FACULTY OF SCIENCE AND TECHNOLOGY

Savitribai Phule Pune University

TE Chemical Engineering

2019 Course

Savitribai Phule Pune University Structure for TE Chemical Engineering- 2019 Course

Subject Code	Subject	L	P		Tut	ISE	ESE	TW	PR	OR	Total	Credits TH+PR
	SEMESTER-I											
309341	Mass Transfer-I	3	4		-	30	70		50	-	150	3+2=5
309342	Chemical Technology -II	3	4		-	30	70	25		50	175	3+2=5
309343	Chemical Engineering Mathematics	3	-	-	-	30	70	-	-	-	100	3
309344	Chemical Engineering Thermodynamics	3	-	-	-	30	70	-	-	-	100	3
309345	Elective-I	3	-		-	30	70	-	-	-	100	3
309346	Computer Aided Chemical Engineering- I	-	2	-	-	-	-	25	-	-	25	1
309347	Seminar	-	-	-	1	-	-	50	-	-	50	1
	Total	15	10		1	150	350	100	50	50	700	21
	SEMESTER-II											
Subject Code	Subject	L	P	Tut	Internship	ISE	ESE	TW	PR	OR	Total	Credits TH+PR
309348	Chemical Reaction Engineering I	3	4	-	-	30	70	25	50	-	175	3+2=5
309349	Mass Transfer II	3	4		-	30	70	50	50	-	200	3+2=5
309350	Transport Phenomena	3		2*	-	30	70	25	-	-	125	3+1=4
309351	Elective-II	3	-	-	-	30	70	-	-	-	100	3
309352	Internship	-	-	-	4			100	-	-	100	4
	Total	12	08	2	4	120	280	200	100	--	700	21
	***Subject Teacher should conduct Tutorial of 2 Hrs per Batch per week.** **8 Minimum Assignments including Numerical relevant to the subject to be submitted by each students as a part of Term Work.**											

Examination Duration: In semester: 60 min. End semester: 150 min. L: Lecture, P: Practical, T: Tutorial, TW: Term work, PR: Practical, OR: Oral.
ISE – In semester Examination, ESE - End semester Examination, Tut- Tutorial.

Elective-I
A. Chemical Industry Management
B. Food Technology
C. Polymer Engineering
D. Downstream Processing
Elective-II
A. Energy Conservation in Chemical Process Industries
B. Process Instrumentation and Control
C. Corrosion Engineering
D. Artificial intelligence and Data Science

309341: MASS TRANSFER –I

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30
Practical : 4 Hours / Week	End Semester: 70
	Practical: 50
	Total: 150
	Credits:3+2=5

Unit 1: Introduction **7 Hrs**

General principles of Mass Transfer, classification of Mass Transfer Operations, choice of separation method, methods of conducting mass transfer operations, design principles. Diffusion Mass Transfer, Molecular Diffusion in gases and liquids, diffusivities of gases and liquids, types of diffusion, Fick's and Maxwell law of diffusion, diffusion in solids, unsteady state mass transfer.

Unit 2: Inter-Phase Mass Transfer **7 Hrs**

Mass transfer coefficients in laminar flow and turbulent flow, theories of mass transfer, mass, heat and momentum transfer analogies. Inter-phase mass transfer, equilibrium in mass transfer, the two resistance theory, continuous co-current, countercurrent and crosscurrent processes, cascades.

Unit 3: Gas Absorption **7 Hrs**

Mechanism of gas absorption, equilibrium in gas absorption, application of mass transfer theories to absorption, absorption in wetted wall columns, values of transfer coefficient, absorption in packed tower and spray tower, calculation of HETP, HTU, NTU, calculations of height of packed and spray tower. Absorption in tray towers, absorption and stripping factors, tray efficiencies, calculation of number of trays for absorption, absorption with chemical reaction.

Unit 4: Humidification and Dehumidification- **7 Hrs**

Principles, vapour-liquid equilibria, enthalpy of pure substances, basic definition of all humidification terms, wet bulb temperature relation, psychrometric chart, Lewis relation, methods of humidification and dehumidification, equipment like cooling towers, tray towers, spray chambers, spray ponds, cooling tower design – HTU, NTU concept, calculation of height of cooling tower.

Unit 5: Equipment for gas liquid operation **7 Hrs**

Types of columns, Types of trays, types of packing, Gas dispersal equipment – bubble columns, mechanically agitated vessels, tray towers. Liquid dispersal equipment – Venturi scrubbers, wetted wall columns, spray towers, packed columns

Unit 6: Drying **7 Hrs**

Principles, equilibrium in drying, type of moisture binding, mechanism of batch drying, continuous drying, time required for drying, mechanism of moisture movement in solid, design principles of tray dryer, rotary dryer, drum dryer, spray dryer, fluidized bed and spouted bed dryer, pneumatic dryer and vacuum dryer.

Practical:-

Minimum Ten practical to be performed out of the following:

1. Tray Dryer – To calculate rate of Drying
2. Rotary Dryer – To study the Characteristics of Rotary Dryer
3. Spray Dryer – To study the design and Operating Principles of Spray Dryer
4. Fluidized Bed Dryer – To study the characteristics of Fluidized bed Dryer
5. Liquid Diffusion – To calculate the Diffusion Coefficient for a liquid –liquid system
6. Winkelmann's method – To find the diffusion Coefficient of vapour in still air
7. To study Solid in air Diffusion
8. Enhancement Factor – To find the enhancement factor for absorption with and without chemical reaction
9. Mass transfer Coefficient – To determine the Mass Transfer Coefficient for Absorption in a Packed Tower
10. Cooling Tower– To study the characteristics of cooling tower
11. Humidifier and Dehumidifier – To study the Characteristics
12. Interphase Mass Transfer Coefficient – To calculate the individual and overall Mass Transfer Coefficient
13. Wetted Wall Column – To find the mass transfer coefficient in a wetted wall Column

References

1. Mass Transfer Operations – Treybal R.E., McGraw Hill

2. Chemical Engineering, Vol. I & II – Coulson J.M. and |Richardson J.F., McGraw Hill

3. Principles of Unit Operations in Chemical Engineering, Foust A.S.

4. Separation Techniques – King C.J. Design of Equilibrium Stage Processes - Smith B.D.

309342: CHEMICAL TECHNOLOGY –II

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30
Practical : 4 Hours / Week	End Semester: 70
	Oral: 50
	TW:25
	Total: 150
	Credits:3+2=5

Unit I: Sulfur and Sulfuric Acid Industries: Elemental sulfur mining by Frasch process, Sulfur production by oxidation-reduction of H2S, Sulfur and sulfur dioxide from pyrites, Sulfuric acid. Contact process, Chamber process. Sea chemicals: Sodium-Magnesium compounds, different methods for different salt recovery. Electrolytic industry: Production of Aluminium, Magnesium. **7 Hrs**

Unit II: Sugar and Starch Industries: Sucrose, ,Extraction of sugar cane to produce crystalline white sugar, Extraction of sugar cane to produce sugar, Starch production from maize, Production of dextrin by starch hydrolysis in a fluidized bed. Pulp and Paper Industries: Sulfate pulp process, Chemical recovery from sulfate pulp digestionliquor, Types of paper products, Raw materials, Methods of production. **7 Hrs**

Unit III: Coal Chemicals: Destructive distillation of coal, Types of carbonization, Coke oven – construction, working and applications. Cements: Introduction, types of cements, properties and applications. Manufacture of Portland cement. Beneficiation & Production of Hydrated lime. Iron and Steel: Production of steel, blast furnace detail. **7 Hrs**

Unit IV: Surface coating industries: Types of surface coating; Paints, varnishes, distempers and enamels. Dyes and dye intermediates industry: Classification of dyes; Dye and dye intermediates; Production of some important dyes, lacquers and toners. Fuel and Industrial Gases: Technology options of producing producer gas, natural gas, water gas, nitrogen, oxygen and carbon dioxide. **7 Hrs**

Unit V: Pharmaceutical industries: Classification of drugs; Drug production based on some selected unit processes. Bio Pharmaceutical Industry: Production of penicillin, antibiotics. Agrochemical industries: Manufacturing process of some important pesticides, insecticides, fungicides, fumigants, plant growth regulators, yield stimulators and herbicides. **7 Hrs**

Unit VI: Petrochemical Industry: C1 Compounds: Production of Methanol, Formaldehyde, and Halogenated Hydrocarbons. C2 Compounds: Production of Ethylene and Acetylene- Steam Cracking of Hydrocarbons, Ethylene Dichloride, Vinyl Chloride. C3 Compounds: Production of Propylene by Indirect Hydration, Acetone, Cumene Aromatic Compounds: Production of Phenol, Phthalic Anhydride and Styrene. **7 Hrs**

Practical (Minimum Eight):

1. Production of Sulfur
2. Production of C1, C2 and C3 compounds
3. Production of single /Triple Super Phosphate/ Ammonium Phosphate.

