FACULTY OF ENGINEERING

Syllabus for the

M.E. (Chemical Engineering)

(w. e. f. 2013-2014)

UNIVERSITY OF PUNE

University of Pune
Structure for M.E. Chemical Engineering- 2012 Course (w.e.f. June-2013)

Semester I

Code	Subject	Teaching Scheme	Examination Scheme					Credits
		Lect/ Pract	Paper		TW	Oral/Presentation	Total	
			In Semester Assessment	End Semester Assessment				
509101	Mathematical and Statistical Methods	4	50	50	--	--	100	4
509102	Management of R&D in Chemical Industries	4	50	50	--	--	100	4
509103	Advanced Separation Processes	4	50	50	--	--	100	4
509104	Research Methodology	4	50	50	--	--	100	4
509105	Elective - I	5	50	50	--	--	100	5
509106	Lab Practice - I	4	--	--	50	50	100	4
Total of First Term		**25**	**250**	**250**	**50**	**50**	**600**	**25**

Semester II

Code	Subject	Teaching Scheme	Examination Scheme					Credits
		Lect/ Pract	Paper		TW	Oral/Presentation	Total	
			In Semester Assessment	End Semester Assessment				
509107	Advanced Transport Phenomena	4	50	50	--	--	100	4
509108	Advanced Process Control	4	50	50	--	--	100	4
509109	Advanced Reaction Engineering	4	50	50	--	--	100	4
509110	Elective - II	5	50	50	--	--	100	4

509111	Lab Practice - II	4	--	--	50	50	100	5
509112	Seminar -I	4	--	--	50	50	100	4
Total of Second Term		**25**	**200**	**200**	**100**	**100**	**600**	**25**

Semester III

Code	**Subject**	**Teaching Scheme**	**Examination Scheme**					**Credits**
		Lect/ Pract	**Paper**		**TW**	**Oral/Presentation**	**Total**	
			In Semester Assessment	End Semester Assessment				
509113	Process Modeling and Simulation	4	50	50	--	--	100	4
509114	Advanced Thermodynamics	4	50	50	--	--	100	4
509115	Elective - III	5	50	50	--	--	100	5
509116	Seminar -II	4	--	--	50	50	100	4
509117	Project Work Stage - I	8	--	--	50	50	100	8
Total of Third Term		**25**	**150**	**150**	**100**	**100**	**500**	**25**

Semester IV

Code	**Subject**	**Teaching Scheme**	**Examination Scheme**					**Credits**
		Lect/ Pract	**Paper**		**TW**	**Oral/Presentation**	**Total**	
			In Semester Assessment	End Semester Assessment				
509118	Seminar -III	5	--	--	50	50	100	5
509119	Project Work Stage - II	20	--	--	150	50	200	20
Total of Fourth Term		**25**	**150**	**150**	**200**	**100**	**300**	**25**

* The Term Work of Project Stage I and II of semester IV and oral/presentation for laboratory practice I and II should be assessed jointly by the pair of internal and external examiners along with the oral examination of the same.

 # It is mandatory for every student that his Project Outcomes (results and conclusion) are 'validated' in the form of minimum one Publication (published or accepted) in a refereed and peer reviewed journal of international repute till the date he/she appears for the Project Work Stage II examination.

List of Electives

Elective I	**Elective II**	**Elective III**	
a. Process Design And Synthesis	a. Industrial Pollution Control	a. Catalysis And Surface Phenomenon	--
b. Application of Nanotechnology in Chemical Engineering	b. Process Optimization	b. Advanced Downstream Processes	--
c. Fluidization Engineering	c. Chemoinformatics	c. Computational Fluid Dynamics	--
d. Computer Aided Design	d. Cleaner Production	d. Bioprocess Engineering	--
Non-credit course (Mandatory)			
Term I, Sem I	**Term I, Sem II**	**Term II, Sem I**	**Term II, Sem II**
Yoga and Meditation	Human Rights and World Peace	Cyber Security /Information security	Industrial Safety and Equipment Maintenance

Note- The Contact Hours for the calculation of load of teacher
Seminar- 1 Hr / week / student &
Project - 2 Hr / week / student

Note: - This syllabus is subject to change without prior notice by the concerned BOS

Guidelines

Lab Practice I & II:
The laboratory work will be based on completion of assignments confined to the courses of that semester.

SEMINAR:
The student shall deliver the seminar on a topic approved by authorities.
Seminar I : Shall be on state of the art topic of student's own choice approved by an authority. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute.
Seminar II : shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected by him/her approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

Seminar III: shall preferably an extension of **seminar II.** The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

PROJECT WORK:
The project work shall be based on the knowledge acquired by the student during the coursework and preferably it should meet and contribute towards the needs of the society. The project aims to provide an opportunity of designing and building complete system or subsystems based on area where the student likes to acquire specialized skills.

Project Work Stage – I
Project work Stage – I is an integral part of the project work. In this, the student shall complete the partial work of the project which will consist of problem statement, literature review, project overview, scheme of implementation (Mathematical Model/SRS/UML/ERD/block diagram/ PERT chart, etc.) and Layout & Design of the Set-up. As a part of the progress report of Project work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic. The student shall submit the duly certified progress report of Project work Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

Project Work Stage - II
In Project Work Stage – II, the student shall complete the remaining part of the project which will consist of the fabrication of set up required for the project, work station, conducting experiments and taking results, analysis & validation of results and conclusions.
The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

Note: Institute must submit the list of candidates, guide and project details (title, area, problem definition, abstract - clearly indicating objectives and scope, sponsorship details, if any) to the university within month of commencement of third semester. The guide must be approved/qualified full time teacher of the Institute. A guide can accept/enroll at the most 8 students per year.

SEMESTER I

509101: Mathematical and Statistical Methods

Teaching Scheme
Lectures: 4 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 4

Objectives

1. To give students an insight in various Chemical Engineering Processes using advanced Numerical and Statistical Methods.
2. To provide adequate background of Mathematics to deal with Chemical Engineering Problems
3. To understand research papers on relevant topics involving advanced Mathematics.
4. To study correlation and regression of multivariate data.
5. To evaluate Experimental design methods and statistical quality control measures.

Ordinary Differential Equations

Introduction to linear differential equations (LDE), LDE with constant coefficients, Series solutions of differential equations: power series method, Legendre's polynomial, Bessel's equation, Sturm Liouville problems, Orthogonal functions, Solving system of differential equations: Laplace transform method, qualitative method (phase plane method, critical points, stability); solving nonlinear, nonhomogeneous linear systems.

Partial Differential Equations

Introduction to partial differential equations, heat equation, wave equation, Laplace's equation in cylindrical and spherical coordinates, potential, solving Dirichlet problem, solution using a Fourier-Legendre series.

