

Learning outcomes:

- Elaborate discussions on various factors contributing towards occupational health issues of the workers in industries will enlighten the student to understand causative factors and its mitigation at source level
- The occupational health programs to associated with various types of industries include battery manufacturing, electro-plating, lead smelting, refineries, pulp & paper industry, etc will be well-known to the student and gives scope to find out innovative solutions

Unit – V

Environmental Impact Assessment: Introduction, comprehensive of EIA, methodology, framework of EIA, considerations, application, purpose of EIA, rapid EIA, **baseline data collection** – air pollution parameters, water pollution parameters, soil pollution, noise pollution, meteorological parameters, socio-economic studies, prediction and assessment of impacts on air environment, water environment, ecological factors, meteorological factors, flora & fauna and socio-economic conditions, environmental matrices, quantitative assessment of adverse effects, **preparation of environmental management plan** – considerations, study observations, process modifications, emission control, development of greenbelt, ecological restoration, soil conservation, rainwater harvesting, recharge of groundwater table, restoration of flora & fauna, reclamation, rehabilitation, conservation of historical monuments, review of EIA plans, modifications, **environmental impact assessment for major industries** – steel plants, refineries, power plants, bulk drugs, tanneries, mining, fertilizers and chemical industries.

Learning outcomes:

- The Environmental Impact Assessment studies are mandatory for all industries for obtaining Environmental clearance from the statutory authorities. The student will learn various steps involved in conducting a systematic Environmental Impact Assessment by considering various impacts on environmental parameters like Air, Water, Land, Meteorological, Noise, etc.
- After completion of the course, the student is expected to be in a position to evaluate appropriate environmental management plans to prevent or mitigate various adverse impacts of the industrial activities on environment

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Text Books:

1. "Hazard identification and risk assessment" by Geoff Wells, Institution of Chemical Engineers, Davis Building, UK
2. "Occupational health and safety guidelines" by Environmental Department, The World Bank, Washington DC
3. "Environmental Impact Assessment" by Larry W.Canter

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CHEM-1.2.4 B – ELECTIVE-III (Petroleum Refinery Engg-II)

Objective: The objective of this course is to provide with the**:**

- Production process for the manufacture of C1 to Aromatic Compounds.
- Design aspects for designing of various equipment used in the process.

Outcomes: The student will be able to:

- Understand the process and mechanism of various production process of C1 to Aromatic compounds.
- Design various equipment used in the production process.

Syllabus:

Petrochemical industry in India, Raw materials for petrochemicals, refinery process for petrochemical feed stocks, pyrolysis for petrochemical feed stocks, separation of hydrocarbons.

Learning outcomes:

- Choose various petrochemical feed stocks for manufacture of petrochemical compounds.
- Discuss various refining process for the manufacture of petrochemical feed stocks.

Petrochemicals from C1 fractions: Synthesis gas, Methanol, Formaldehyde, Chloromethanes, Hydrogen cyanide, Methyl amines.

Petrochemicals from C2 fractions: Polyethylene, Ethanol, Ethylene Oxide, Acetaldehyde, Ethyl Benzene, 1-2 dichloroethane, Vinylchloride, Vinylacetate, Ethanol amines.

Learning outcomes:

- Design and evaluate a process for the manufacture of C_1 fractions.
- Design and evaluate a process for the manufacture of C_2 fractions.

Petrochemicals from C3 fractions: Isopropanol, Acetone, Propylene oxide, Acrylonitrile, Cumene, Isoprene, Oligomers and co-oligomers of Propylene.

Petrochemicals from C4 fractions: Butadiene, Diisobutene, Butanol, Methacrylic acid, Maleic anhydride.

Learning outcomes:

- Design and evaluate a process for the manufacture of C_3 fractions.
- Design and evaluate a process for the manufacture of C_4 compounds.

Petrochemicals from Aromatic compounds: Production and separation of aromatics, Aniline, Phenol, Maleic anhydride, Toluene diisocynate, Phthalic anhydride, Dimethyl terephthalate.