4. Production of paper.
5. Production of ethyl alcohol
6. Production of soap
7. Production of Detergent
8. Production of Portland cement
9. Mass balance calculations of any two processes using process calculation approach.
10. Heat balance calculations of any two processes using process calculation approach.
11. Calculations based on recycle operations.
12. Process flow sheets drawing of any two processes using CAD.

References:

1. Chemical Technology- Venkateshwaralu, Vol. I, II, III, IV Chemical Engg. IIT Madras
2. Outlines of Chemical Technology, Dryden
3. Unit Processes in Organic Synthesis, Groggins P., McGraw Hill.
4. Chemical Process Industries, Shreeve R.N., McGraw Hill.
5. Industrial Chemicals, Feith – Keys and Clerk.

309343: CHEMICAL ENGINEERING MATHEMATICS

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30
	End Semester: 70
	Total: 100
	Credits:3

Unit 1: Error and Roots of Equation **7 Hrs**

Problems based on Process Calculation, Fluid Flow operation and Heat Transfer to be solved using following methods: Error Definition, Round of Error, Error Propagation, Total Numerical Error. Bracketing method: Graphical, Bisection, False-Position. Open Method: Single variable Newton Raphson, Secant method, multiple roots. Roots of Polynomial: Mullers Method. Caley Hamilton method.

Unit 2: Linear Algebraic Equation **7 Hrs**

Problems based on Process Calculation, Fluid Flow operation and Heat Transfer to be solved using following methods :Gauss Elimination, Gauss-Jordon Elimination, LU Decomposition, Tridiagonal Systems (Thomas Algorithm), Gauss Seidel and Relaxation Method. Eigen values and Eigen Vectors of Matrices.

Unit 3: Regression Analysis and Interpolation **7 Hrs**

Problems based on Process Calculation, Fluid Flow operation and Heat Transfer to be solved using following methods. Statistical Data Analysis: Least square method, curve fitting and regression. Linear Regression, Polynomial Regression, Multiple Linear regression, Non-linear regression, Newton's Interpolation, Newton's Divided Difference Interpolation, Polynomial, Lagrangian Interpolation. Numerical Integration: Trapezoidal method, Simpson 1/3rd rule, Simpson 3/8th rule

Unit 4: Ordinary Differential Equation **7 Hrs**

Problems based on Process Calculation, Fluid Flow operation and Heat Transfer to be solved using following methods. Euler's method, Modified Euler's method, 2nd order Runge-Kutta Method, 4th order Runge-Kutta method, Systems Equations. Picards method of successive approximations.
Ordinary Differential Equation: Boundary Value Problems, Taylor series method.

Unit 5: Finite Difference Methods **7 Hrs**

Problems based on Process Calculation, Fluid Flow operation and Heat Transfer to be solved using following methods .Introduction to finite difference method. Boundry value problems of exact differential equations up to second order. Hyperbolic equations, Finite difference approximations to derivatives. Elliptical Equation, Control Volume Approach, Heat Conduction Equation.

Unit 6: Optimization **7 Hrs**

Problems based on Process Calculation, Fluid Flow operation and Heat Transfer to be solved using following methods: Basic concept of optimization and formulation, Nature of optimization. Linear programming by simplex method. Applications of optimization based on simplex method. Golden search method and its application.

References

1. Steven C Chapra, Raymond P Canale, 'Numerical Methods for Engineers', 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Dehli, 2007
2. Santosh K Gupta, 'Numerical Methods for Engineers', New Age International Publishers Limited, 1995
3. Thomas F Edgar, David M Himmeblau, Leon S Lason, 'Optimization of Chemical Processes', 2nd Edition, Mc-Graw Hill Publication, 2002
4. S. Balgurusamy, 'Numerical methods', Tata McGraw Hill Publication, New Delhi, 2008
5. Curtise F Gerald, Patrick O Wheatley, 'Applied Numerical Analysis', 6th Edition, Pearson Education Asia, 2002.

309344: CHEMICAL ENGINEERING THERMODYNAMICS

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30
	End Semester: 70
	Total: 100
	Credits: 3

Unit 1: Solution Thermodynamics **7Hrs**

State and path functions, intensive and extensive properties, Fundamental property relations for closed systems, Maxwell relationships, residual properties, chemical potential, effect of T and P on chemical potential, criteria for phase equilibrium, partial properties, ideal gas mixtures, fugacity and fugacity coefficients for pure species, Pointing factor, for species in solution, generalized correlations, ideal solutions.

Unit 2: Solution Thermodynamic applications **7Hrs**

Excess properties, VLE data, fugacity, activity coefficients, excess Gibb's energy, Margules equation, van Laar equation, property changes of mixing.

Unit 3: Vapor-liquid equilibrium **7Hrs**

The nature of equilibrium, criteria of equilibrium, effect of T and P on VLE, azeotropes, the phase rule, Duhem's theorem, Raoult's law, VLE by modified Raoult's law, dew point and bubble point calculations, VLE from K-value correlations, Flash calculations, Henry's law.

Unit 4: Phase Equilibria **7Hrs**

Equilibrium and stability, liquid-liquid equilibrium, solid-liquid equilibrium, osmotic equilibrium and osmotic pressure, thermodynamic consistency.

Unit 5: Chemical Reaction Equilibria **7Hrs**

The reaction coordinates, Application of the criteria for equilibrium to chemical reactions, the standard Gibbs free energy change and the equilibrium constant, effect of temperature on equilibrium constant, evaluation of the equilibrium constant.

Unit 6: Equilibrium constant **7Hrs**

Relation of equilibrium constant to composition, calculation of equilibrium conversion for single reactions, The phase rule and Duhem's theorem for reacting systems, multireaction equilibria, Introduction to fuel cells.

References:-

1. Introduction to Chemical Eng. Thermodynamics: J. M. Smith, H. C. Van Ness & M. M.Abbott.
2. Principles of Chemical Equilibrium: Kenneth Denbigh
3. Chemical Engineering Thermodynamics: B. F. Dodge
4. Chemical Engineering Thermodynamics: T. E. Daubert
5. Thermodynamics for Chemists: Glasstone S.
6. Thermodynamics for Chemical Engineers: Weber and Meissner
7. Chemical and Process Thermodynamics: B. G. Kyle
8. Molecular Thermodynamic: Praunitz
9. Chemical Engineering Thermodynamics: Narayanan
10. Chemical Engineering thermodynamics: Y.V.C. Rao

309345: Elective-I

A. Chemical Industry Management

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30 End Semester: 70 **Total: 100** **Credits: 3**

Unit 1: Management Science **7 Hrs**

A. Management, its growth, concepts of administration and management of organization. Definition of management, functions, authority and responsibility, unity of command and direction decision making in management by objectives.

B. Personality: Physical appearance, body language, voice, communication style, content of communication, enriched communication through Sensory Specific Language. Business style and professional image: Dress codes, Guidelines for appropriate business attire.

C. Business organization: Different forms of organization, their formation and working, different organization structure- line organization, functional organization, line and staff organization.