Complex Analysis

Introduction to differentiation and integration of complex functions, power series (Taylor's and Maclaurin's method), Laurent series, residue integration method, complex analysis applied to potential theory (conformal mapping, heat problems, fluid flow problems), Poisson's integral formula.

Mathematical Statistics

Probability Theory: Introduction, random variables, probability distributions (binomial, Poisson, hypergeometric, normal), mean and variance of a distribution, Random sampling, sampling estimation, estimation of parameters, confidence intervals, testing of hypothesis,

testing goodness of fit, analysis of variance (ANOVA), test of significance of large and small samples.

Correlation and Regression Analysis

Correlation: Types of correlation, methods of studying correlation, Karl Pearson's method, Rank correlation, partial correlation (zero, first, and second-order coefficients), multiple correlation, correlation ratio, interclass correlation, bivariate normal distribution.

Regression: Linear and nonlinear (curvilinear) correlation, bivariate and multiple regression, least square regression plane.

Experimental Designs and Statistical Quality Control:

Experimental Designs: Introduction, randomized block design (RBD), latin square design (LSD), latin cube, factorial experiment design.

Statistical Quality Control: Introduction, control charts, setting up the control limits, acceptance sampling, operating characteristic (OC) curve.

References

1. Kreyszig, E., "Advanced Engineering Mathematics", 6th Edition, John Wiley & Sons, 1988.
2. Gupta, S.C. and Kapur, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 1999.
3. Arvind Varma and Massimo Morbidelli, "Mathematical Methods in Chemical Engineering", Oxford University Press, New York, 1997.
4. M.D. Raisinghania, "Advanced Differential Equations", S.Chand and Company Limited, 2005
5. Jenson, V. G. and G. V. Jeffreys, "Mathematical Methods in Chemical Engineering", Academic Press, New York, 1963.
6. O'Neil, P. V., "Advanced Engineering Mathematics", 2ndEdition, Wadsworth, Belmont, 1991.
7. Strang, G., "Linear Algebra and its Applications", Harcourt, Brace, Jovanovich publishers, San Diego, 1988.
8. Wylie, C. R. and L. C. Barrett, "Advanced Engineering Mathematics", 6th Edition, Mc-Graw-Hill, New York, 1995.

509102: Management of R&D in Chemical Industries

Teaching Scheme
Lectures: 4 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 4

Objectives

1. To give students a research perspective
2. To acquaint the students with a systematic approach to research
3. To give an insight into research data evaluation methods
4. To acquaint the students with the rules and regulations pertaining to research

Research Perspective in Science and Technology

Knowledge society, Value education, Quality education, Role of educational technology, Policy of higher education and research, Status of research in science and technology: Global and Indian. Rules and regulations, Introduction to research methodology

Experimental and Computational Techniques in Chemical Engineering Research, Laboratory safety Measures, Ethics in Engineering Research, Intellectual property rights, Process of Applying for Patenting Research, Copyright

Research Planning and Execution

Nature of planning. Choice and Objectives of technological forecasting. Proposal preparation and motivative efforts, initiate the research and development programme. Concept of creativity, group approach to idea generation. Conditions for successful growth of creative ideas of realization. Quality of research personnel and staff selection. Organization and special problems of research and development. Conducting a research and development project. Scheduling, monitoring, and decision-making for cost effectiveness. Accountability and responsibility.

Computer Applications

Spread sheet applications – formulae, functions, data storing, statistical data analysis, generating charts/graphs etc, Presentation tools Microsoft Power Point, Open Office or similar tools, Web Search Google, Yahoo, advanced search techniques

Writing a research report

Developing an outline, Key elements, Objectives, Introduction, Experimental Work, Results and Discussion, Conclusion, Referencing and various formats for reference writing of books and

research papers. Prewriting considerations, Thesis writing, Formats of publications in Research Journals, Research Proposal writing.

References

1. Montgomery, Douglas C. (2007), “Design and Analysis of Experiments”, Wiley India
2. Montgomery, Douglas C. & Runger, George C. (2007), “Applied Statistics & Probability for Engineers” Wiley India
3. Kothari C.K. “Research Methodology - Methods and Techniques”, New Age International, New Delhi, 2004
4. Pannerselvam R., “Research Methodology”, Prentice Hall of India, New Delhi, 2004
5. Krishnaswamy, K.N., Sivakumar, AppaIyer and Mathiranjan M. (2006), “Management Resarach Methodology; Integration of Principles, Methods and Techniques”, Pearson Education, New Delhi
6. S.C. Gupta and V.K.Kapoor, “Fundamentals of Statistics”, Sultan Chand & Sons, New Delhi, 1999.
7. R Kirk, “Experimental Design”, 3rd ed.
8. Pedhajur E. J., “Multiple Regression in Behavioral Research”
9. Rummel R J., “Applied Factor Analysis”
10. Thorndyke R.M., “Correlation Procedures for Research”

509103: Advanced Separation Processes

Teaching Scheme
Lectures: 4 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 4

Objectives

1. To familiarize students with various advanced aspects of separation processes and the selection of separation processes.
2. To enable students to understand the principles and processes of adsorption, membrane separation and chromatography and to design an absorber or a membrane unit to achieve a specified separation.
3. To introduce them to new trends used in the separation technologies.

Introduction to Separation Processes

Review of conventional processes, recent advances in separation techniques based on size, surface properties, ionic properties and other special characteristics of substances, Process concept, Theory and equipment used in cross flow filtration, cross flow electro filtration, dual functional filter, Surface based solid - liquid separations involving a second liquid, Sirofloc filter.

Membrane Separations

Types and choice of membranes, Plate and frame, tubular, spiral wound and hollow fibre membrane reactors and their relative merits, Commercial, pilot plant and laboratory membranes permeators involving dialysis, reverse osmosis, Design aspects of Nanofiltration, Ultrafiltration, Microfiltration and Donnan dialysis, Design aspects of Pervaporation and Permeation techniques for liquids and gases, Ceramic Membranes.

Separation by Adsorption Techniques

Mechanism, Types and choice of adsorbents, adsorption techniques, HPLC, GPC, HPTLC techniques of analytical separation, Recent Advances and Process Economics of Analytical Separation., Reactive absorption for removal of hazardous gases like H_2S, SOx etc.

Ionic Separations

Controlling factors, Applications, Types of equipment employed for electrophoresis, Dielectrophoresis, Ion exchange chromatography and electro dialysis, Commercial Processes.