Learning outcomes:

Design a process for the production of aromatics.

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Develop a process for the separation of aromatics.

Design of petrochemical equipment: Pyrolysis furnace, pyrolysis reactor, super fractionator, fixed bed reactor, multiphase reactor.

Learning outcomes:
Design of pyrolysis furnace, pyrolysis reactor and super fractinator.
Design of fixed bed reactor, multiphase reactor.

Text Books :

1. Ethylene & its derivations - S.A. Miller
2. Propylene and its derivations - E.G. Hancock.
3. Benzene, Toluene, Xylene and their Derivations. E.G. Hancock.
4. Petrochemicals by B.K.Bhaskara Rao.

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IPCE-1.2.4 C- ELECTIVE-III (Electro Chemical Engineering-II)

Objectives: The main objectives are to provide

1. Knowledge on Electroplating, Electroforming, electro refining, electro wining.
2. Knowledge on Electrolysis and Manufacturing process.
3. Knowledge on primary & secondary batteries and fuel

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

1. Explain different electrochemical ore beneficiation techniques, electroplating, electro refining and electro winning.
2. Take part in commercial and industrial manufacturing units using electrolysis.
3. Design, test and evaluate batteries e.g. Primary and secondary batteries, charge/discharge cycles, overpotential, battery capacity, state of charge, state of health, impedance.
4. Construct, Compare and test Fuel cells.

Syllabus:

Part –A

Electroplating, Electroforming and Electrophoresis
Electrorefining of metals - Copper, Silver, Gold, Nickel, Lead and Cobalt.
Electrowinning of metals - Copper, Zinc, Cadmium, Chromium and Manganese.

LO1: Appraise various metal extraction procedure by electrochemical means
LO2: Recommend the process conditions

Electrolysis of Alkali Halides and Sulfates - Chlorine and Caustic, Potassium halides, Hydrochloric acid, Fluorine and sodium sulfate.
Manufacture of Hydrogen and Oxygen. Electrolytic Reduction and Oxidation - Persalts, Cuprous oxide, Mercuric oxide, Manganese dioxide and Perchlorates.
Electrolysis of fused Salts - Aluminum, Magnesium, Sodium, Beryllium and Zirconium.

LO3: Choose appropriate manufacturing processes of ionic salts by electrochemical schemes
LO4: Compare different sets of conditions for the manufacture of a given salts

Part –B

Batteries: Classification of cells and batteries, theoretical cell voltage, capacity, energy, electrochemical principles and reactions
Primary batteries: Zinc carbon batteries (Leclanche and Zinc chloride cell system), Magnesium and Aluminum batteries, Alkaline manganese dioxide batteries, Lithium batteries.

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Secondary batteries: Lead acid batteries, nickel cadmium batteries, nickel metal hydride batteries, lithium ion batteries, rechargeable zinc, alkaline, manganese dioxide batteries

LO5: Evaluate the working behavior of different batteries
LO6: Estimate the charge discharge characteristics of a battery

Fuel cells: Molten carbonate fuel cell(MCFC), phosphoric acid fuel cell(PAFC), Solid oxide fuel cell (SOFC), proton exchange membrane fuel cell(PEMFC).

LO7: Assess the working of different Fuel cells
LO8: Construct and test of Fuel Cell

Textbooks:

1. Electrochemical Engineering by Mantell, C.L. McGraw–Hill
2. Electrochemistry Principles and Applications Edmund Potter, Cleaver–Hume Press Ltd.
3. Handbook of batteries by David linden and Thomas B Reddy, McGraw –Hill

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IPCE-1.2.5- ELECTIVE-IV
IPCE-1.2.5 A-ELECTIVE-IV (Corrosion Engineering-II)
Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Objectives:

- To enable the principles of corrosion, common corrosion forms, uniform, galvanic, pitting, inter granular, crevice, dezincification, stress corrosion, corrosion fatigue, hydrogen embrittlement corrosion control methods, and material selection to reduce corrosion cost.
- To enable the ability to understand electrochemical fundamentals
- To enable the ability to understand corrosion preventing methods

Outcome:

- The student would know application of weight loss method
- The student would know application of cathodic protection, anodic ptotection
- At the end of this course, the student would know effective surface preparation of specimen can be done
- After completion of this course, the student would understand the causes and the mechanisms of various types of corrosion, including uniform corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion.
- The student would know application of Corrosion Processes and Evans Diagrams and application of electroplating, coatings and importance of inhibitors.

