SYLLABI FOR MASTER OF ENGINEERING IN CHEMICAL ENGINEERING WITH SPECIALIZATION IN ENVIRONMENTAL ENGINEERING EXAMINATIONS 2020-2022

MASTER OF ENGINEERING IN CHEMICAL ENGINEERING WITH SPECIALIZATION IN ENVIRONMENTAL ENGINEERING

This ME will be extension of ME Chemical ongoing in the department. Students will be given option on the basis of merit of OCET / GATE for specialization in

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SCHEME OF TEACHING AND EXAMINATION (2020-2022)

Paper	Subject	Teaching Hrs. per Week				End Term	Mid Term	Total Marks
SECOND SEMESTER		L	T	P	C			
CHE 2.1	Heat Transfer	4	-	-	4	50	50	100
CHE 2.2	Research Methodology	4	-	-	4	50	50	100
CHE 2.3	Chemical Reaction Engineering	4	-	-	4	50	50	100
CHE 2.4	Process Dynamics & Control	4	-	-	4	50	50	100
CHE 2.5	Process Modeling & Simulation	4	-	-	4	50	50	100
Practical								
CHE 2.6	Process Modeling & Simulation	-	-	2	1	-	25	25
CHE 2.7	Seminar	-	-	2	1	-	25	25
	Total	20	-	4	22	250	300	550
CHE 2.8	Solid Waste Management	4	-	-	4	50	50	100
	Total	24	-	4	26	300	350	650

Note: Allotment of project thesis will be done at the end of second semester and before summer vacation.

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SCHEME OF TEACHING AND EXAMINATION (2020-2022)

Paper	Subject	Teaching Hrs. per Week				End Term	Mid Term	Total Marks
THIRD SEMESTER		L	T	P	C			

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SCHEME OF TEACHING AND EXAMINATION (2020-2022)

Paper	Subject	Teaching Hrs. per Week				End Term	Mid Term	Total Marks
FOURTH SEMESTER		L	T	P	C			
CHE 4.1	Thesis	-	-	30	15	-	-	-
	Total	-	-	30	15	-	-	-

NOTE:
The student is required to make seminar presentation(s) of the results achieved before the submission of the thesis.

1.

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FIRST SEMESTER

Paper Title: MATHEMATICAL METHODS IN CHEMICAL ENGINEERING (Theory)
Paper Code : CHE 1.1 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Numerical solutions of simultaneous and higher order differential equations: Runge-Kutta method, Picard's method. Approximate methods for B.V. problems: Finite difference method.
Approximate and numerical solutions of PDE's: Finite difference approximation to derivatives. Numerical solutions of elliptic equations (Laplace and Poisson's equations), Parabolic equations and Hyperbolic equations.
Integral Functions: Gamma functions, Beta functions, Elliptic integrals and functions and error functions.

SECTION-B

Solution methods for linear difference equations, complementary solutions and particular solutions. Nonlinear equations (Riccatic equations).
Z-Transforms: Introduction, some standard Z-transforms, linearity property damping rule, some standard results, shifting rules, initial and final value theorems, convolution theorem, evaluation of inverse transforms, applications to difference equations.
Fourier Transforms: Introduction, fourier integrals, properties of fourier transforms, convolution theorem, Parseval's identity for F-transform, relation between fourier and laplace transforms, fourier transforms of the derivatives of a function. Applications to boundary value problems.

***Books Recommended*:**

1. Jain, R. K. & Iyengar, S. : Advanced Engg. Mathematics, 2nd Edition, Narosa Publishing House, New Delhi, 2003.
2. Grewal, B. S. : Higher Engineering Mathematics, Khanna Publishers, New Delhi, 41st Edition.
3. Kreyszig, Erwin : Advanced Engineering Mathematics, 8th Edition, Wiley Eastern, New Delhi, 2002.
4. Jain, R.K. : Numerical Solution of Differential Equations, 2nd Edition, Prentice Hall, 1987.
5. Mickley, H.S., Sherwood, T.K. and Reed, C.E. : Applied Mathematics in Chemical Engineering
6. Sastry, S.S. : Introductory Methods of Numerical Analysis

Paper Title: FLUID MECHANICS(Theory)
Paper Code : CHE 1.2 Max. Marks 50 Credits : 4 Time: 3 hours

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Paper Title: MASS TRANSFER(Theory)
Paper Code : CHE 1.3 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

Section A

Fundamentals of Separation Processes; Basic definitions of relevant terms

Multicomponent distillation – Binary vapour-liquid equilibria, p-x-y diagrams, t-x-y diagrams, x-y diagrams, activity coefficients, relative volatility. Prediction of VLE by UNIFAC method.