Other Techniques

Reactive separation processes - Reactive extraction and distillation , Separations involving Iyophilisation, Industrial viability and Examples, Zone melting, Adductive crystallization, Supercritical fluid extraction, Ultrasound and Microwave assisted extraction, Oil spill Management, Industrial effluent treatment by modern techniques, Foam Separation technique.

References

1. Lacey, R.E. and Loaeb S. - “Industrial Processing with Membranes", Wiley –Inter Science, New York, 1972.
2. King, C.J. " Separation Processes ", Tata McGraw - Hill Publishing Co., Ltd., 1982.
3. Schoew, H.M. - “New Chemical Engineering Separation Techniques", Interscience Publishers, 1972.
4. Roussel Ronald W. - “Handbook of Separation Process Technology", John Wiley, New York, 1987.
5. Kestory, R.E. - “Synthetic Polymeric Membranes ", Wiley, New York, 1987.
6. Osadar, Varid Nakagawa I - “Membrane Science and Technology ", Marcel Dekker 1992.

509104: Research Methodology

Teaching Scheme
Lectures: 4 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 4

Objectives:

1. To understand the process through which the researcher has to go through.
2. The course will help to reduce the mistakes one makes in the way of doing Research.
3. To improve one's built-in aptitude for research.

Introduction
Research methodology: Definition of scientific and technical research, Objectives of research Types of research, Various steps in research process, Problem formulation, Literature search and information management, Research plan, Mathematical tools for analysis, Developing a research question-choice of a problem, Literature review: surveying, synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research purposes, Ethics in research – APA Ethics code.

Quantitative methods for problem solving
Statistical modeling and analysis, Time series analysis probability distributions, Fundamentals of statistical analysis and inference, Multivariate methods, Concepts of correlation and regression, Fundamentals of time series analysis and spectral analysis, Error analysis, Applications of spectral analysis, Evaluation of results.

Design of Experiments:
a) Objectives, strategies, Factorial experimental design, Designing engineering experiments, basic principles - replication, randomization, blocking, Guidelines for design of experiments.
b) Single Factor Experiment: Hypothesis testing, Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effects model, Estimation of variance components, Model adequacy checking.
c) Two factor Factorial Design, Basic definitions and principles, main effect and interaction, response surface and contour plots, General arrangement for a two - factor factorial design; Models - Effects, means and regression, Hypothesis testing.

Tabular and graphical description of data
Tables and graphs of frequency data of one variable, Tables and graphs that show the relationship between two variables, Relation between frequency distributions and other graphs, Preparing data for analysis.

Soft Computing
Computer and its role in research, Use of statistical soft ware SPSS, GRETL etc. in research. Introduction to evolutionary algorithms - Fundamentals of Genetic algorithms, Simulated Annealing, Neural Network based optimization, Optimization of fuzzy systems.

Structure and Components of Research Report and Presentation
Types of report, Layout of research report, Mechanism of writing a research report, Referencing in academic writing, Research report preparation: abstract, description of instruments and materials, experimental procedures, description of results, discussion of results, conclusions. Citation methods: Foot Note, Text Note, End Note and Bibliography. Writing a blogSpot, Article, Essay, Research Paper, Research Project, Legislation Drafting, Judgment Writing, Thesis, Dissertation, Book, Reviews - Book Review; Case Review. Presentation: Scientific and technical presentations, Planning the presentation (formulation of objectives, analysis of audience), Preparing the presentation, Presentation delivery techniques, Organizing the presentation forum.

Introduction to Intellectual Property Rights: Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. Recent Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Softwares etc. Traditional knowledge Case Studies, IPR and IITs.

Exercise: *One Minor Research Proposal preparation in a proper format following above guidelines should be made compulsory to every student as a compulsory Assignment.*

Text Books

1. C.R. Kothari, Research Methodology Methods and Techniques, 2/e, Vishwa Prakashan, 2006
2. Donald H.McBurney, Research Methods, 5th Edition, Thomson Learning, ISBN:81-315-0047-0,2006

Reference Books

1. Donald R. Cooper, Pamela S. Schindler, Business Research Methods, 8/e, Tata McGraw-Hill Co. Ltd., 2006.
2. Fuzzy Logic with Engg Applications, Timothy J.Ross, Wiley Publications, 2nd Ed[d]
3. Simulated Annealing: Theory and Applications (Mathematics and Its Applications, by P.J. van Laarhoven & E.H. Aarts[e]
4. Genetic Algorithms in Search, Optimization, and Machine Learning by David E. Goldberg.
5. Beach,D.P. and T.K.E. Alvager, 1992, Handbook for Scientific and Technical Research, Prentice-Hall, Englewood Cliffs, N.J.

6. Day,R.A., 1988, How to Write and Published Scientific Paper, Oryx Press, Phoenix, AZ, 1988
7. Hautala, P.C., 1989, Technical and Managerial Communication, Univ. of Idaho Press, Moscow, ID
8. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007
9. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New”

509105 [Elective – I] (a): Process Design and Synthesis

Teaching Scheme
Lectures: 5 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 5

Objectives:

1. To understand the systematic approaches for the development of conceptual chemical process designs
2. To learn the advances in problem formulation and software capabilities which offer the promise of a new generation of practical process synthesis techniques based directly on structural optimization.
3. Learning chemical process synthesis, analysis, and optimization principles
4. Product design and development procedure and Process life cycle assessment.

Introduction

Introduction to fundamental concepts and principles of process synthesis and design and use of flow sheet simulators to assist process design. Process Flow sheet Models: An Introduction to Design, Chemical process synthesis, analysis and optimization. Introduction to commercial process design software such as HYSYS, Aspen plus etc., Chemical Process (reactor, heat exchanger, distillation etc) analysis using commercial software

Product design and developments

Process engineering economics and project evaluation Life Cycle Assessments of process: From design to product development, Project costing and performance analysis, Environmental concerns, Green engineering, Engineering ethics, Health and safety.