Syllabus:

Corrosion in selective environments: Marine, Acids (Sulfuric acid, Hydrochloric acid, Nitirc acid, Phosphoric acid) Biological and industrial gases (SO_2H_2S).

- Able to understand corrosion and its mechanism in marine atmosphere.
- Able to understand corrosion in acidic media like Sulfuric acid, Hydrochloric,etc.

Corrosion Testing - Purposes, Materials and specimen. Surface preparation, Measuring and weighing , Exposure Techniques - duration, Planned - Interval Tests, Aeration, cleaning specimens after exposure, Temperature, Standard expression for corrosion rates - Galvanic

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Corrosion, Erosion Corrosion, crevice Corrosion, Intergranular corrosion, test for stainless steels, warren test pitting, stress corrosion, Paint tests, Sea Water tests, Presenting and summarizing data - Nomo graph for corrosion rates and interpretation of results.

- Able to understand the importance of surface preparation.
- Able to understand the application of Standard expression for corrosion rates using weight loss method.
- Able to understand the application of different corrosion tests.

Cathodic and anodic protection, surface preparation for coatings and chemical conversions: Degreasing, Descaling , Polishing - Anodized coating : anodizing oxidizing, chromate coating, phosphate coatings - Metallic coatings : Hot dipping, cementation, vapor deposition of metallic coating; Sprayed coatings: flame spraying plasma spraying, Galvanizing - Electroplating : Nickel & chromium coatings, chromizing.- Organic coatings : paints, enamels, lacquers, resin mixtures.

- Able to understand the application of Cathodic and anodic protection.
- Able to understand the uses of Degreasing, Descaling , Polishing.
- Able to understand the importance of Hot dipping, cementation, vapor deposition of metallic coating.

Linings, laminates, reinforced plastic, fibre glass - Corrosion inhibitors: mechanism of inhibition, recirculating of water of water systems.

- Able to understand the importance of Corrosion inhibitors and mechanism of inhibition.

Measurement and testing of preventive coatings ; Thickness and Resistance tests for anodized, Painted, electroplated surfaces using polarization resistance, Linear polarization, curve fit analysis and Electrochemical impedance spectroscopy.

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- Able to understand the Thickness and Resistance tests.
- Able to understand the linear polarization and curve fit analysis.

Reference books :

1. Mars G.Fontana - Corrosion Engineering

2. Burns, R.M., Bradley, W.W., 'protective coatings for Metals.' Chapters 2 to 18.

Reference Books :

Corrrosion Volumes 1 & 2 by L.L. Shrier, Newnes - Butter-worths, London.

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IPCE- 1.2.5 B - Elective-IV (Energy Engineering-II)
Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Course objectives:

1. The student is provided with the fundamentals of renewable energy processes.
2. Basic information to comprehend the various non-conventional energy systems would be illustrated to the student.
3. Various ways of obtaining energy from ocean can be demonstrated to the student.
4. The methods of energy conservation and the opportunities for conservation would be emphasized.
5. Economics involved in the energy production processes would be enumerated to the student.

Course Outcomes:

1. Methods to be adopted to utilize biomass as an important energy source
2. Application of thermodynamics to obtain energy from various sources
3. Possible mechanism to draw energy from wind and other natural resources
4. Knowledge about energy conservation and storage
5. Emerging technologies to produce energy such as thermionics, thermoelectricity etc.