Unit 2: Personnel Management **7 Hrs**

Manpower planning, sources of recruitment, selection and training of staff, job evaluation, merit rating, performance appraisal, wage administration and system of wage payment, incentive, motivations, industrial fatigue, trade unions – industrial relations. Introduction to personal selling & salesmanship: Defining personal selling and salesmanship, Selling as a profession, Objectives and importance of personal selling, Essentials of personal selling, traditional & modern selling approach, ethics in Selling, role of selling in marketing, types of selling, qualities of winning sales Professionals-physical, mental, social and character traits.

Unit 3: Purchase and stores management **7 Hrs**

Concepts of quotation, tenders and comparative statement, inspection and quality control, inventory, carrying cost and fixed cost of inventory, examples of cost of Inventory, stores management, functions of storekeeper, methods of inventory : LIFO, FIFO. Credit analysis and appraisal principles of credit management: Principles of lending –evaluation of borrower – sanction limit-principles of good lending.

Unit 4: Marketing management **7 Hrs**

Concepts of selling, marketing, definition of marketing, market research and of pricing, penetration, pricing, skimming pricing, distribution of product, advertising and promotion. Introduction to product management: Product management as a basis of marketing organization structure. Role of product manager, skills required for product management. Product management in consumer product industry vs industrial product industry. Overview of product level marketing plans.

Unit 5: Export and import management **7 Hrs**

Concepts of international trade, duties, antidumping duty, cost involved in exporting a product, pricing of export product. Government aids for export promotion, export houses, export promotion counsel, MODVAT, patent

and patent rights. Quality Management: TQM, quality circles, ISO systems. Inflation: Meaning, types of inflation, causes, effects, control of inflation, value of money, index numbers, construction, utility, limitations, business cycles, phases of business cycles.

Unit 6: Management Laws **7 Hrs**

Concepts of contract act, offer, and acceptance, types of contracts, void contract, concept of guarantee and warranty. Introduction of MRTP and FERA. Work study: Work measurement, motion and time study flow process chart, flow diagram, silo chart, string chart, therbligs. Patent law: Patent cooperation treaty, patent act 1970, procedure for filing patent applications, patent granting procedures, revocation.

References:

1. Stonier, A. W. and Hague, D. C., "A Text Book of Economic Theory", Longman.
2. Bach, George Leland, "Economics -Analysis, Decision Making and policy", Prentice Hall Inc. Englewood Cliffs N. J.
3. Bonham F, "Economics", Sir Isaac Pitman and Sons Ltd., London.
4. Seth, M. L., "Principles of Economics", Lakshmi Narayan Agarwal, Agra.
5. Agarwal, A. N., "Indian Economy", Vikas Publishing House Pvt. Ltd., New Delhi.
6. Datta R. and Sundharam, K. P. M., "Indian Economy" S. Chand & Co. Ltd., New Delhi
7. Peter F. Drucker, "The Practice of Management", Allied publishers pvt. ltd., Bombay.
8. Barat, Nikhil, "Production management & Control", Academic Publishers, Calcutta.
9. Garrett, Leonard J. & Silver, Milton, "Production Management Analysis", Harcourt Brace Jovanovich, Inc. New York.
10. Kuchhal, S. C., "Financial Management: An- Analytical & Conceptual Approach", Chaitanya Publishing House, Allahabad.
11. Pandey, L. M., "Financial Management", Vikas Publishing House Pvt. Ltd., New Delhi.
12. Kotlel, Philip, "Marketing Management: Analysis, Planning & Control", Prentice –Hall of India Pvt. Ltd: New Delhi
13. Sinha, J. C., "Marketing and Salesmanship", S. Chand & Co., Delhi. 14. H.L. Ahuja, "Modern economics", S. Chand and co. ltd., New Delhi.
15. Management for Business and Industry-C. S. George Jr.
16. Principles of management- Knoots and O. Donnell.

309345: Elective-I

B. Food Technology

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30 End Semester: 70 **Total: 100** **Credits: 3**

Unit I: Principles of Food Processing **7 Hrs**

Scope and importance of food processing. Principles and methods of food preservation freezing, heating, dehydration, canning, additives, fermentation, irradiation, extrusion cooking, hydrostatic pressure cooking, dielectric heating, microwave processing, storage of food, modified atmosphere packaging. Refrigeration, freezing and drying of food, minimal processing, radiation processing.

Unit II: Technology of Milk And Milk Products **7 Hrs**

Sources and composition of milk, processing of market milk, standardization, toning of milk, homogenization, pasteurization, sterilization, storage, transportation and distribution of milk. Milk product processing-cream, butter oil, cheese, cheese spread, condensed milk, evaporated Milk, whole and skimmed milk powder, ice cream, khoa, channa, paneer, fermented milk products, dahi shrikhand and similar products.

Unit III: Fruit and Vegetable Technology **7 Hrs**

Principles and methods of fruit and vegetable preservation. Composition and related quality factors for processing. Principles of storage of fruits and vegetables. Types of storage: natural, ventilated low temperature storage. preservation of fruits and vegetables by heat, chemicals, sugar, salt, fermentation, drying etc. canning of fruits and vegetables, tin cans, glass containers seaming technology, aseptic canning technology. Fruit and vegetable juices, preparation of syrups, cordials and nectars, juice concentrates pectin and related compounds, jams, jellies, marmalades, preserves.

Unit IV: Principles of Food Engineering **7 Hrs**

Unit operation in food engineering processing of food grains, theory of size reduction equipment's and effect of size reduction on foods, evaporation extrusion, hot air dehydration, baking, roasting and hot oil frying theory, equipment's, applications and effect on food materials for freezing / freeze drying and freeze concentration.

Unit V: Food Packaging **7 Hrs**

Introduction to packaging. Packaging operation, package-functions and design. Principle in the development of protective packaging. Deteriorative changes in foodstuff and packaging methods for prevention, shelf life of packaged foodstuff, methods to extend shelf-life. Food containers-rigid containers, corrosion of containers (tin plate). Flexible packaging materials and their properties. food packaging materials and their properties. Food packages-bags, pouches, wrappers, carton and other traditional package, containers-wooden boxes, crates, plywood and wire bound boxes, corrugated and fibre board boxes, textile and paper sacks.

Unit VI: Food Quality Assurance **7 Hrs**

Objectives, importance and functions of quality control. Methods of quality, concepts of rheology, assessment of food materials-fruits, vegetables, cereals, dairy products, meat, poultry, egg and processed food products. Food regulations, grades and standards, concept of Codex Almentarious/HACCP/USFDA/ISO 9000 series etc. Food adulteration and food safety, basis, trends and composition of India's foreign trade.

Reference Books:

1) Lewis, M.J. 1990. Physical Properties of Food and Food Processing Systems. Wood head, UK.

2) Charm S. E. Fundamentals of food Engineering, AVI, 1963.

3) Hall, Farral, Rippen, Encyclopedia of food Engineering, AVI 1970.

4) Mirajkar M, Menon- Food Science and Processing Technology Vol I & II New Delhi, Kanishka Publishers.

5) Fellows P. , Ellis H., 1990 – Food Processing Technology Principles and Practice –New York

6) Held man, D.R. and Lund, D.B. Ed. 1992. Handbook of Food Engineering marcel Dekker, New York.

7) Rang Anna, S. 1986. Handbook of Analysis and Quality Control for Fruits and Vegetable Products. Tata McGraw Hill, New Delhi.

8) Painy, F.A. and Painy, H.Y. 1983. A Handbook of Food Packaging. Leonard Hill, Glasgow, UK.

9) Salunkhe, D.K. and Kadam, S.S. Ed. 1995. Handbook of Vegetable Science and Technology, Production, Composition, Storage and processing Marcel Dekker, New York.