Graphical methods for estimating stage requirements for binary systems for one feed, two feed, one feed and one side stream with constant relative volatility.
Analytical methods like Fensky and Underwood equations. Smoker equations and its applications. Methods of estimation of minimum reflux, optimized feed stage and minimum number of stages.
Supercritical fluid extraction – Supercritical fluids, Phase equilibria, Industrial applications; Important supercritical processes – Decaffination of coffee, Extraction of oil from seeds, Residuum oil supercritical extraction

Section B

Membrane Separation : Classification of membrane processes; Membrane Materials , Membrane Modules, Transport in Membranes, Dialysis and Electrodialysis, Reverse Osmosis , Gas Permeation, Pervaporation, Ultrafiltration, Microfiltration

Adsorption, Ion Exchange, and Chromatographic separation processes: Sorbents – Adsorbents, Ion Exchangers and Sorbents for Chromatography, Slurry Adsorption (Contact Filtration), Fixed-Bed Adsorption (Percolation), Thermal-Swing Adsorption, Pressure-Swing Adsorption, Continuous, Countercurrent Adsorption Systems, Simulated-Moving-Bed Systems, Ion-Exchange Cycle, Chromatographic Separations

Books Recommended

1. Smith, B. D.: Design of Equilibrium Stage Processes, McGraw Hill, N. Y., 1963
2. King, C J: Separation Processes, Tata McGraw Hill, New Delhi, 2nd Edition, 1982
3. Nath K: Membrane Separation Processes, pHI, New Delhi, 2011.

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Paper Title: TRANSPORT PHENOMENA (Theory)
Paper Code : CHE 1.5 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Instructions for the Paper setter: Total number of questions to be set = 08 with the following distributions:
Unit-I : 01 Unit-II : 02 , Unit-III : 02 , Unit-IV: 02 , Unit-V : 01. The students will be required to attempt 5 questions selecting at least 01 question each from Unit-II , Unit-III and Unit-IV, and at least one question from Unit-I and Unit-V

Section-A

Unit-I

Introduction – Mechanism of molecular transport of momentum. Velocity distributions in laminar flow – shell momentum balances – Flow of falling film – flow of fluids through circular tubes, annulus and between parallel plates. Creeping flow around sphere – Drag calculations.

Unit-II

Equations of change for isothermal systems – Equation of continuity, Equation of Motion, Equations of change in curvilinear coordinates, use of equations of change to set up steage (4912b)4T J s2of (4ste eb s upeloon pistribution –912(b)4(9

Unit-V Temperature distributions in solids and in laminar flow- shell energy balances – Heat conduction with electrical, Nuclear, viscous and chemical heat source, Heat conduction through cooling fin, Forced convection and free convection. Unsteady heat conduction for semi-infinite slab. Equations of change for non-isothermal systems – Equation of energy – use of equations of change to set up steady state flow problems.

Books Recommended: TEXT BOOKS

Bird, R.B., Stewart, W. E. and Lightfoot, E. N.: Transport Phenomena, 2nd Edition, n, John Wiley & Sons, 2002.

Brokley, R.S. and Hershey, H.C.: Transport Phenomena: A unified Approach, McGraw Hill Publications, 1988.

Paper Title: AIR POLLUTION CONTROL ENGINEERING (Theory)
Paper Code : CHE 1.6 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

Section A

Brief history about air pollution

Magnitude and effects of major and secondary air pollutants

Air quality and emission standards

Control Technologies:

Particulate control technology: Principles of Operation, Design Methodology and Considerations, Industrial applications and Problems encountered in the working of particulate control equipments: gravitational settling chambers, cyclone separators, gas filteration, electrostatic precipitators, particulate removal by scrubbing, adsorption of gaseous emissions