Syllabus:

Fundamentals of energy science and technology: Introduction – Energy, economy and social development – Oil crisis of 1973 – classification of energy sources – consumption trend of primary energy resources – importance of non-conventional energy sources – energy chain – common forms of energy – advantages and disadvantages of conventional energy sources – salient features of non-conventional energy sources – energy densities of various fuels – environmental aspects of energy – The United Nations Framework Convention on Climate Change – Energy-environment-economy – World energy status – energy scenario in India. **Energy conservation and efficiency:** Introduction – important terms and definitions – important aspects of energy conservation – global efforts, achievements and future planning – energy conservation/efficiency scenario in India – energy audit – energy conservation opportunities –

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cogeneration – combined cycle plants. **Energy storage:** Introduction – necessity of energy storage – specifications of energy storage devices – energy storage methods.

Learning outcomes:

1. The student can identify the ways and means of conservation of energy once the student completes learning this unit.
2. The student can appraise the necessity of energy storage and recommend the methods for energy storage at the end of the unit.

Wind energy: Introduction – origin of winds – nature of winds – wind turbine siting – major applications of wind power – basics of fluid mechanics – wind turbine aerodynamics – wind turbine types and their construction – wind energy conversion systems – wind-diesel hybrid system – effects of wind speed and grid condition – wind energy storage – environmental aspects – wind energy program in India.

Learning outcomes:

1. By studying this unit, the students will be able to predict where the wind power plants can be located.
2. At the end of this unit, the students can recommend appropriate technology for obtaining geothermal energy in a given situation.

Biomass: Introduction – Photosynthesis process – usable forms of biomass, their composition and fuel properties – biomass resources – biomass conversion technologies – urban waste to energy conversion – biomass gasification – biomass liquefaction – biomass to ethanol production – biogas production from waste biomass – energy farming. **Geothermal energy:** Introduction – applications – origin and distribution of geothermal energy – types of geothermal resources – analysis of geothermal resources – exploration and development of geothermal resources – environmental considerations – geothermal energy in India.

Learning outcomes:

1. After completing this unit, the students will be able to choose appropriate biogas plant for a given location and able to provide dimensions of the same. .
2. At the end of this unit, the students will be able to recommend a process for utilizing the biomass for a given application.

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Ocean Energy: Introduction: Tidal energy – wave energy – ocean thermal energy. **Small hydro resources:** Introduction – advantages and disadvantages of small hydro schemes – layout of a micro-hydroscheme - water turbines – turbine classification, characteristics and selection – generators – present status.

Learning outcomes:

1. At the end of this unit, the students can recommend appropriate technology for obtaining energy from ocean in a given situation.
2. Suitable scheme for generating electricity from small hydroresources can be suggested by the student after the completion of this unit.

Emerging technologies: Introduction – fuel cell – hydrogen as energy carrier. **Miscellaneous non-conventional energy technologies:** Introduction – magneto hydrodynamic power conversion – thermoelectric power generation – thermionic power conversion. **Financial and economic evaluation:** Introduction – basic terms and definitions – calculations for the case of single payment – calculation for uniform series of payments – calculations for uniform gradient series of payments – calculations for geometric gradient series of payments – effect of inflation on cash flows – comparative economic evaluation of alternatives – effect of depreciation and tax on cash flow.

Learning outcomes:

1. New technologies for obtaining energy from various renewable sources can be evaluated by the student.
2. Economic factor in the energy production by various technologies can be compared by the student at the end of this unit.

Text book:

Non-Conventional Energy Resources by B.H. Khan, 3/e, McGraw Hill (2017).

Reference book:

Fundamentals of Renewable Energy Processes by Aldo V. Da Rosa. Elsevier (2005).

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IPCE- 1.2.5 C - Elective-IV (Reaction Engineering-II)
Common for M.Tech (Chemical, MPE, IPCE, CACE & Biotechnology)

Syllabus:

UNIT - I

Laboratory Reactors - Interpretation of Experimental Data - Interpretation of Laboratory Kinetics Data - Homogeneous and Heterogeneous Laboratory Reactors. Calculation of Global Rate - The structure of Reactor Design.

(Scope: Chapter 12 of J.M Smith 3rd Edition)

UNIT - II

Design of Heterogeneous Catalytic Reactors Isothermal and Adiabatic Fixed Bed Reactors Non-isothermal, Non-adiabatic Fixed Bed Reactors.