309345: Elective-I

C. Polymer Engineering

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30 End Semester: 70 **Total: 100** **Credits: 3**

Unit – I: Introduction and Classification of Polymers. Thermosets, Thermoplastics, Linear Branch, Cross Linked Polymers. Factors influencing the polymer properties. **7 Hrs**

Unit – II : Addition & Condensation polymers, Polymerization Techniques, Bulk Solution Suspension, Emulsion, Interfacial Polymerization with their merits & Demerits. **7 Hrs**

Unit – III: Molecular Weights, Mn, Mw, Mv, Polydispersity Index. Different Methods of determination of Molecular weight. Effect of Molecular weight on Engg. Properties of Polymers, Numerical based on theory.

7 Hrs

Unit – IV: Kinetics of free radical polymerization (initiation propagation & termination.) Chain transfer agents. Kinetic of Step growth polymerization. Copolymers & its Kinetics Coordination Polymerization. **7 Hrs**

Unit – V: Polymer additives, compounding. Fillers plasticizers lubricants colourants UV stabilizers, fire retardants, antioxidants. Different moulding methods of polymers. **7 Hrs**

Unit – VI: Manufacturing of typical polymers with flow-sheet diagrams, their properties & applications: PE, PP, PS, PPO, Teflon Polyesters, Nylons, Kevlar, Nomex. Thermosets like Epoxies, unsaturated polyesters, phenolics, vinyl esters, cynate esters etc. Elastomers like natural rubber, butyl, neoprene, Bunas Silicons, Thiokol etc. Numerical/Problems based on Theory **7 Hrs**

References:

1. Principals of Polymerization, Odion G.G., MaGraw Hill.

2. Text Book of Polymer Science, Billmer F.W, John Wiley & Sons.

3. Polymer Science, Gowarikar et al.

4. Text Book of Polymer Science, F. Rodrigues.

5. Polymer Science & Technology, Fried J.R., PHI.

6. Rubber Technology & Manufacturing, Blow C.M., Hepbun C.

7. Synthetic Rubbers Chemistry & Technology, D.C. Blackly.

8. Plastics by Brydson.

309345: Elective-I

D. Downstream Processing

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30 End Semester: 70 **Total: 100** **Credits: 3**

Unit I: Introduction: **7 Hrs**

Introduction to Downstream processes, examples. Applications & Advantages.

Unit II: Centrifugal separation: **7 Hrs**

Theory, application, equipment's, power requirement, chemical separation for Gas-Liquid system, Gas-Solid system. Super critical fluids extraction in food, pharmaceutical, environmental and petroleum applications, water treatment, desalination, Bio separation, dialysis, industrial dialysis.

Unit III: Downstream Processes in Petrochemical Industry: **7 Hrs**

Cryogenic distillation for refinery, petrochemical off gases, natural gases, gas recovery-Olefin, Helium, Nitrogen, Desulfurization - coal, flue gases

Unit IV: Advanced Distillation Processes: **7 Hrs**

Azeotropic & extractive distillation - residue curve maps, homogeneous azeotropic distillation, pressure swing distillation, Column sequences, and heterogeneous azeotropic distillation.

Unit V: Energy conservation in separation processes: **7 Hrs**

Energy balance, molecular sieves - zeolites, adsorption, catalytic properties, manufacturing processes, hydrogel process, application, New trends.

Unit VI: Non-Ideal Mixtures and Ion Exchange: **7 Hrs**

Separations process synthesis for nonazeotropic mixtures, non ideal liquid mixtures, separation synthesis algorithm, Ion exchange - manufacture of resins, physical & chemical properties, capacity, selectivity, application, regeneration, equipment, catalysis use.

References:

1. Perry's "Chemical Engg. Handbook": McGraw Hill Pub.

2. Douglas J.M., "Conceptual Design of Chemical Processes", McGraw Hill

3. Liu Y.A., "Recent Developments in Chemical Process & Plant Design", John Wiley & Sons Inc.

4. Timmerhaus K.D., "Cryogenic Process Engg.", Plenum Press

5. Othmer Kirk "Encyclopedia of Separation Technology, Vol I & II", Wiley Interscience

309346: COMPUTER AIDED CHEMICAL ENGINEERING – I

Teaching Scheme:	**Examination Scheme:**
Practical : 2 Hours / Week	Term Work: 25
	Total: 25
	Credits:1

Minimum 10 practical and a compulsory home paper.

Applications of numerical Techniques in chemical engineering to be evaluated by following methods:
Topics may include but are not restricted to:

1. Eigen values and Eigen vector computations for Level Control Applications.
2. Applications of Vectors to problems in Fluid Mechanics, Continuity equations, Stream lines, Equations of motion, Bernoulli's equations.
3. Numerical interpolation
4. Numerical integration.
5. Integration of ODE – Equation for Batch Reactions.
6. Numerical differentiation.
7. Root-finding method – two nonlinear equations.
8. Linear programming for solving Liquid Level in Tank model.
9. Data fitting.
10. Process calculation using MS-EXCEL.
11. Application of neural networks.
12. Fuzzy logic applications.
13. Application of support vector machines.
14. Design Algorithms
15. Non-linear optimization methods-Interacting and non-interacting systems
16. Regression Analysis.

Home paper for each student or group of students is compulsory.
(A paper written by a student may be five to six pages in double spacing, a few figures may get added.)

309347: Seminar

Teaching Scheme:	**Examination Scheme:**
Tutorial : 1 Hours / Week	**Term Work: 50**
	Credits:1

The seminar may be a review of literature of specific phenomena/new process. Working model to demonstrate the principle, alternatively a small experimentation to investigate chemical engineering. Data/unit process/ unit operation. Based on this study focused report should be submitted. It is expected that the student collect information from reference books, journals and Internet. The report submitted should reveal the student's internalization of the collected information. Mere compilation from the net and other resources is discouraged.

Format of the Seminar report and TW assessment:

1. The Seminar report should be based on a detailed study of any relevant topic to Chemical Engineering, be neatly written or typed on white paper. The typing shall be with normal spacing and on one side of the paper [A-4 size].
2. The report should be submitted with front and back cover of card paper neatly cut and bound or spirally together with the text.
3. Front cover: This shall have the following details.
   a. Title of the seminar report.
   b. The name of the candidate with roll number examination seat number at the middle.
   c. Name of the guide below the candidate's details.
   d. The name of the institute and year of submission on separate lines at the bottom.
4. Seminar approval sheet.
5. The format of the text of the seminar reports:

The report shall be presented in the form of a technical paper. The introduction should be followed by literature survey. The report of analytical or experimental work done, if any, should then follow. The discussion and conclusions shall form the last part of the text. They should be followed by nomenclature and symbols used followed by acknowledgement. The bibliography should be at the end. References should be written in the standard format. The total number of typed pages, excluding cover shall be about 25 to 30 only. All the pages should be numbered. This includes figures and diagrams. Two copies of the seminar report shall be submitted to the college. The candidate shall present the Seminar before the examiners. The total duration of presentation and after-discussion should be about 30 minutes max. [25 min + 5 min]. Audience can ask questions only if the examiner permits. [Such questions will not have any bearing on marks].

The assessment for the subject shall be based on

1. Report submitted.
2. Presentation.
3. Discussion.

SEMESTER: II

309348: CHEMICAL REACTION ENGINEERING –I

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30
Practical : 4 Hours / Week	End Semester: 70
	Practical: 50
	TW: 25
	Total: 175
	Credits:5

Unit 1: Kinetics of Homogeneous Reactions **7 Hrs**

Defining a rate equation and its representation, single and multiple reactions, elementary and non elementary reactions, molecularity and order of reactions, kinetic models for non-elementary reactions, searching mechanism, rate controlling step.

Unit 2: Analysis and interpretation of Batch Reactor data **7 Hrs**

Constant volume batch reactor, integral and differential methods of analysis, variable volume batch

Unit 3: Reactor Design **7 Hrs**

Introduction, conversion of mass in reactors, performance equation for ideal stirred tank reactor, tubular flow reactor, batch reactor, space time and space velocity. Isothermal Reactors for single Reactions: Batch reactor, mixed versus plug flow reactors, second order reactions, graphical comparison, multiple reactor system, plug flow reactors in series and in parallel, equal size mixed reactors in series, reactors of different types in series, recycle reaction (flow, batch), auto-catalytic reactions, non- steady flow semi-batch reactors.