Air pollution control by combustion: thermal combustion, catalytic combustion

Control of sulfur dioxide emissions

Emission control of nitrogen oxides

Control of organic emissions

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SECOND SEMESTER

Paper Title: HEAT TRANSFER(Theory)
Paper Code : CHE 2.1 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Analysis of Convection Heat Transfer: Convection heat transfer, boundary layer fundamentals, conservation of mass, momentum and energy for laminar and flow over a flat plate, dimensionless Boundary – Layer equations & similarity parameters, dimensional analysis, integral equations of the laminar boundary layer, analysis between momentum and heat transfer over a flat surface; turbulent flow and turbulent boundary layers analysis, analysis for turbulent flow over a flat surface.
*Heat Transfer by Natural Convection***:** Natural convection, temperature a velocity distribution in thermal boundary layers, governing equations of mass, momentum and energy for natural convection past vertical plane surface, approximate integral boundary layer analysis for natural convection, working correlations for various shapes, natural convection from finned surface, natural convection in enclosed spaces, natural convection from finned surfaces, mixed free and forced convection.
*Forced convection Inside Tubes & Ducts***:** Analysis of laminar forced convection in long tube, correlations for laminar forced correction, analogy between heat and momentum transfer in turbulent flow, working correlations for turbulent forced convection, forced convection in noncircular sections.

SECTION-B

*Forced Convection over Exterior Surfaces***:** Flow over bluff bodies, local heat transfer coefficient distribution around cylinders, effect of various parameters on local heat transfer coefficient, heat transfer from tube bundles in cross-flow, heat transfer from non-circular sections.
Heat Transfer with phase change: Drop wise and film wise condensation, analysis of laminar film condensation on vertical surfaces, working correlations for various shapes, effects of non-condensable gases, vapor velocity, sub-cooling of condensate, super heating of vapor, orientation of tube on condensation heat transfer coefficient, condensation on tube bundles, turbulent film condensation.
Boiling heat transfer, Pool boiling, forced convective boiling in horizontal and vertical tubes, sub cooled pool boiling, bubble departure diameter, bubble frequency, nucleation sites, effect of various parameters on boiling heat transfer coefficient.
Heat transfer in fixed bed, heat transfer in fluidized bed, heat transfer in cyclone heat exchanger.

Heat transfer by combined conduction, convection and Radiation: Thermocouple lead error in surface temperature measurements, heat transfer from radiating fins, the flat plat solar collector, the heat pipe.

***Books Recommended*:**

1. Kays, W. M. & Crawford, M. E. : Convective Heat and Mass Transfer, 3rd Edition, McGraw Hill International Editions, 1993.
2. Frank Kreith & Mark S. Bohn : Principles of Heat Transfer, 6th Edition, Asian Books Private Limited, 2001.
3. Ghoshdastidar, P. S. : Heat Transfer, Oxford University Press, 2004.
4. J P Holman : Heat Transfer, 9th edition, Tata McGraw-Hill, New Delhi. 2008

Paper Title: RESEARCH METHODOLOGY (Theory)
Paper Code : CHE 2.2 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Introduction: Meaning, Features, Objectives/Motives & types of Research; Attributes of good Research, Research Methods and Research Methodology; Research Process, Significance of Research in Managerial decision making.
Research Design: Meaning, Characteristics and various concepts relating to research design and classification of research design, Importance.
Measurement and Scaling: Data Types Nominal, Ordinal and Ratio scale; scaling techniques.
Formulation of Hypothesis: Meaning, Characteristics and concepts relating to testing of Hypothesis (Parameter and statistic, Standard error, Level of significance, type-I and Type-II errors, Critical region, one tail and two tail tests); Procedure of testing Hypothesis. Numerical problems based on chi-square test and Ftest (variance ratio test only).
Data Collection: Sources of Data-Primary/Secondary Methods of collecting data; direct personal interview, indirect oral interview, information through local agencies, mailed questionnaire method, schedule sent through enumerators; questionnaire and its designing and characteristics of a good questionnaire.
Sampling Design: Meaning and need of Sampling, Probability and non-probability sampling design, simple random sampling, systematic sampling, stratified sampling, cluster sampling and convenience, judgement and quota sampling (non-probability), determination of sample size.

SECTION – B

Data Analysis & Interpretation: Introduction to Multivariate analysis- Multiple and partial correlation, multiple regression analysis (with two independent variables), specification of

regression models and estimation of parameters, interpretation of results. Analysis of Variance

Conversion and Reactor Sizing: Design equations for isothermal batch and flow systems. Applications of design equations for CSTR and plug flow reactors, Reactors in series, space time and space velocity.

Rate Laws and Stoichiometry: Relative rates of reaction, rate constant, elementary reactions, nonelementary reactions, reversible reactions, batch system stoichiometric table, flow system stoichiometric table, volume change with reaction.

Isothermal Reactor Design: Design structure for isothermal reactors, scale-up of liquid phase batch reactor data to design of CSTR, tubular reactors.