(Scope: Chapters 13.1 - 13.9 of J.M Smith 3rd Edition)

UNIT - III

Design of fluidized bed Reactors - Two -Phase Fluidized Bed model - Operating characteristics - Slurry Reactors - Trickle - Bed Reactors - Optimization.

(Scope: Chapter 13.10 - 13.13 of J.M Smith 3rd Edition.)

UNIT - IV

Fluid - Solid Noncatalytic Reactions - Design concepts - Single Particle Behavior - Reactor Models.

(Scope: Chapter 14 of J.M Smith 3rd Edition)

UNIT - V

Short notes from the portions of all the above four units. Four bits are to be answered out of 7 bits (Not more than 2 bits to be given from any one Unit).

Text Book: Chemical Engineering Kinetics by J.M Smith, McGraw - Hill Book Company , 1980, 3rd Edition.

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IPCE 1.2.6: AUDIT COURSE -2
IPCE 1.2.6 A : DISASTER MANAGEMENT (Audit Course -2)
Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Introduction to Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types and Magnitude.

Repercussions Of Disasters And Hazards: Economic Damage, Loss of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Disaster Prone Areas in India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological and Other Agencies, Media Reports: Governmental And Community Preparedness.

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment and Warning, People's Participation In Risk Assessment. Strategies for Survival

Disaster Mitigation Meaning, Concept and Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

REFERENCES:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.

2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.

3. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi.

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IPCE 1.2.6 B: ENTREPRENEURSHIP (Audit Course -2)

Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Unit -I : 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.

Unit-II : 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.

Unit-III 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.

Unit-IV : 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.

Unit-V : 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,

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III SEMESTER

IPCE-2.1.1: Elective –V

IPCE-2.1.1 A- Elective –V (Environmental Biotechnology)

(Common with Biotechnology)

Objectives:

- Student to learn and understand environmental problems locally as well as global issue and consequencies.
- To learn about xenobiotics and their effect on ecosystem. To learn about biodiversity available.
- To learn about alternative and noval methods like biosorption of metals and bioleaching.

Outcome:

- Students have enough skills to identify the environmental problems and control measures.
- Students are in a position to plan to treat various industrial effluent using biotechnological methods

Syllabus:

Unit-1 Ecosystem

Environment, types of Environment, Environment and Development, Environmental management, environmental education, principles of ecology, ecosystems, types of ecosystems, ecosystem structure and functioning, food chains, food webs, Ecological pyramids, nutrient cycling, microbial associations.

Learning Outcomes:

On completion of this topic, the student will be able to

i. Understand various types of ecosystems, association of components of ecosystems

ii. Have an idea about food chains, food webs, ecological pyramids etc.

Unit-2 Pollution control

Source, effects and control aspects of various pollutants: Air (Particulate matter, SOx, NOx, COx, CHx, noise), water (primary, secondary and advanced treatment techniques), solids (recycling, incineration and bioconversion) Global environmental problems: global warming,

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ozone depletion and acid rain. Industrial effluent treatment: case studies of paper and pulp, tannery, pharmaceutical, fertilizer and petroleum industries.

Learning Outcomes:

On completion of this topic, the student will be able to

i. Have an ability to discuss various types of pollution & its control.

ii. Identify Global environmental problems and treatment if necessary.

Unit-3 Biological Activities in the Environment

Biodegradation of Xenobiotics: Xenobiotic compounds in the environment, persistent compounds, degradation mechanisms.

Bioremediation: Bioremediation by microorganisms, bioremediation process and technologies, measuring bioremediation in the field, monitoring and efficacy of bioremediation.

Biosorption of metals: Microorganisms and metal absorption, factors affecting bioabsorption, bioreactors and bioabsorption, phytoremediation.

Bioleaching: Types of bioleaching, advantages and disadvantages of bioleaching, methods for bioleaching.