Reactor Networks

Geometry of mixing and basic reactor types, The Attainable Region (AR) approach, AR in higher dimensions & for other processes, Reactive Separation processes, Fundamental behavior and problems, Separation through reactions. Reactive Residue Curve Maps

Synthesis of Separation Trains

Criteria for selection of separation methods, select ion of equipment**:** Absorption, Liquid-liquid extraction Membrane separation, adsorption, leaching, drying, crystallization

Distillation

Ideal distillation - Column and sequence fundamentals, Sharp splits & sequencing Phase diagrams for 2, 3 and 4 components, Feasibility and vapor ow rates for single columns, Residue curve basics, **Non-ideal Distillation -** Azeotropic systems; detecting binary azeotropes, Residue curve maps for azeotropic systems, Topological analysis, Feasibility for single azeotropic columns ,Binary VLLE and pressure-swing separation, Non-ideal distillation synthesis. Equipment sequencing: VLE + VLLE, Detailed Residue Curve Maps, Residue curve maps: Interior structure

Heat Exchanger Network Synthesis

Introduction & problem highlights, HENS basics & graphics, The pinch point approach, Performance targets, trade-off & utilities, Heat & power integration, HENS as mathematical programming

References

1. Douglas, J. "Conceptual Design of Chemical Processes", New York, NY: McGraw-Hill Science/Engineering/Math, 1988. ISBN: 0070177627.
2. Seider, W. D., J. D. Seader, and D. R. Lewin. "Product and Process Design Principles: Synthesis, Analysis, and Evaluation",. 2nd ed. New York, NY: Wiley, 2004. ISBN: 0471216631.
3. Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwitz., "Analysis, Synthesis, and Design of Chemical Processes", 2nd Edition, 2002, Prentice Hall ISBN-10: 0-13-064792-6
4. Biegler L.T., Grossmann I.E. and Westerberg A.W., "Systematic Methods of Chemical Process Design", Prentice Hall, 1997.

509105 [Elective – I] (b): Application of Nanotechnology in Chemical Engineering

Teaching Scheme
Lectures: 5 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 5

Objectives

1. To understand the fundamentals of the preparation and properties of nanomaterials from a chemical engineering perspective.
2. To gain knowledge of structure, properties, manufacturing, and applications of various nanomaterials and characterization methods in nanotechnology
3. To give a survey of the key processes, principles, and techniques used to build novel nanomaterials and assemblies of nanomaterials

Introduction

Introduction to nanotechnology, Feynman's Vision-There's Plenty of Room at the Bottom, Classification of nanostructures, Nanoscale architecture, Chemical interactions at nanoscale, Types of carbon based nanomaterials, Synthesis of fullerenes, Graphene, Carbon nanotubes, Functionalization of carbon nanotubes, One, two and multidimensional structures, Crystallography.

Approaches to Synthesis of Nanoscale Materials

Top down approach, Bottom up approach Bottom-up vs. top-down fabrication; Top-down: Atomization, Sol gel technique, Arc discharge, Laser ablation, RF sputtering; Bottom-up: Chemical Vapor Deposition (CVD), Metal Oxide Chemical Vapor Deposition (MOCVD), Atomic layer deposition (ALD), Molecular beam Molecular self-assembly; Ultrasound assisted, microwave assisted, Mini, micro and nanoemulsion. Wet grinding method, Spray pyrolysis, Ultrasound assisted pyrolysis, atomization techniques. Surfactant based synthesis procedures, Types of molecular modeling methods.

Characterization of Nanoscale Structures and Surfaces

Size, shape, crystallinity, topology, chemistry analysis using X-ray imaging, Transmission Electron Microscopy, HRTEM, Scanning Electron Microscopy, SPM, AFM, STM, PSD, Zeta potential, DSC and TGA.

Semiconductors and Quantum dots

Intrinsic semiconductors, Extrinsic semiconductors, Review of classical mechanics, de Broglie's hypothesis, Heisenberg uncertainty principle Pauli exclusion principle Schrödinger's equation Properties of the wave function, Applications: quantum well, wire, dot, Quantum cryptography

Polymer-based and Polymer-filled Nanocomposites

Nanoscale Fillers, Nanofiber or Nanotube Fillers, Plate-like Nanofillers, Equi-axed Nanoparticle Fillers, Inorganic Filler Polymer Interfaces, Processing of Polymer Nanocomposites, Nanotube/Polymer Composites, Layered Filler Polymer Composite Processing, Nanoparticle/Polymer Composite Processing: Direct Mixing, Solution Mixing, In-Situ Polymerization, In-Situ Particle Processing, In-Situ Particle Processing Metal/Polymer Nanocomposites, Properties of nanocomposites.

Applications to Safety, Environment and Others

Chemical and Biosensors- Classification and Main Parameters of Chemical and Biosensors, Nanostructured Materials for Sensing, Waste Water Treatment, Nanobiotechnology, Drug Delivery, Nanocoatings, Self cleaning Materials, Hydrophobic Nanoparticles, Photocatalysts, Biological nanomaterials, Nanoelectronics, Nanomachines & nanodevices, Societal, Health and Environmental Impacts.

References

1. Louis Hornyak G., Dutta Joydeep, Tibbals Harry F. and Rao Anil K., "Introduction to Nanoscience", (CRC Press of Taylor and Francis Group LLC), May 2008, 856pp, ISBN-13: 978142004805
2. Ajayan P. M., Schadler L. S., Braun P. V., "Nanocomposite Science and Technology", Edited by WILEY-VCH Verlag GmbH Co. KGaA, Weinheim ISBN: 3-527-30359-6, 2003.
3. Kelsall Robert W., Hamley Ian W., Geoghegan Mark, "Nanoscale Science and Technology", John Wiley & Sons, Ltd, 2006.
4. Kal Ranganathan Sharma, "Nanostructuring Operations in Nanoscale Science and Engineering", McGraw-Hill Companies, Inc. ISBN: 978-0-07-162609-5, 2010.
5. "Organic and inorganic nanostructures".-(Artech House MEMS series), Nabok, Alexei, ISBN 1-58053-818-5, 2005.

509105 [Elective – I] (c): Fluidization Engineering

Teaching Scheme
Lectures: 5 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 5

Objectives

1. To study the phenomenon of fluidization with industrial processing objective
2. To study the various regimes of fluidization and their mapping
3. To study the design of equipments based on fluidization technique

Introduction

Phenomenon of fluidization, behavior of fluidized bed, contacting modes, advantages and disadvantages of fluidization, fluidization quality, selection of contacting mode

Industrial applications

Beds for Industrial applications, coal gasification, synthesis reactions, physical operations, cracking of hydrocarbons

Mapping of fluidization regimes

Characterization of particles, minimum fluidization velocity, pressure drop versus velocity diagram, The Geldart classification of solids, fluidization with carryover of particles, terminal velocity of particles, distributor types, gas entry region of bed, pressure drop requirements, design of gas distributor, power consumption

Bubbles in dense bed

Davidson model for gas flow, the wake region and movement of solids at bubbles, coalescence and splitting of bubbles, bubble formation above a distributor, slug flow

Bubbling fluidized beds

Emulsion movement, estimation of bed properties, bubble rise velocity, scale up aspects, flow models, two phase model, K-L model

Entrainment and elutriation

Freeboard behavior, gas outlet, entrainment from tall vessel, freeboard entrainment model, high velocity fluidization, pressure drop in turbulent and fast fluidization

Solids movement

Vertical and horizontal movement of solids, Dispersion model, large solids in beds of smaller particles, staging of fluidized beds