Collection and Analysis of Rate Data: Differential method and integral method of rate analysis, method of half-lives, differential reactors. Evaluation of laboratory reactors: fixed bed, stirred batch reactor, stirred contained solids reactor, continuous-stirred tank reactor, straight-through transport reactor, recirculating transport reactor.

Multiple Reactions: Conditions for maximizing the desired product in parallel reactions. Maximizing the desired product in series reactions. Stoichiometric table using fractional conversion for multiple reactions.

Non-Isothermal Reactor Design: Energy balances: basic ideas about constant or mean and variable heat capacities, heat added to the reactor. Non-isothermal continuous flow reactors at steady state: application to the CSTR, adiabatic tubular reactor, steady state tubular reactor with heat exchange. Multiple steady states (MSS) in a CSTR.

SECTION-B

Catalysis and Catalytic Reactions: Steps in a catalytic reaction, synthesizing a rate law, mechanism and rate limiting steps, design of reactors for gas-solid reactions, heterogeneous data analysis for reactor design.

Diffusion and Reaction in Porous Catalysts: Molar flux, Fick's first law, binary diffusion, diffusion and reaction in spherical catalyst pellets, estimation of diffusion and reaction limited regimes.

Reactors for Catalytic Reactions: Fluidized reactors: information about suspended solid reactors, bubbling fluidized bed (BFB), K-L model for BFB and circulating fluidized beds (CFB). Slurry reactors: rate of gas absorption, transport to catalyst pellet, diffusion and reaction in catalyst pellet, rate law and determining the rate limiting step, slurry reactor design. Fixed bed catalytic reactor: mass transfer and reaction in packed bed.

Distribution of Residence Times for Chemical Reactors: General characteristics, measurement of RTD: pulse input and step tracer experiment.

Models for Non-Ideal Reactors: One parameter models: the tank-in-series model and the dispersion model. Two parameter models: real CSTR modeled with an exchange volume and real CSTR modeled using bypassing dead space.

***Books Recommended*:**

1. Fogler, H. S. : Elements of Chemical Reaction Engineering, 4th Edition, Pearson Prentice Hall, 2007.

2. Levenspiel, O. : Chemical Reaction Engineering, 3rd Edition,Wiley India Pvt Ltd.,2007.
3. Smith, J. M. : Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1981.

Paper Title: PROCESS DYNAMICS AND CONTROL(Theory)
Paper Code : CHE 2.4 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

A brief review of frequency response technique, Ziegler-Nichols controller tuning rules, Bode and Nyquist plots, Bode and Nyquist stability criterions, development of empirical models from frequency response data: Graphical methods for 1st order plus dead time and 2nd order plus dead time processes.
*Advanced Control Strategies***:**
Cascade control: Closed loop behavior and controller design for cascade control.
Feed forward control: Logic of feed forward control, designing of feed forward controllers, practical aspects on the design of feed forward controllers, feed forward-feed back control, ratio control.
Feed back control systems with large dead time: Smith Predictor scheme.
Selective Control Systems: Override control and Auctioneering control systems

SECTION-B

A brief review of the dynamic behavior of control systems, Stability of control systems by root locus method using P, PI and PID controllers, ¼ decay ratio criterion.
*Multivariable Control***:** State space representation of physical systems, transfer function matrix, interaction of control loops, relative gain array and selection of loops, design of non-interacting control loops: Decouplers.
*Model based control***:** Direct synthesis method (DSM)-controller design based on process model and desired closed loop transfer function. Internal Model Control: basic structure of IMC, design of internal model controller (IMC) and conventional feedback controller.
*Digital control***:** Introduction to direct digital control (DDC), sampling continuous signals and its reconstruction.

***Text Books Recommended*:**

1.

Reference Books

3. Seborg, D. E., Edgar, T. F. & Mellichamp, D. A. : Process Dynamics and Control, John Wiley & Sons, Singapore, 2nd Edition, 2004.
4. Luyben, W.L. &Luyben M. L. : Essentials of Process Control, McGraw Hill, International Editions, Singapore, 1997.

Paper Title: PROCESS MODELLING AND SIMULATION(Theory)
Paper Code : CHE 2.5 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Introduction to mathematical modeling; Advantages and limitations of models and applications of process models of stand-alone unit operations and unit processes; Classification of models – Simple vs. rigorous. Lumped parameter vs. distributed parameter; Steady state vs. dynamic, Transport phenomena based vs. Statistical, empirical vs analytical. Concept of degree of freedom analysis.