Learning Outcomes:

On completion of this topic, the student will be able to

i. Understand various biological activities like biodegradation, bioleaching, biosorbtion of metals, bioremediation etc, occurring in the Environment.

ii. advantaged & disadvantages of above biological activities.

Unit-4 Biodiversity: Levels of biodiversity, value of biodiversity, global biodiversity, hotspots of biodiversity, threats to biodiversity, conservation of biodiversity.

Learning Outcomes:

On completion of this topic, the student will be able to

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i. Have an idea of Biodiversity, its value & levels.

ii. Understand threats & hotspots and conservation of biodiversity.

Unit-5 Environment and energy: Biomass sources, biomass production and utilization for energy, biomass conversation routes, energy crops, biofuels, biodiesel, hydrogen Production, conservation of energy. Biofertilizers, biopesticides, biofilters, biosensors, biopolymers and bioplastics.

Learning Outcomes:

On completion of this topic, the student will be able to

i. Have an ability to understand Environment & its energy conservation.

ii. To identify & utilize biofertilizers, biopesticides, biosensors, biofilters, biopolymers & bioplastics, etc

TEXT BOOKS:

1. Environmental Pollution Control Engineering by C. S. Rao. Wiley Eastern Limited
2. Waste Water Treatment: Rational Methods of design and industrial practices by M. Narayana Rao and Amal K. Datta. Oxford & IBH publishing Co. Pvt. Ltd.
3. Environmental Biotechnology: Basic concepts and applications by Indu Shekhar Thakur. 1. K. International Pvt. Ltd.

REFERNCE BOOKS:

1. Microbial Ecology: A conceptional approach by Lunch, 1. M. Oxford Black N.S.D.
2. Environmental Biotechnology by Geetha Bali. APH Publishing Corporation.

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IPCE-2.1.1 B- Elective –V (Waste to Energy)

Introduction to energy from waste: characterisation and classification of waste as fuel – agrobased, forest residues, industrial waste, Municipal solid waste.

Waste to energy options: combustion (unprocessed and processed fuel), gasification, anaerobic digestion, fermentation, pyrolysis.

Conversion devices: combustors (Spreader Stokes, Moving grate type, fluidized bed), gasifier, digesters.

Briqueting technology: Production of RDF and briquetted fuel. Properties of fuels derived from waste to energy technology: Producer gas, Biogas, Ethanol and Briquettes,

Comparison of properties with conventional fuels. Power generation using waste to energy technologies: Cl and Sl engines.

IGCC and IPCC concepts. Landfills: Gas generation and collection in land fills, Introduction to transfer stations.

Comparison with non-energy options like Vermiculture, Composting.

TEXT BOOKS

1. M.M. EL-Halwagi, Biogas Technology- Transfer and diffusion, Elsevier Applied science Publisher, New York, 1984.

2. D.O Hall and R.P. Overeed, Biomass – regenerable energy, John Willy and Sons Ltd. New York. 1987.

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IPCE-2.1.1 C : Elective-V (Process Modeling and Simulation)
Common for M.Tech (Chemical, MPE, CACE & IPCE)

Objective:

Deals with writing various process models based on basic physical process. It also deals with solving the various models by means of numerical methods by computer simulation. By studying this course, one can simulate various chemical processes by computer simulation.

Outcome:

1. Understand the writing of a model of a process based on basic physical processes like mass, momentum and energy balances.
2. Able to develop a model equation for Tanks, Isothermal and Non-Isothermal Systems
3. Able to understand the models for binary distillation column, batch reactors, etc.
4. Able to solve the model equations by numerical methods.

Syllabus:

Principles of formulation - Continuity equations – Energy equation – Equation of motion – Equations of state – Transport equations – Chemical Kinetics – Algebraic and Integral / differential equations, Explicit and Implicit equations –Numerical Integration,Feed forward and feed backward control.

Basic modeling for tank system, mixing vessel – Simultaneous mass and energy balances – Models for boiling, batch distillation, and partial condenser.

Models for Reactor – Model for heterogeneous catalysis – Models for pumping system – Model for heat exchanger.