Gas dispersion

Gas dispersion in beds, gas interchange between bubble and emulsion, estimation of gas interchange coefficient

Design of fluidized bed reactors

Design of catalytic reactors, pilot plant reactors, information for design, bench scale reactors, design decisions, deactivating catalysts, Design of noncatalytic reactors, kinetic models for conversion of solids, models for shrinking particles, conversion of solids of unchanging size

References

1. Levenspiel O. and Kunnii D., “Fluidization Engineering”, John Wiley, 1972
2. Liang-Shih Fan, “Gas-Liquid-Solid Fluidization Engineering”, Butterworths, 1989

509105 [Elective – I] (d): Computer Aided Design

Teaching Scheme
Lectures: 5 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 5

Objectives:

1. To understand importance and applications of CAD in the field of chemical engineering
2. To understand the basic structure and components of CAD software
3. To understand the underlying thermodynamic and physical principles
4. To give insight into the approaches used in the simulation of flow sheets
5. To understand flow charts, computer languages and numerical methods used for writing algorithms

Introduction

Introduction to CAD, Scope and applications in chemical Engineering, Mathematical methods used in flow sheeting and simulation, Introduction to solution methods for linear and non-linear algebraic equations, solving one equation one unknown, solution methods for linear and nonlinear equations , general approach for solving sets of differential equations, solving sets of sparse non-linear equations.

Properties Estimation

Physical properties of compounds, Thermodynamic properties of gases and binary mixtures, Viscosity, Vapour pressure, Latent heat, Bubble point and drew point calculation, phase equilidria, Vapour-liquid equilibria, Liquid phase activity coefficients, K-values, Liquid phase activity coefficients, K-values, Liquid-Liquid equilidria, Gas solutions.

Equipment Design

Computer aided design of reactors evaporators adsorption columns. Distillation columns (specific attention to multi components systems. Heat exchangers)

Flow Charts And Numerical Recipes In C

Linear and nonlinear equations, Ordinary and partial differential equations.

Computer Aided Flow Sheet Synthesis

Computerized physical property systems – physical property calculations, degrees of freedom in process design, degrees of freedom for a unit, degrees of freedom in a flow sheet, steady state flow sheeting and process design, approach to flow sheeting systems, introduction to sequential

modular approach, simultaneous modular approach and equation solving approach, sequential modular approach to flow sheeting, examples. Tear streams, convergence of tear streams, partitioning and tearing of a flow sheet, partitioning and precedence ordering, tearing a group of units.Flow sheeting by equation solving methods based on tearing

Dynamic Simulation

Dynamic simulation of stirred tanks system with heating Multi component system, Reactors, Absorption and distillation columns, Application of orthogonal collocation and weighted residuals techniques in heat and mass transfer systems, Introduction to special software for steady and dynamic simulation of Chemical engineering systems. Introduction to various commercial design software and optimizers used in field of chemical engineering.

References

1. Douglas James M., “Conceptual design of Chemical Processes", McGraw -Hill Book Company, New York, 1988
2. Remirez, W.F. - " Computational methods for Process Simulations ", Butterworths, New York, 1989
3. Sinnott R.K. "Chemical Engineering”, Volume 6, Pergamon Press, New York, 1989
4. Westerberg A.W., et al, “Process Flow Sheeting”, Cambridge University Press
5. Biegler Lorenz T, et al, “Systematic method of Chemical Process Design”, Prentice Hall
6. Crowe C.M., et al, “Chemical Plant Simulation-An Introduction to Computer Aided Steady State Analysis”, Prentice Hall
7. Anil Kumar, “Chemical Process Synthesis and Engineering Design”,TMH,1981

509106: Laboratory Practice – I

Teaching Scheme
Lectures: 4 Hrs/Week

Examination Scheme
Term Work: 50 Marks
Oral/Presentation: 50 Marks
Credits: 4

Objectives

1. To learn Operation of Analytical Instruments
2. To study Development of HEN, Column series
3. To understand Linear and non linear regression
4. To learn Error analysis methods
5. To understand Waste Water Analysis

Important: The students are required to preserve the samples, compounded materials, test specimens, tested specimens, 'original' result papers such as charts, graphs, data sheets soft copies of modeling and analysis etc. and should be submitted alongwith the journal for evaluation, failing which the TW will not be granted.

Lab Practice I :
The laboratory work will be based on completion of assignments confined to the courses of that semester.

The assessment will be done jointly by the pair of internal and external examiners along with the oral examination of the same.

Each student should perform at least 08 experiments from the following list and submit the journal which will form the term-work for the subject.

1. Analysis of multi-component mixtures using HPLC/GC.
2. Analysis of metal salt solutions using AAS.
3. Parameter Identification of Thermodynamic Models
4. Heat Exchanger Network Development for given process
5. Development of Distillation Column Sequencing for multi component separation using process simulators.
6. Solving various types of process design problems involving material and energy balances, mass heat and momentum transfer operations in reaction engineering and thermodynamics using soft wares like Excel, PolyMath etc.
7. Statistical Analysis of Linear and Nonlinear Correlation of the Arrhenius Equation Constants
8. Error Analysis of Linearization Methods in Regression of Data for the Van-Laar and Margules Equations.
9. Spectrophotometric analysis of impurities of water.

10. Determination of BOD, COD from waste water.
11. Determination of TDS and DO from waste water.
12. Characteristics of Fluidized bed column.
13. Separation of mixture using RO module.

Important instructions:

1. **Each experiment is to be supported with compulsory assignment which should be the part of the journal.**
2. **Assignments / 'theory practicals' are to be strictly avoided as laboratory practice experiments.**

SEMESTER II

509107: Advanced Transport Phenomena

Teaching Scheme
Lectures: 4 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 4

Objectives

1. To familiarize the student with basic concepts of transport phenomena and brief review of mathematics
2. To enable students to understand the equations of change for isothermal flow and for non-isothermal flow
3. To introduce them details of equations of change for multi component systems
4. To give them insight into properties of two-dimensional flows and aspects of dimensional analysis

Introduction

Basic concept and review of classical flow problems using shell balances.

Review of mathematics

Scalar, Vectors, Tensors, divergence partial derivative, substantial derivative, total derivative,

The equations of change for isothermal flow

Equations of continuity, equation of motion, the equation of mechanical energy, non-Newtonian fluids. Newton's low of viscosity, Non Newtonian fluids, Rheological behavior of non-newtonian fluid

The equations of change for non-isothermal flow

Equations of energy, the energy equation in curvilinear coordinates, use of equations of change to set up steady state heat transfer for problems.
Basic concept and review of classical flow problems using shell balances.