Unit 4: Multiple reactions **7 Hrs**

Parallel and series reactions, performance of various ideal reactors, qualitative and quantitative discussion for multiple reactions, instantaneous and overall fractional yield.

Unit 5: Temperature and pressure effects **7 Hrs**

Temperature dependency from Arrhenius law, thermodynamics, collision theory, transition state theory, comparison of theories, rate of reactions predicted by theories, single reactions: heat of reaction from thermodynamics, equilibrium constants from thermodynamics, graphical design procedure, heat effects, adiabatic operations, non adiabatic operations.

Unit 6: Deviations from Ideal Reactor **7 Hrs**

Self mixing of a single fluid & two miscible units, Residence time distribution, F,C,E, curves and relation between them. Models for non-ideal reactions, dispersion model, tanks in series model, segregated flow model.

Practical: Minimum of **eight** experiments out of the following list should be performed.

1. Study of saponification of ethyl acetate reaction in batch reactor.
2. Determination of Arrhenius parameters.
3. Study of pseudo first order reaction. Acid catalyzed hydrolysis of methyl acetate
4. Study of saponification of ethyl acetate reaction in mixed flow reactor.
5. Study of saponification of ethyl acetate reaction in plug flow reactor

6. CSTRs in series.
7. RTD studies in PFR.
8. RTD studies in MFR.
9. RTD studies in Helical coil reactor.
10. CSTR followed by PFR.

References:

1. Chemical Reaction Engineering: Levenspile O.
2. Chemical Engineering Kinetics: Smith J.,
3. Elements of Chemical Reaction Engineering: H. Scott, Fogler.

309349: MASS TRANSFER –II

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30
Practical : 4 Hours / Week	End Semester: 70
	Practical: 50
	Total: 150
	Credits:5

Unit 1: Distillation **7 Hrs**

Distillation principle, vapour-liquid equilibria for ideal and non-ideal systems, ideal solutions, positive and negative deviations from ideality, relative volatility, binary and multicomponent systems, methods of distillation - differential , flash, azeotropic, extractive, low pressure, steam distillation, batch rectification.

Unit 2: Continuous Rectification **7 Hrs**

Continuous rectification for binary system, multistage (tray) towers, packed towers for distillation, reboilers, distillation column internals, Lewis Sorrel, McCabe Thiele, and Ponchon-Savarit methods for multistage operations, tray efficiencies, concept of reflux, minimum reflux ratio, optimum reflux, total reflux, Fenske's equation, use of open steam, Partial and total Condensers, cold reflux, Fenske Underwood equation, concept of multi component distillation.

Unit 3: Liquid-Liquid Extraction **7 Hrs**

Ternary liquid equilibria, single stage extraction, multistage crosscurrent, countercurrent and cocurrent extraction, calculations based on triangular diagrams, x – y coordinates and solvent free basis, Continuous counter current extraction with reflux, total reflux, stage efficiency, continuous contact extraction in packed towers, HTU and NTU concept, types of extractors – stage type and differential type.

Unit 4: Solid-Liquid Extraction (Leaching) **7 Hrs**

Leaching equipment-continuous counter current leaching, ideal stage equilibrium, operating time, constant and variable underflow, number of ideal stages, stage efficiencies, calculation of single stage and multistage leaching processes.

Unit 5: Adsorption and Ion Exchange **7 Hrs**

Adsorption – Basic principle and equilibria in adsorption, types of adsorption-physical and chemical adsorption, break through curve, adsorption hysteresis, calculations of single stage, multistage adsorption, rate of adsorption in fixed bed, adsorption Isotherms-Langmuir and Freundlich, Introduction to pressure swing adsorption (PSA), and temperature swing adsorption (TSA). Ion Exchange: principles of ion exchange, techniques and applications, equilibria and rate of ion exchange, equipment's.

Unit 6: Crystallisation & Novel Techniques **7 Hrs**

Principle of crystallization, rate of crystal growth, size distribution, solubility curves, Mier's supersaturation theory, material balance, enthalpy balances, calculation of yield, equipments.

Introduction to membrane separation techniques: ultra filtration, nanofiltration, reverse osmosis, types of membranes and membrane modules, fluxes and driving forces in membrane separation processes.

Practical:

Minimum 10 practical's to be performed out of the following list.

1. Simple Distillation
2. Total Reflux
3. Steam Distillation
4. Vapour liquid equilibrium
5. Liquid-liquid equilibrium for ternary system
6. Liquid – Liquid Extraction (single stage and multistage)
7. Characterization of Spray Extraction Column
8. York Schibel Column
9. Distillation using Sieve Plate, Bubble Cap Column
10. Batch/ Continuous Leaching
11. Process of Crystallization and its Characteristics
12. Batch Crystallization
13. Ion Exchange
14. Adsorption

References:

1. Treybal R.E. "Mass Transfer Operation"
2. Richardson J. F. and Coulson J.M. "Chemical Engineering", Vol. I , II
3. McCabe and Smith, 'Unit Operations in Chemical Engineering" 4. Henley E. J. and Seader H.K. "Stage wise Process Design" , McGraw Hill
5. Smith B.D., "Design of Equilibrium Stage Process".
6. Foust A.S., "Principles of Unit Operations"
7. King C. J. "Separation Processes", McGraw Hill A.L. Lyderson, "Mass Transfer in Engineering Practices", John Wiley

309350: Transport Phenomena

Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30
Tutorial: 2 Hrs/ Week	End Semester: 70
	TW : 25
	Total: 125
	Credits: 4

Unit 1: Momentum Transport **7 Hrs**

Importance of transport phenomena, analogous nature of transfer process, introduction of viscosity and mechanism of momentum transport: Newton's law of viscosity, Newtonian & Non-Newtonian fluids, pressure and temperature dependence of viscosity, theory of viscosity of gases and liquids. Velocity distribution in laminar flow: Shell momentum balances of - a) Flow of falling film b) Flow through the circular tube c) Flow through an annulus d) Flow in a narrow slit e) Adjacent flow of two immiscible fluids

Unit 2: Energy Transport **7 Hrs**

The introduction of thermal conductivity and mechanism of energy transport: Fourier's law of heat conduction, temperature and pressure dependence of thermal conductivity in gases and liquids.

Temperature distribution in solids and in laminar flow & numerical problems - a) Shell energy balance, boundary conditions b) Heat conduction with electrical heat source c) Heat conduction with a nuclear heat source d) Heat conduction with a viscous heat source e) Heat conduction with a chemical heat source f) Heat conduction with variable thermal conductivity g) Forced and free convection h) Heat conduction in a cooling fin

Unit 3: Mass Transport **7 Hrs**

Introduction of diffusivity and mechanism of mass transport: Definitions of concentrations, velocities and mass fluxes, Fick's law of diffusion, temperature and pressure dependence of mass diffusivity.

Concentration distribution in solids and in laminar flow & numerical problems - a) Shell mass balances, boundary conditions b) Diffusion through stagnant gas film c) Diffusion with heterogeneous chemical reaction d) Diffusion with homogeneous chemical reaction e) Diffusion through Pyrex tube, leaching etc.

Unit 4: Unsteady Momentum Transport **7 Hrs**

Equations of change for isothermal system -

a) The equation of continuity b) The equation of motion c) Equation of change in curvilinear coordinate systems d) Use of equation of change to set up steady flow problem e) Equation of mechanical energy f) Dimensional analysis of equation of change

Unit 5: Interphase transport in isothermal system **7 Hrs**

Interphase transport - a) Defining friction factors b) Friction factors for flow in tube, around spheres & packed column. Macroscopic balances for Isothermal systems - a) The macroscopic mass, momentum and mechanical energy balances b) Sudden enlargement and liquid-liquid ejector c) Semi empirical expressions for Reynolds stresses

Unit 6: Simultaneous & Analogy momentum, heat and mass transfer **7 Hrs**

Interphase transport in multi component system -

a) Definition of binary mass transfer coefficient in one phase b) Co-relation of binary mass transfer coefficient in one phase at low mass transfer rates c) Co-relation of binary mass transfer coefficient in two phases at low mass transfer rates d) Definition of transfer coefficient for high mass transfer rates Reynolds analogy, Prandtl's analogy, Chilton and Colburn analogy & Martinnelli's analogy.