Operational blocks in simulation- Simulation Programming – Simulation examples of three CSTR's in series, gravity flow tank, binary distillation column, non–isothermal CSTR.

Implicit function convergence ,Internal–halving convergence, Newton–Raphson method, False position convergence, Explicit convergence methods, Numerical Integration, Euler Integration, Runge - Kutta (fourth order) method.

Textbooks:

1. Process Modeling, Simulation and Control for Chemical Engineers by Luyben, W.L., McGraw Hill Books Co.
2. Mathematical Modeling in Chemical Engineering by Roger, G.E. Franks – John Wiley Sons Inc.

Reference Book:

Mathematical Methods in Chemical Engineering by V.G. Jenson and G.V. Jefferys, Academic Press – 2nd Edition.

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IPCE-2.1.2: Elective –VI (Open Elective)

IPCE-2.1.2 A : Elective-VI (Nanotechnology)
Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Objectives:

Nanotechnology may be treated as **Green technology**. It is one of the most advanced technologies now-a-days. It leads to have revolutionary changes in the fields of medical, Bio-medical, and fabrication of materials. Technologists are able to prepare ageless materials with the help of nano-techniques. Main objectives of the subject nanotechnology are :

1. To define green technology properly
2. To expose the students with new techniques of the nanotechnology.
3. To make them to learn the importance of quantum technology
4. To learn the procedure ageless materials to avoid wear-tear.
5. To learn the importance of nano –robots, machines
6. To know about the latest microscopes such as SEM, TEM
7. To know the importance of nanotechnology in the dawn of optical instruments

Outcome:

1. Application of nanotechnology in the development of energy
2. Application of nanotechnology in the development of solar panels, Fuel cells
3. Knew the importance of atoms manipulation
4. Knew that the applications of nanoparticles in the development of DVD, LEDs etc.
5. Biomedical applications in terms of preparing artificial, drug delivery, encapsulation, addition to that pharmaceuticals.

Syllabus:

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1. Introduction to nanotechnology, molecular and atomic size, surface and dimensional spaces. Molecular nanotechnology: atoms by inference, electron microscopes, nanomanipulator, nanotweezers, atom manipulation, nanodots, nanolithography.

Learning Outcomes:

- Define the term nanotechnology to understand in a better way the subject basics
- Demonstrate the different types of Electron Microscopes and their uses.

2. Nanopowders and nanomaterials: preparation, plasma arcing, chemical vapor deposition, sol-gels, electrodeposition, Ball milling, applications. Carbon nanotubes: types, formation, assemblies, purification, properties and uses.

Learning Outcomes:

- Summarize the nanomaterials used for the preparation of nanopowders
- Apply and selection of the different methods to prepare nanopowders
- Classify the carbon nanotubes and purification process.

3. Molecular mimics: Catenanes and rotaxanes, various molecular switches, synthesis of rotaxanes and catenanes, molecular computers, chemical rotors, prodders, flippers, atom shuttles, actuators, contacts.

Learning Outcomes:

- Categorize the molecular switches and synthesis of rotaxane and catenanes
- Examine the function of molecular computers

4. Nanobiometrics: Lipids as nano-bricks and mortar, self – assembled monolayers, proteins, 3-D structures arising from amines acids, nanoscale motors, Biological Computing, ion channels as sensors, Information in DNA structure, using DNA to build nano-cubes, hinges, smart glue, wire template.

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Learning Outcomes:

- Evaluate the importance of nanobiometrics as self-assembled monolayers and nanoscale motors.
- Explain the process of biological computing and using DNA as hinges, smart glue, wire template

5. Optics, photomics and solar energy: Properties of light and nanotechnology, Interaction of light and nanotechnology, Nanoholes and photons, Imaging, New low cost energy efficient windows and solar absorbers based on nanoparticles, Photonic crystals, surface wave guides and control of light paths.

Learning Outcomes:

- Discuss about the optics, photomics and solar energy with reference to light properties.
- Chose a technique using nanoparticles to manufacture solar absorber, photonic crystals and change the light path.