The equations of change for multi component systems

The equations of continuity for a binary mixture, the equation of continuity of A in curvilinear coordinates, the multicomponent equations of change in terms of the flows, the multi component fluxes in terms of the transport properties, use of equations of change to setup diffusion problems.

Macroscopic Balances for Multicomponent Systems Mass, momentum and energy Balances

Velocity, temperature and concentration distributions with more than one independent variables, unsteady flow, stream function, potential flow, boundary layer theory, steady state two dimensional flow for momentum, heat and mass.

Two-dimensional flows

Stream function. Limiting cases: Creeping flow, Inviscid flow, Boundary layer theory, Turbulent flow: Transition to turbulence, Turbulence models.

Introduction, fluctuations and time smoothened equations for velocity, temperature and concentration, time smoothing of equation of change , equation of energy, equation of continuity of A, Reynolds stresses. Turbulence in pipe flow, stirred vessels, fluidized beds and bubble columns.

Dimensional Analysis

Introduction, momentum, heat and mass transfer, Analogy between heat, mass and momentum transfer, Reynolds analogy, Chilton & Colburn J factor analogy

References

1. Bird R.B., Stewart W.E. and Lightfoot E.N., “Transport Phenomena”, Wiley international Edition, New York 2002
2. Batchelor G.K., “An Introduction to Fluid Dynamics”, Cambridge University Press, Cambridge, 1967
3. Salterry J.C., “Momentum Energy and Mass Transfer in Continua”, Robert E. Kridger publishing company. New York 1981
4. Welty James R., Wicks Charles E. and Wilson Robert E., “Fundamentals of Momentum, Heat and Mass Transfer”, , John Wiley & sons, Inc New York
5. Davis J.T., “Turbulence Phenomena”

509108: Advanced Process Control

Teaching Scheme	**Examination Scheme**
Lectures: 4 Hrs/Week	**In Semester Assessment: 50 Marks**
	End Semester Assessment: 50 Marks
	Credits: 4

Objectives

1. To establish control-relevant process model using first-principle, and empirical approaches
2. To design complex control structures for processes with difficult dynamics
3. To analyze and design multi-loop (MIMO) control systems
4. To understand discrete-time control systems
5. Applications of advanced process control systems
6. Development of plant-wide control system

Control-relevant Process Modeling and Process Identification

Introduction, process model forms(state-space, transform-domain, frequency-response, impulse-response, transfer function models for continuous-time and discrete-time systems), formulating dynamic process models based on fundamental principles (theoretical modeling). Degrees of freedom and process control, linearization of non-linear process models.

Process Identification (Empirical Process Modeling): Principles of empirical modeling, step, impulse, and frequency- response methods of identification.

Regulatory Control Systems

Conventional (classical) single-loop feedback control systems: Servo and regulatory response characteristics, stability analysis methods, PID controller, PID controller design (tuning) methods.

Enhancements to single-loop regulatory control (complex control structures)**:** Design of Cascade control, feed forward control, ratio control, split-range control, override control, anti-reset windup.

Controller design for processes with difficult dynamics**:** Controller design for time-delay systems, inverse-response systems, open-loop unstable systems.

Multivariable Regulatory Control Systems

Introduction, multiple single-loop control systems, interaction analysis and loop pairing using relative gain array (RGA) method, decoupling control, singular value decomposition.

Discrete-time Control Systems (Digital Computer Control Systems)

Introduction, sampling and reconstruction of continuous-time signals (analog signals), Z-transform, discrete-time process models (ARMAX, ARX MA models), PRBS signal, empirical model identification using least-square estimation method, real-time identification, recursive adaptive algorithm for extended least-squares, dynamic analysis of discrete-time systems. Computer implementation of PID- controller, set-point weighted PID-controller, pole placement, digital controller design.

Advanced Process Control Systems (APC)

Model-based control systems (DS, GMC, IMC), single- and multivariable model-predictive control (MPC), non-linear MPC (NLMPC), batch process control systems.

Plant-wide Control Systems

Introduction, interaction of plant design and control system design, hypothetical plant for plant-wide control studies, systematic procedure for plant-wide control, degrees of freedom analysis, internal feedback of material and energy, steady-state and transient behavior flow-sheet controllability analysis, design of plant wide control systems, effect of control structure on closed-loop performance.

References

1. Seborg, Edgar, Mellichamp, “Process Dynamics and Control”, Wiley student edition
2. Bequette, “Process Control”, Prentice Hall Publications
3. Stephanopoulos, “Chemical Process Control”, Prentice Hall Publications.
4. Marlin, “Process Control”, Mc Graw Hill Publication.
5. Ogunike, Ray, “Process Dynamics, Modelling and Simulation”, Mc Graw Hill Publication
6. Chidambaram M., “Computer Control of Processes”, Alpha Science.
7. Erckson K.T., Hedrick J.L., “ Plantwide Process Control”, John Wiley &Sons, Inc.
8. Kulkarni A.P., “Process Instrumentation and Control”, Nirali publications, Pune

509109: Advanced Reaction Engineering

Teaching Scheme
Lectures: 4 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 4

Objectives

1. To learn the heterogeneous catalyzed reactions and the models involved in reactor design
2. To study mass and heat transfer mechanisms in the different reactors
3. To appreciate the importance of both external and internal transport effects in gas-solid and liquid-solid systems
4. To design isothermal and non-isothermal reactors for heterogeneous catalytic reactions

Kinetics of Heterogeneous Reactions

Catalytic Reactions, Rate controlling steps, Langmuir - Hinshelwood model, Rideal - Eiley Mechanism, Steady State approximation, Noncatalytic fluid - solid reactions, Shrinking and unreacted core model.

Population Balance Models

Mixing concepts, Residence Time Distribution, Response measurements, Segregated flow model, Dispersion model, Series of stirred tanks model, Recycle reactor model, Analysis of non-ideal reactors.

External Diffusion Effects in Heterogeneous Reactions

Mass and heat Transfer coefficients in packed beds,Quantitative treatment of external transport effects, Modelling diffusion with and without reaction.

Internal Transport Processes in Porous Catalysts

Intrapellet mass and heat transfer, Evaluation of effectiveness factor, mass and heat transfer with reaction.

Design of Heterogeneous Catalytic Reactors

Isothermal and adiabatic fixed bed reactors, Non-isothermal and non-adiabatic fixed bed reactors. Introduction to multiphase reactor design, Two phase fluidized bed model, slurry reactor model, Trickle bed reactor model.