Review of numerical methods used for solution of; linear and non linear equations, ODE's and PDE.

Simple examples of process models; Models giving rise to nonlinear algebraic equation (NAE) systems, - steady state models of flash vessels, equilibrium staged processes distillation columns, absorbers, strippers, CSTR, heat exchangers, evaporators, etc.

REFERENCE BOOKS

1. Jana, A.K. : Chemical Process Modeling and Computer Simulation, PHI, 2008.
2. Bequette, B.W. : Process Control: Modeling Design of Simulation, PHI.
3. Denn, M. : Process Modeling, Wiley, N.Y., 1990.

Paper Title: PROCESS MODELLING AND SIMULATION (Practical)
Paper Code : CHE 2.6 Max. Marks 25 Credits : 1

Practicals based on theory covered in Paper CHE 2.5.

Paper Title: SEMINAR(Practical)
Paper Code : CHE 2.7 Max. Marks 25 Credits : 1

Title: SOLID WASTE MANGEMENT
Paper Code : CHE 2.8 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

Section A

Waste generation, Need and requirements for management and planning Solid waste- types, generation trends, quality and quantity aspects

Review on types of solid waste – Municipal waste, urban , rural and industrial wastes, Special wastes- tyres, household hazardous wastes, demolition waste, domestic waste; sewage sludge and municipal waste; slaughterhouse waste; agricultural waste; Radioactive waste; Electronic wastes: Mining waste.

Integrated Solid waste Management; Solid waste characterization: ultimate and proximate analysis; Waste reduction at source, volume reduction Collection techniques. Transport of solid waste and its optimization, transfer stations

Management and disposal of Hazardous wastes and Biomedical waste.

Section B

Environmental Impact Assessment

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M. E. (CHEMICAL ENGINEERING)
THIRD SEMESTER

Paper Title: OPEN ELECTIVE(Theory)
Paper Code : CHE 3.1 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

1. ANALYTICAL TECHNIQUES

SECTION-A

Complexometric titrations: Complexes-formation constants; chelates – EDTA, Chelon Effect, EDTA equilibria, effect of pH on EDTA equilibria, EDTA titration curves, endpoint – detection and indicators; Importance of complexometric titrations.
Solvent Extraction: Distribution law, extraction process, factors effecting extraction, technique for extraction, quantitative treatment of solvent extraction equilibria, classification of solvent extraction systems. Advantages and applications of solvent extraction.

Chromatography:Introduction to chromatography, principles, classification of chromatographic techniques, thin layer and paper chromatography – principle and technique.
Column Chromatography – Factors affecting column efficiency and applications. Gas – liquid chromatography – theory, instrumentation and applications. HPLC – instrumentation, method, column efficiency and applications.

Thermoanalytical methods: Principle, classification of methods.
TGA – Instrumentation, factors affecting results and analysis of data. applications.
DTG – Instrumentation, analysis of data and applications.
DTA – Principle, Instrumentation and applications.

SECTION-B

IR Spectroscopy: Origin, rigid rotor model, harmonic oscillator model, principle, modes of vibrations of atoms in polyatomic molecules, instrumentation, selection rules, identification of organic compounds on the basis of infrared spectra.

UV-Vis Spectroscopy: Introduction, laws of absorption, origin of spectra, types of transitions, selection rules, identification of organic compounds using UV-VIS spectroscopy.
NMR: Principle, chemical shift, spin-spin coupling shift reagents, instrumentation, spectra and molecular structure, identification of organic compounds on the basis of NMR.

Electron Microscopy : Introduction to electron microscopy, classification of electron microscopy methods, Scanning electron microscopy , Instrumentation and applications. Scanning Tunnelling microscopy –Principle and comparison with SEM

Atomic force microscopy AFM- Principle Instrumentation and its basic application

2. ***Books Recommended*:**

1. Skoog, D. A. & West D. M. : Principles of Instrumental Analysis, 5th Edition, Saunders College Publishers, USA.
2. Skoog, D. A. & West D. M. : Fundamentals of Analytical Chemistry, 7th Edition, Saunders College Publishers, USA.
3. Willard, Meritt, Dean & Settle : Industrial Methods of Analysis, 7th Edition.
4. Galen W. Ewing. : Industrial Methods of Chemical Analysis, 5th Edition.
5. Silverstein R. M. & Webster F.X. : Spectrometric identification of Organic Compounds, 6th Edition, John Wiley and Sons, Inc., USA.