6. Nanoelectrons: birth of electrons, semiconductors, transistor, integrated circuits, the tools of micro and nanofabrication, quantum electronic devices, quantum information and quantum computers, experimental implementations of quantum computers.

Learning Outcomes:

- Appraise different phased in the development of nanoelectornics tools.
- Construction of quantum computers and its experimental implementations.

7. Future applications: microelectomechanical systems, nano-robots , ageless materials, invisible mending of atomic dislocations inside damaged materials, nanomechanics and nanoelasticity, nanoparticle coatings, nanoelectronic and magnetic devices and new computing systems, optoelectronic devices, environmental applications.

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Learning Outcomes:

- Assess the future application of nanotechnology in various fields
- Create new tools with nanotechnology to prepare new devices

Text-book:

1. M.Wilson, K.Kannangara, G. Smith, M. Simmons and B. Ragues, **Nanotechnology**, Overseas press (India) Private Ltd; New Delhi, 2005.

Reference books:

1. G. Ali Mansoori*, **Principles of Nanotechnology**, World Scientific Publishing Company, 2005.
2. G. Timp, Nanotechnology, Springer-Verlag, Network, 1999.
3. P. Poole and F.J. Owens, Introduction to Nanotechnology, John Wiley, 2003.
4. D.Ratner and M.Ratner, Nanotechnology: A Gentle Introduction, Pearson Education,2003.
5. B. Bhusan, Handbook of Nanotechnology, Springer, 2004

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IPCE-2.1.2 B: Elective-VI (POLLUTION CONTROL)
Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

Objectives:

- Focus on classification of air pollutants, water pollutants and solid waste –causes, effects and control methods, need of environmental Legislation.

Outcome:

- Enables the students to adopt the preventive measures for the control of air pollutants, waste water treatment methods, and solid waste management methods in domestic, municipal waste.
- Enables the students to understand the control measures of pollutants emitted from different industries like Paper and pulp, fertilizer, sugar and alcohol, petrochemical and petroleum refinery, pharmaceutical and metal finishing industries.

Syllabus:

Kinds of ecology, environment and ecofactors, types of ecosystems, sulphur cycles, phosphorous cycle, Nitrogen cycle and hydrological cycle

Sources for water, Air and solid pollution, Analysis and effects of the pollutants in air, in water, Solids(particulate matter, SOx, NOx, Cox, CHx).

Limits of pollutants, Environmental Legislation.

Control aspects of various pollutants Air (Particulate matter, SOx, NOx, COx, CHx, Noise) water (primary, secondary and territory treatment techniques) Solids (recycling, incineration,bio-conversion).

Case studies of Industries: Paper and pulp, petrochemical, Fertilizer, Pharmaceuticals, tannery, sugar and alcohol industries, metal finishing industries.

Learning Outcomes:

- Describe different ecosystems
- Explains the bio-geochemical cycles
- classify the main types of pollution and their effects
- Describe the sources of pollution and their characteristics
- Describe the effects of air and water pollution on the environment and on human health
- Explain the importance of Environmental Legislation for pollution prevention and control
- Evaluate the preventive measures for the control of air pollutants – SPM
- Select the most appropriate technique to control SOx, NOx, COx, CHx

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- Describe the primary, secondary and territory treatment techniques waste water treatment methods
- Propose control measures of pollutants emitted from different industries like paper and pulp
- Plan to select most appropriate technique to control pollutants from petrochemical and refineries
- Explain the control aspects of pollutants from Fertilizer, Pharmaceuticals
- Elucidate the control aspects of pollutants from tannery, sugar and alcohol industries, metal finishing industries

Text books:-

1. S.P.Mahajan., Pollution control in process Industries, Tata McGraw hill publishing company.
2. Arcadio P. Sincero and Georgia Sincero., Environmental Engineering
3. Environmental Pollution Control., by C.S.Rao, wiely eastern ltd.

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IPCE-2.1.2 C: Elective-VI (Corrosion Engineering)
Common for M.Tech (Chemical, MPE, CACE, IPCE, Biotechnology)

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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