References

1. Transport Phenomena, Bird R. B., Stewart and Lightfoot, John Wiley & Sons

2. Analysis heat and mass transfer, Eckert Erg and Brake R. M.

3. Fundamentals of momentum, heat and mass transfer, James Welty, Charles Wicks

4. Energy Mass and Momentum transport phenomena in continua", Slattery J. C.

309351: Elective-II

A. Energy Conservation in Chemical Process Industries

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30 End Semester: 70 **Total: 100** **Credits: 3**

Unit I: Energy Scenario **7 Hrs**

Classification of energy sources, commercial and noncommercial energy, energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario. energy and environment, air pollution, climate change, energy security, energy conservation and its importance, energy strategy for the future, energy conservation act-2001 and its features. Applications of renewable energy sources.

Unit II: Energy Management and Audit **7 Hrs**

Definition, energy audit – need, types of energy audit, energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use requirement maximizing system efficiencies, optimizing the input requirements, fuel and energy substitution, energy audit instruments, role, responsibilities and duties of energy manager.

Unit III: Energy Available for Industrial Use **7 Hrs**

Introduction, methodology for forecasting industrial energy supply and demand. New energy technologies and conservation, motivation of implementing conservation measures, evaluating costs and benefits of conservation measures.

Unit IV: Management and Organization of Energy Conservation Programs **7 Hrs**

Human aspect of energy conservation, involvement tree, elements of energy management program, romoting energy conservation, program planning, setting goals, setting priorities, allocation of resources, scheduling, measuring, monitoring and reporting, organization of energy conservation programs, plant level organization, division level organization, corporate level organization.

Unit V: Guidelines for Improving Process Operations for Energy Conservation **7 Hrs**

Energy conservation checklist, potential energy conservation in boilers, chilled water plants and central air – conditioning system, compressors and fans, heat pumps and cooling systems, water heaters and coolers, lighting systems, motors and transformers, mixing vessels, heat exchangers, evaporators, distillations, housekeeping.

Unit VI: Case Studies –Waste - Minimization and Resource Conservation. 7 Hrs

Make detail study report for dairy industry, sugar industry, distilleries, fertilizer industry, food industry, cement, and petroleum. These must include-importance of waste minimization and its classification, housekeeping, process change, recycling, product modification, waste minimization methodology steps, benefits of waste minimization.

Reference Books:

1. Industrial Energy Management and Utilization, Larry C. Witte, Philip S. Schmidt, Davis R. Brown. 1988
2. Handbook of Industrial Energy Conservation, S. David HU.
3. Energy Engineering and Management- Amlan Chakrabarti, PHI Learning-2011.
4. Guide book for National Certification Examination for Energy Managers and Energy Auditors- Book 1,2,3 and 4. Bureau of Energy Efficiency (BEE)
5. Energy Conservation in the Process Industries- W. F. Kenny, Academic Press Inc., 1984
6. Energy Conservation in the Chemical and Process Industries, Colin D. Grant, the Institution of Chemical Engineers. 1979
7. Solar Engineering of Thermal Processes, John A. Duffie and William A. Beckman, 3rd Edition-2006

309351: Elective-II

B. Process Instrumentation and Control

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30 End Semester: 70 **Total: 100** **Credits: 3**

Unit 1: Fundamentals of Process Instrumentation **7 Hrs**

Need and scope of process instrumentation, classification of process variables, measurement problem analysis, basic measurement terms, Functional elements of instruments, static and dynamic characteristics of measuring instruments (zeroth, first, and second-order instruments/ systems), measurement system configuration, transducer elements (types and classification). Intermediate elements: instrument amplifiers, compensators, differential and integrator elements, signal conditioners (signal generation and processing), filtering and signal analysis, data acquisition and conversion (ADC, DAC), digital signal transmission and processing (serial communication, telemetry), indicating and recording elements.

Unit 2: Temperature measuring instruments **7 Hrs**

Introduction, classification, temperature scales (units), mechanical temperature sensor (filled system thermometers, expansion thermometers), electrical temperature sensors (RTD, thermistors, thermocouples), radiation sensors (optical and radiation), solid-state sensors, quartz sensors, calibration methods (comparison and fixed point).

Unit 3: Pressure and strain measuring instruments **7 Hrs**

Introduction, classification, low, medium, and high pressure measuring instruments, pressure scales (units), manometers, elastic element pressure gauges with pressure equations (using bourdon tube, diaphragms, capsule, and bellows), transduction/ electrical sensors with pressure equations (based on variable capacitance, resistance, and inductance/reluctance-LVDT), force- balance transducers along with mathematical equations, solid-state devices, thin-film transducers, digital transducers, piezoelectric transducers, vibrating element sensors, pressure multiplexer, calibration of pressure sensors using dead- weight tester, Mechanical, optical, and electrical strain gauges.

Unit 4: Level and Flow Measuring Instruments **7 Hrs**

Level measuring instruments: Introduction, classification, direct methods (point contact methods, sight or gauge glass methods, buoyancy methods using floats and displacers), indirect methods (hydrostatic pressure methods, capacitance methods, radiation methods, ultrasonic methods, weighing method, sonic methods), solid level measurement. Flow measuring instruments: Introduction, classification (rate of flow and total flow meters), pressure head- type flow meters (orifice plate, venturi tube, flow nozzle, pitot tube), variable- area

flow meters (rotameters), electromagnetic, mechanical (positive displacement and turbine- type), anemometer, ultrasonic - type, vortex- flow type, thermal - type, laser anemometers, mass flow meters (cover mathematical treatment for all the sensors).

Unit 5: Instrumental Methods of Chemical Analysis **7 Hrs**

Introduction, classification, basic components of analytical instruments, measurements used Absorption and emission spectrometric methods: ultraviolet (UV), visible, and infrared (IR) spectroscopy, atomic absorption spectroscopy (AAS), mass spectroscopy, Refractometry Chromatographic methods: gas chromatography (GC), liquid chromatography (LC), high performance liquid chromatography (HPLC). Electrochemical methods: measurement of pH, colourimetric, conductometric, potentiometric, Process instruments and automatic on-line analysis

Unit 6: Fundamentals of Process Dynamics **7 Hrs**

Introduction to process dynamics (PD), mathematical tools for process control (laplace transform, complex numbers), ideal forcing functions, control-relevant theoretical process modeling, transfer function and state-space models, poles and zeros of transfer function and their effect on dynamic response, block diagram representation, studying dynamic behavior of linear time invariant (LTI) systems, dynamic behavior of pure gain, pure capacitive, first order, second-order systems, dead time systems (derive differential equation model, transfer function, response to standard test signals and response characteristics along with physical examples), process identification using step response data, Introduction to feedback control system (FBCS), Introduction to ON-OFF, P, PI, PD, PID controllers.

References:

1. Instrument Engineers' Handbook (Process Measurement)- Bella G. Liptak, Elsevier
2. Instrument Engineers' Handbook (Process Control)- Bella G. Liptak, Elsevier
3. Instrumentation devices and systems- Rangan, Sharma, Mani, Tata McGraw Hill Publishing Co. Ltd.
4. Instrumental methods of analysis – Willard, Merritt, Dean, Settle, CBS Publishers and Distributors
5. Instrumental approach to Chemical Analysis- Shrivastava, Jain, S. Chand and Co.
6. Handbook of Analytical Instruments- Khandpur, Tata McGraw Hill Publishing Co. Ltd.
7. Process Control- Bequette, PHI publications
8. Chemical process control- Stephanopoulos, PHI publications
9. Process Dynamics and Control- Seborg, Edgar, Mellichamp- John Wiley and sons Inc.