2. PROJECT MANAGEMENT

SECTION-A

Project Management: concept of project management, project management systems, responsibilities and qualities of a project manager, project management team-composition, functions and responsibilities, co-ordination procedures. Manpower planning; recruitment and selection job description, specification and evaluation, performance appraisal, basis of remuneration and incentives. Project Identification: Principles of project identification, importance of capital investment, decision making industrial policy resolution, industrial development and regulation act, supply and demand analysis, incentives for industrially backward areas and small scale industries, foreign collaboration and foreign exchange regulations. Appraisal criteria and selection of investment: Non discounting criteria, discounting criteria, appraisal and selection in practice.

SECTION-B

Feasibility studies: Preparation of techno-economic feasibility report, feasibility analysis technical economic, commercial and financial planning: Network analysis, PERT/CPM Bar chart.

Preconstruction Planning. Project Scheduling control and Monitoring: Resource Scheduling, manpower scheduling, multi project scheduling, cost scheduling, PERT/Cost scheduling optimisation, crash costing and updating and leveling of resources, Implementation of Project schedules. Financial Control: Budgeting and cost control, sources of long term funds for

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1. Prasanna Chandra : Project Preparation Appraisal Implementation, 3

SECTION-B

Explosive and inflammable substances. Radioactive hazards. Fire prevention. Good housing keeping in industrial environment.

Standard safety procedures and disaster control. Indian legislation on safety and prevention of hazards and safety code.

Case study of typical hazardous industry.

***Books Recommended*:**

1. Wells, G.L. : Safety in process Plant Design.
2. Lees, F.P. : Loss Prevention in Process Industries.
3. Chanleft, E.T. : Environmental Protection.
4. Berthowex, P.M. and Rudd, D.E. : Strategy of Pollution control.

5. COMPOSITE MATERIALS

SECTION-A

Concepts underlying formation, characteristics and behavior of plastic-based composites such as fiber glass laminates, structural sandwiches, plywood and load-bearing adhesive joints. Typical components such as metals, glass, synthesis and natural adhesives, plastics, foams, wood, paper, fabrics and rubber.

SECTION-B

Correlation between adhesion principles and physical behavior,. Methods of design, analysis, fabrication and testing. Discuss failure mechanisms of chemical and mechanical types.

Paper Title: ELECTIVE(THEORY)

Treatment Methods for water &waste **:**Sources and characterization of water pollution.
Primary Treatment: gravity separator, equalization tanks, Sedimentation, Flotation
Secondary Treatment – Design of :UpflowAnarerbic, Sludge Blanket (USAB) reactor, Activated Sludge process – Rotating Biological Contactors (RBC), Trickling Filters;
Natural Treatment - Wetland Systems, Waste Stabilization Ponds.
Tertiary Treatment systems: Disinfection etc.
Sludge and solid wastes treatment: Identification of hazardous wastes – disposal and waste minimization, waste management,

SECTION-B

Air Pollution Control : Air pollutants : Sources, effects, temperature inversions, plume behavior, characterization, stack height, Gaussian Plume design model, Measurement and emission estimates, Isokinetic Sampling.

Control methods

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set. The students will be required to attempt 5 questions selecting at least 2 from each section.

Section A

Waste Water Generation, Types And Characteristics: Physical, chemical and biological water quality parameters

International And National Standards For Waste Water : In-stream Standards, Potable water Standards, Wastewater effluent Standards

Water and Waste Water Treatment Plants: Water Treatment Plants, Waste Water treatment Plants**,** Design Flow Rates and Parameters

Unit Operations, Processes And Design Of Primary Treatment: Coagulation and Flocculation, Sedimentation,Filtration, Ammonia Removal

Section B

Unit Operations, Processes And Design Of Aerobic And Anaerobic Digestion : Activated sludge processes: Design and applications, Trickling filter, Rotating Biological contractors , Anaerobic digestion and sludge

Unit Operations, Processes And Design Of Tertiary Treatment: Adsorption, Ion Exchange, Membrane Processes, microfiltration, Advanced Oxidation processes(homogenous and heterogenous)

Books Recommended

1. Peavy, H.S, Rowe D R Tchobanoglous G,. : Environmental Engineering (McGRAW – Hill International Editions)
2. Reynolds and Richard: Unit Operations and Processes in Environmental Engineering
3. Henry J G &Heinke G W: Environmental Science and Engineering (Second Addition)
4. Hammer & Hannes, Water and Wastewater Technology, PHI
5. Droste R L , Theory and Practice of water and wastewater Treatment, Wiley, India