References

1. Smith J.M. - "Chemical Engineering Kinetics ", McGraw-Hill, 1981
2. Bischoff and Fromment - " Chemical Reactor Design and Analysis ", Addision – Wesley, 1982
3. Fogler H.S - " Elements of Chemical Reaction Engineering ", Prentice - Hall 1986

509110 [Elective – II] (a): Industrial Pollution Control

Teaching Scheme
Lectures: 5 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 5

Objectives

1. To understand the importance of industrial pollution and its abatement
2. To study the underlying principles of industrial pollution control
3. To acquaint the students with case studies
4. Student should be able to design complete treatment system

Air Pollutant Abatement

Air pollutants, dynamics, plume behavior, dispersion of air pollutants, dynamics, plume behavior, dispersion of air pollutants, atmospheric dispersion equation and its solutions, Gaussian plume models. Design concepts for pollution abatement systems for particulates and gases. Such as gravity chambers, cyclone separators, filters, electrostatic precipitators, condensation, adsorption and absorption, thermal oxidation and biological processes. **Case studies on air pollution control in Chemical Industries.**

Waster water treatment processes

Design concepts for primary treatment, grid chambers and primary sedimentation basins, biological treatment Bacterial population dynamics, kinetics of biological growth and its applications to biological treatment, process design relationships and analysis, determination of kinetic coefficients, activated sludge process. Design, trickling filter design considerations, advanced treatment processes. Study of environment pollution from process industries and their abatement. Fertilizer, paper and pulp, inorganic acids, petroleum and petrochemicals, recovery of materials from process effluents. Case studies on water pollution control in Chemical Industries.

Solid waste and Hazardous waste management

Sanitary land fill design, Hazardous waste classification and rules, management strategies, Nuclear waste disposal Treatment methods – component separation, chemical and biological treatment, incineration, solidification and stabilization, and disposal methods**. Latest Trends in solid waste management.**

References

1. Rao C.S., “Environmental Pollution Control Engineering”, 2nd edition

2. Mahajan S.P., “Pollution Control in Process Industries”.
3. Nemerow N.L., “Liquid waste of industry- theories, Practices and Treatment”, Addison Wesley, New York, 1971
4. Weber W.J., “Physico-Chemical Processes for water quality control”, Wiley Interscience New York, 1969
5. Strauss W., “Industrial Gas Cleaning”, Pergamon, London, 1975
6. Stern A.C., “Air pollution”, Volumes I to VI, academic Press, New York, 1968

509110 [Elective – II] (b): Process Optimization

Teaching Scheme
Lectures: 5 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 5

Objectives

1. To study Formulation of optimization problems and main solution techniques
2. To formulate algorithms of numerical methods of optimization
3. To understand the impact of optimization in areas like process design, process control, etc.
4. To provide an overview of state-of-the-art optimization techniques in chemical Engineering

Introduction

Introduction to process optimization, formulation of various process optimization problems (Nature and scope of optimization, general procedure for solving optimization problems) and their classification, Basic concepts of optimization: Continuity of function, unimodal and multimodal function, convex and concave function, necessary and sufficient conditions for stationary points.

Optimization of One Dimensional Functions

Unconstrained multivariable optimization- direct search methods, Bracketing methods: Exhaustive search method, Bounding phase method, Region elimination methods: Interval halving method, Fibonacci search method, Golden section search method. Point-Estimation method: Successive quadratic estimation method.

Indirect first order and second order method. Gradient-based methods: Newton-Raphson method, Bisection method, Secant method, Cubic search method. Root-finding using optimization techniques

Multivariable Optimization Algorithms

Optimality criteria, Unidirectional search, direct search methods: Evolutionary optimization method, simplex search method, Powell's conjugate direction method. Gradient-based methods: Cauchy's (steepest descent) method, Newton's method.

Constrained Optimization Algorithms

Basic concepts, simplex method, revised simplex method, Kuhn-Tucker conditions, Transformation methods: Penalty function method, method of multipliers, Sensitivity analysis, Direct search for constraint minimization: Variable elimination method, complex search method.

Non linear programming

The Lagrange multiplier method, quadratic programming, reduced gradient method, random search method, successive linear and quadratic programming, optimization of staged and discrete processes, optimization of dynamic processes.

Specialized & Non-traditional Algorithms

Integer Programming: Penalty function method, Nontraditional Optimization Algorithms: Genetic Algorithms: Working principles, differences between GAs and traditional methods, similarities between GAs and traditional methods, GAs for constrained optimization, other GA operators, Real-coded GAs, Advaced GAs.

References

1. Deb K. “Optimization for engineering design: Algorithms and Examples”, Prentice Hall of India, New Delhi, 1995
2. Edgar T. F., Himmelblau D. M. and Ladson, “Optimization of Chemical Processes”, 2nd Ed., McGraw Hill, New York, 2003
3. Beveridge G. S., Schechter R. S. “Optimization Theory and Practice”, McGraw Hill, New York, 1970
4. Rekllitis G. V., Ravindran A. And Ragdell K. M., “Engineering Optimization- Methods and Applications”, John Wiley, New York, 1983
5. Rao S.S., “Engineering Optimization: Theory and Applications”, 4th Ed., John Wiley and Sons, New Jersey, 2009

509110 [Elective – II] (c): Chemoinformatics

Teaching Scheme
Lectures: 5 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 5

Objectives

1. To give students a concept of Chemo-informatics related to chemical structure databases and database search methods
2. To understand the quantum methods and models involved in drug discovery and targeted drug delivery
3. To study the application of Chemical Libraries, Virtual Screening, Prediction of Pharmacological Properties

Chemo-informatics

Introduction, scope and application, Basics of Chemo-informatics, Current Chemo-informatics resources for synthetic polymers, pigments. Primary, secondary and tertiary sources of chemical information, Databases: Chemical Structure Databases (PubChem, Binding database, Drugbank), Database search methods:chemical indexing, proximity searching, 2D and 3D structure and substructure searching. Drawing the Chemical Structure: 2D & 3D drawing tools (ACD Chemsketch) Structure optimization.

Introduction to quantum methods

Combinatorial chemistry (library design, synthesis and deconvolution), spectroscopic methods and analytical techniques,Representation of Molecules and Chemical Reactions:Different types of Notations, SMILES Coding, Structure of Mol files and Sd files (Molecular converter, SMILES Translator).

Analysis and use of chemical reaction information

Chemical property information, spectroscopic information, analytical chemistry information, chemical safety information, Drug Designing: Prediction of Properties of Compounds, QSAR Data Analysis, Structure-Activity Relationships, Electronic properties, Lead Identification, Molecular Descriptor Analysis.

Target Identification

Molecular Modeling and Structure Elucidation: Homology Modelling (Modeller 9v7, PROCHECK), Visualization and validation of the Molecule (Rasmol, Pymol Discovery studio),

Applications of Chemoinformatics in Drug Research - Chemical Libraries, Virtual Screening, Prediction of Pharmacological Properties.