309351: Elective-II

C. Corrosion Engineering

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30 End Semester: 70 **Total: 100** **Credits: 3**

Unit I: **7 Hrs**

Introduction and Scope, Corrosion: Definition, wet and dry corrosion, mechanism, electrochemical principles and aspects of corrosion, Faradays laws, specific conduction, specific resistance, transport no. mobility etc. various forms of corrosion, a brief review of corrosion rate expressions. Thermodynamic aspects of corrosion, equlibrium potential, Narnst equation for electrode potential. EMF series, overvoltage, application of Nernst equation to corrosion reactions, calculation of corrosion rates

Unit II: **7 Hrs**

Polarisation and Corrosion Potentials, reference electrodes for corrosion measurements, types of polarisation, concentration, activation and resistance polarisations, Tafel equation, Tafe constant, Evans Diagrams. Anodic control, cathodic control, mixed control. Pourbaix-diagram for Fe -H2O system.

Unit III: **7 Hrs**

Galvanic corrosion, uniform attack, pitting corrosion, dezincification, cavitation, erosion, fretting corrosion, intergranular and stress corrosion cracking. Remedial measures for the above.

Unit IV: **7 Hrs**

High temperature oxidation, Pilling Bedworth ratio, mechanisms of Oxidation, corrosion, testing procedures and evaluation: Corrosion of iron and steel in aqueous media, Effect of velocity, temperature and composition of media.

Unit V: **7 Hrs**

Prevention techniques, modification of the material by alloying, appropriate heat treatment. Chemical and Mechanical methods of surface treatment coatings - metallic, non-metallic linings, cathodic protection, passivity and anodic protection.

Reference Books:

1. Corrosion Engineering by Fontana and Greene, McGraw-Hill.
2. Corrosion and Corrosion Control, H.H. Uhllg, Wiley.
3. An introduction to Electrochemistry by Samuel Glasstone, Affiliated East West Press Private, Limited.

309351: Elective-II

D. Artificial intelligence and Data Science

Teaching Scheme:	**Examination Scheme:**
Lectures : 3 Hours / Week	In Semester: 30 End Semester: 70 **Total: 100** **Credits: 3**

Unit I: Introduction, Scope, historical perspective; Implication of AI applied to problems in engineering analysis and design. **7 Hrs**

Unit II: Formal concepts in design, knowledge representation and data bases; Coupled symbolic and numerical computation; Qualitative reasoning, uncertainly, truth maintenance; integrated compute aided engineering. **7 Hrs**

Unit III: Knowledge based process control; Adaptive and learning systems; Applications of Neural Networks; Fuzzy logic and genetic algorithms; AI oriented languages and architectures. **7 Hrs**

Unit IV: Expert systems design and development; ES tools and techniques Applications in various chemical and bio – Chemical processes. **7 Hrs**

Unit V: Logic and Reasoning Knowledge Based Reasoning: Agents, Facets of Knowledge. Logic and Inferences: Formal Logic, Propositional and First Order Logic, Resolution in Propositional and First Order Logic, Deductive Retrieval, Backward Chaining, Second order Logic. **7 Hrs**

Unit VI: Problem Decomposition and Planning Problem Decomposition: Goal Trees, Rule Based Systems, Rule Based Expert Systems. Planning: STRIPS, Forward and Backward State Space Planning, Goal Stack Planning, Plan Space Planning, A Unified Framework for Planning. **7 Hrs**

References:

1. Venkat Venkatasubramanian, 2019, the Promise of Artificial Intelligence in Chemical Engineering: Is It Here, Finally?, AIChE, Vol. 65, No. 2
2. Zeinab Hajjar, Shokoufe Tayyebi and Mohammad Hosein Eghbal Ahmadi, 2018, Application of AI in Chemical Engineering.
3. Eghbal-Ahmadi M-H, Zaerpour M, Daneshpayeh M, Mostoui N. Optimization of fluidized bed reactor of Oxidative coupling of methane. International Journal of Chemical Reactor Engineering. 2012; 10:1-21
4. Araromi DO, Sonibare JA, Emuoyibofarhe JO. Fuzzy identification of reactive distillation for acetic acid recovery from waste water. Journal of Environmental Chemical Engineering. 2014; 2:1394-1403
5. Shih-Bo Hung and Ming-Jer Lee, 2006, Control of Different Reactive Distillation Configurations, AIChE,

Vol. 52, No. 4

6. Nilsson Nils J , “Artificial Intelligence: A new Synthesis, Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN: 978-1-55-860467-4 2.
7. Patrick Henry Winston, “Artificial Intelligence”, Addison-Wesley Publishing Company, ISBN: 0-201-53377-4 3.
8. Andries P. Engelbrecht-Computational Intelligence: An Introduction, 2nd Edition-Wiley India- ISBN: 978-0-470-51250-0

309352: Internship

Teaching Scheme:	**Examination Scheme:**
Internship : 4 Hours / Week	**Total: 100** **Credits: 4**

The T&P cell will arrange internship for students in industries/organization after second, fourth and six/seventh semester(s) or as per AICTE/ affiliating University guidelines. Institutions may also device online system for arranging &managing internships. The general procedure for arranging internship is given below:

- **Step 1: Request Letter/ Email from the office of Training & Placement cell** of the college should go to industry to allot various slots of 4-6 weeks during summer vacation as internship periods for the students. Students request letter/profile/ interest areas may be submitted to industries for their willingness for providing the training. (Sample attached)
- **Step 2: Industry will confirm the training slots** and the number of seats allocated for internships via Confirmation Letter/ Email. In case the students arrange the training themselves the confirmation letter will be submitted by the students in the office of Training & Placement through concerned department. Based on the number of slots agreed to by the Industry, TPO will allocate the students to the Industry. In addition, the internship slots may be conveyed through Telephonic or Written Communication (by Fax, Email, etc.) by the TPO or other members of the T&P cell / Faculty members who are particularly looking after the Final/Summer Internship of the students.
- **Step 3: Students on joining Training** at the concerned Industry / Organization, submit the Joining Report/ Letters / Email.
- **Step 4: Students undergo industrial training** at the concerned Industry / Organization. In-between Faculty Member(s) evaluate(s) the performance of students once/twice by visiting the Industry/Organization and Evaluation Report of the students is submitted in department office/TPO with the consent of Industry persons/ Trainers. (Sample Attached)
- **Step 5: Students will submit training report** after completion of internship.
- **Step 6: Training Certificate** to be obtained from industry.
- **Step 7: List of students** who have completed their internship successfully will be issued by Training and Placement Cell.

PROCEDURES / FORMATS FOR ORGANIZING INTERNSHIPS

FORMAT1. STUDENT INTERNSHIP PROGRAM APPLICATION

Complete and submit to the TPO/ Internship Program Coordinator. Type or write clearly.

1. Student Name:		
2. Campus Address:		Phone:
3. Home Address:		Phone:
3a. Student email address:		

4. Academic Concentration		5. Internship Semester:_____Year.	
6. Overall GPA:			
9. Internship Preferences			
	Location	Core Area	Company/ institution
Preferance-1			
Preferance-2			
Preferance-3			
Faculty mentor Signature:_____Date_____. Signature confirms that the student has attended the internship orientation and has met all paperwork and process requirements to participate in the internship program, and has received approval from his/her Advisor..			
Student Signature:_____Date_____. Signature confirms that the student agrees to the terms, conditions, and requirements of the Internship Program			

FORMAT 2: REQUEST LETTER FROM INSTITUTE TO INTERNSHIP PROVIDER

To

The General Manager (HR)

.....

.....

Subject: REQUEST FOR 04/06 WEEKS INDUSTRIAL TRAINING of M.Tech/4 years Degree Programme,

Dear Sir,

Our Students have undergone internship training in your esteemed Organization in the previous years. I acknowledge the help and the support extended to our students during training in previous years.

/ (For first time industry) You must be aware that AICTE has made internship mandatory for all technical education students.

In view of the above, I request your good self to allow our following_____students for practical raining in your esteemed organization. Kindly accord your permission and give at least one-week time for students to join training after confirmation.

S. No.	Name	Roll No.	Year	Discipline

If vacancies exist, kindly do plan for Campus/Off Campus Interview for_____batch passing out students in above branches. CHECK THIS

A line of confirmation will be highly appreciated.

With warm regards,

Yours sincerely,

Training & Placement

FORMAT 3: RELIEVING LETTER OF STUDENT

To

.....

.....

Subject: Relieving letter of student and Industry. Dear

Sir,

Kindly refer your letter/e-mail dated..... on the above cited subject. As permitted by your good self the following students will undergo Industrial Internship in your esteemed organization under your sole guidance & directions:

S.No.	Name of Students	Roll No.	Branch

This training being an essential part of the curriculum, the following guidelines have been prescribed in the curriculum for the training. You are therefore, requested to please issue following guidelines to the concerned manager/Industrial Supervisor.

1. Internship schedule may be prepared and a copy of the same may be sent to us.
2. Each student is required to prepare Internship diary and report.
3. Kindly check the Internship diary of the student daily.
4. Issue instruction regarding working hours during training and maintenance of the attendance record.

You are requested to evaluate the student's performance on the basis of grading i.e. Excellent, Very Good, Satisfactory and Non Satisfactory on the below mentioned factors. The performance report may please be forwarded to the undersigned on completion of training in sealed envelope.

S.No.	Name of Students	Evaluation Ranking

a	Attendance and general behaviour	
b	Relation with workers and supervisors	
c	Initiative and efforts in learning	
d	Knowledge and skills improvement	
e	Contribution to the organization	

Your efforts in this regard will positively enhance knowledge and practical skills of the students, your cooperation will be highly appreciated and we shall feel obliged.

The students will abide by the rules and regulation of the organization and will maintain a proper discipline with keen interest during their Internship. The students will report to you on dated..... along with a copy of this letter.

Yours sincerely,

Training & Placement Officer

FORMAT 4: STUDENT'S DAILY DIARY/ DAILY LOG

DAY-1		DATE		
Time of arrival		Time of Departure		Remarks
Deptt./Division		Name of finished Product		
Name of HOD/ Supervisor With e-mail id				
Main points of the day				

Signature of Industry Supervisor

ORMAT 5: SUPERVISOR EVALUATION OF INTERN

Student Name:_____ Date:_____

Work Supervisor:_____ Title:_____

Company/Organization:_____

Internship Address: _____

Dates of Internship: From_____ To_____

Please evaluate your intern by indicating the frequency with which you observed the following behaviors:

Parameters	Needs improvement	Satisfactory	Good	Excellent

Behaviors				
Performs in a dependable manner				
Cooperates with co-workers and supervisors				
Shows interest in work				
Learns quickly				
Shows initiative				
Produces high quality work				
Accepts responsibility				
Accepts criticism				
Demonstrates organizational skills				
Uses technical knowledge and expertise				
Shows good judgment				
Demonstrates creativity/originality				
Analyzes problems effectively				
Is self-reliant				
Communicates well				
Writes effectively				
Has a professional attitude				
Gives a professional appearance				
Is punctual				
Uses time effectively				

Overall performance of student intern (circle one):

(Needs improvement/ Satisfactory/_____Good/_____Excellent)

Additional comments, if any:

Signature of Industry supervisor_____HR Manager _____

FORMAT 6: STUDENT FEEDBACK OF INTERNSHIP (TO BE FILLED BY STUDENTS AFTER INTERNSHIP COMPLETION)

Student Name: _____ Date:_____

Industrial Supervisor: _____ Title:_____

Supervisor Email: _____ Internship is:_____Paid___Unpaid_____

Company/Organization: _____

Internship Address: _____

Faculty Coordinator: _____ Department: _____

Dates of Internship: From _____ To _____

Please fill out the above in full detail

Give a brief description of your internship work (title and tasks for which you were responsible): Was your internship experience related to your major area of study?

_____Yes, to a large degree_____Yes, to a slight degree_____No, not related at all

Indicate the degree to which you agree or disagree with the following statements.

This experience has:	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
Given me the opportunity to explore a career field					
Allowed me to apply classroom theory to practice					
Helped me develop my decision-making and problem-solving skills					
Expanded my knowledge about the work world prior to permanent employment					
Helped me develop my written and oral communication skills					
Provided a chance to use leadership skills (influence others, develop ideas with others, stimulate decision-making and action)					
This experience has:	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
Expanded my sensitivity to the ethical implications of the work involved					

Made it possible for me to be more confident in new situations					
Given me a chance to improve my interpersonal skills					
Helped me learn to handle responsibility and use my time wisely					
Helped me discover new aspects of myself that I didn't know existed before					
Helped me develop new interests and abilities					
Helped me clarify my career goals					
Provided me with contacts which may lead to future employment					
Allowed me to acquire information and/ or use equipment not available at my Institute					

In the Institute internship program, faculty members are expected to be mentors for students. Do you feel that your faculty coordinator served such a function? Why or why not?

How well were you able to accomplish the initial goals, tasks and new skills that were set down in your learning contract? In what ways were you able to take a new direction or expand beyond your contract? Why were some goals not accomplished adequately?

In what areas did you most develop and improve?

What has been the most significant accomplishment or satisfying moment of your internship? What did you

dislike about the internship?

Considering your overall experience, how would you rate this internship? (Circle one). (Satisfactory/

Good/ Excellent)

Give suggestions as to how your internship experience could have been improved. (Could you have handled added responsibility? Would you have liked more discussions with your professor concerning your internship? Was closer supervision needed? Was more of an orientation required.

FORMAT 7 : PROFORMA FOR EVALUTION OF INTERNSHIP BY INSTITUTE

DEPARTMENT OF TRAINING AND PLACEMENT

Ph._____Fax_____Email_____

*Evaluation (I)*_____

1. Name of Student_____Mob. No. _____
2. College Roll No._____University Roll No. _____
3. Branch/Semester_____Period of Training_____
4. Home Address with contact No._____
5. Address of Training Site: _____
6. Address of Training Providing Agency:_____
7. Name/Designation of Training In-charge _____
8. Type of Work_____
9. Date of Evaluation _____

a) Attendance: _ (Satisfactory/ Good/ Excellent)

b) Practical Work: (Satisfactory/ Good/ Excellent

c) Faculty's Evaluation: _ (Satisfactory/ Good/Excellent)

d) Evaluation of Industry:_____(Satisfactory/ Good/ Excellent)

Overall grade: (Satisfactory/ Good/ Excellent)

Signature of Faculty Mentor *Signature of Internship Supervisor (Industry)*

With date and stamp

***Photocopy of the attendance record duly attested by the training in-charge should be attached with the evaluation Proforma**

FORMAT 8: INTERNSHIP EVALUATION REPORT

(For 4 years Degree Programme)

Name & Address of Organization

_____

_____

_____

Sr. No.	Name of Student	Roll No.	Marks to be awarded by			OVER ALL GRADE
			Punctuality Grade (Satisfactory/ Good/ Excellent)	Maintenance of Daily Diary Grade (Satisfactory/ Good/ Excellent)	Skill Test Grade (Satisfactory/ Good/ Excellent)	

FORMAT 9: ATTENDANCE SHEET

(For 4 years Degree Programme)

Name & Address of Organization

_____

_____

_____

Name of Student	
Roll. No	
Name of Course	
Date of Commencement of Trg.:	
Date of Completion of Training:	

Initials of the student

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Month & Year																															

Note :

1. Attendance Sheet should remain affixed in Daily Training Diary. **Do not remove or tear it off.**
2. Student should sign/initial in the attendance column. Do not mark 'P'
3. Holidays should be marked in **Red Ink** in attendance column. Absent should be marked as **'A' in Red Ink.**

Signature of Company internship supervisor with company stamp/ seal

(Name_____) Contact No.