Drug Discovery

Structure based drug designing, Docking Studies (Target Selection, Active site analysis, Ligand preparation and conformational analysis, Rigid and flexible docking, Structure based design of lead compounds, Library docking), Pharmacophore - Based Drug Design, Pharmacophore Modeling (Identification of pharmacophore features, Building 2D/3D pharmacophore hypothesis), Toxicity Analysis-Pharmacological Properties (Absorption, Distribution and Toxicity), Global Properties (Oral Bioavailability and Drug-Likeness) (ADME, OSIRIS, and MOLINSPIRATION)

References

1. Bajorath J (2004), "Chemoinformatics: Concepts, Methods and Tools for Drug Discovery" Humana Press
2. Leach A, Gillet V, "An Introduction to Chemoinformatics" Revised edition, Springer
3. Gasteiger J. Engel T. "A textbook of Chemoinformatics" Wiley- VCH GmbH & Co. KGaA
4. Bunin B. Siesel B. Guillermo M. "Chemoinformatics: Theory, Practice & Products", Springer
5. Lavine B. (2005), "Chemometrics and Chemoinformatics", American Chemical Society
6. Casteiger J. and Engel T (2003) "Chemoinformatics" Wiley-VCH
7. Bunin Barry A. Siesel Brian, Morales Guillermo,Bajorath Jürgen. Chemoinformatics: Theory, Practice, & Products Publisher:New York, Springer. 2006.
8. Leach Andrew R., Valerie J. Gillet, "An introduction to Chemoinformatics", Publisher: Kluwer academic, 2003. ISBN: 1402013477
9. Gasteiger Johann, Handbook of Chemoinformatics: From Data to Knowledge (4 Volumes), 2003. Publisher: Wiley-VCH.

509110 [Elective – II] (d): Cleaner Production

Teaching Scheme
Lectures: 5 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 5

Objectives

1. To give student an understanding about the concept of cleaner production
2. To understand in detail the methodologies involved
3. Financial evaluation of cleaner production technologies
4. To study the practical applications of cleaner production technologies

Introduction

Cleaner production definition: Evaluation of cleaner production, Cleaner production network, Area covered by cleaner production (what is not cleaner production?).Difference between cleaner production and other methods, End of the pipe treatment to curb pollution, prerequisites of cleaner production.

Cleaner production technique

Waste reduction at source, (a) Good house keeping, (b) Process changes: change in raw material, batter process, control, equipment modification and technology changes, Recycling: on site recovery and reuse creation of useful byproducts, Product modification.

Cleaner production methodology

Making team for cleaner production, Analyzing process steps, Generating C.P opportunities Selection of C.P solution, Implementing C.P solution

Energy audit

Energy audit related to cleaner production, Energy audit's need and scope, Types of energy audit. Preliminary or walk through energy audit. Detailed energy audit, Methodology of energy audit, Energy balance and identifying the energy conservation opportunities.

Financial analysis of cleaner production

Gathering base line information, Determining the capital or investment cost, Establishing lifetime of equipment and annual depreciation, Determine revenue implication of the project. Estimating change in operating cost, Calculating incremental cash flow, Assessing project's viability.

Cleaner Production Application

C.P in chemical process industry, Practical ways & means to save material loss in loading/unloading and unit operations equipment like distillation column, drying and other equipments like heat exchanger, vacuum unit, conveying, etc. Practical ways & means for energy saving in industries. Case Studies of cleaner production.

References

1. "Cleaner Production Worldwide", 1993, United Nations Environment Programme, Industry and Environment, Paris, France, 1993
2. "Cleaner Production: Training Resource Package", UNEP IE, Paris, 1996
3. "Clean Technology for manufacture of Specialty Chemicals", Editor-W. Hoyle and M. Lancaster, Royal Society of Chemistry, U.K
4. Randall Paul M, "Engineers Guide to Cleaner Production Technologies".
5. Ahluvalia V. K., "Green Chemistry: Environmentally Benign Reactions".
6. Sanders R.E., "Chemical Process Safety: Learning from case Histories", Oxford Butter Worth Publication
7. "Training Manual Package" by NCPC

509111: Lab Practice II

Teaching Scheme
Lectures: 4 Hrs/Week

Examination Scheme
Term Work: 50 Marks
Oral/Presentation: 50 Marks
Credits: 4

Objectives

1. To learn Process Modeling and Simulation of Chemical operations and processes
2. To understand Dynamic Behavior of processes.
3. To understand Close loop control of processes.
4. To learn Dynamic simulation of chemical processes.
5. To get acquainted with Controllability Analysis of chemical processes.

Important: The students are required to preserve the samples, compounded materials, test specimens, tested specimens, 'original' result papers such as charts, graphs, data sheets soft copies of modeling and analysis etc. and should be submitted alongwith the journal for evaluation failing which the TW will not be granted.

Lab Practice II:
The laboratory work will be based on completion of assignments confined to the courses of that semester.

The assessment will be done jointly by the pair of internal and external examiners along with the oral examination of the same.

Each student should perform at least 08 experiments from the following list and submit the journal which will form the term-work for the subject.

1. Simulation of Non Isothermal CSTR.
2. Simulation of Batch Reactor.
3. Dynamic modeling of Binary Distillation column control using Matlab/Simulink
4. Dynamic modeling of Non Isothermal CSTR using Matlab/ Simulink
5. Dynamic modeling of Single Component Vaporizer using Matlab/ Simulink
6. Computer Aided Process design of reactors with or without heat transfer.
7. Computer Aided Process design Multi-component Distillation columns.
8. Steady state flow sheeting of Processes with recycles /Purge/Bypass etc.
9. Study of dynamic behavior of simple systems such as tank in series, double effect Evaporators, etc.
10. Loop pairing and interaction analysis of process variables using relative gain analysis method (RGA).
11. Dynamic simulation of Simple processes with controllers.
12. Dynamic simulation & controllability analysis of Binary distillation column.

Important instructions:

1. **Each experiment is to be supported with compulsory assignment which should be the part of the journal.**
2. **Assignments / 'theory practicals' are to be strictly avoided as laboratory practice experiments.**

509112: Seminar – I

Teaching Scheme	**Examination Scheme**
Lectures: 4 Hrs/Week	**Term Work: 50 Marks**
	Oral/Presentation: 50 Marks
	Credits: 4

Objectives:

1. To make the student aware of recent advances in the areas of chemical engineering.
2. To train the student to carry out literature survey to collect the technical information.
3. To develop the oral and written presentation skills amongst the students.
4. To develop technical writing skills through report preparation.

SEMINAR:

The student shall deliver the seminar on a topic approved by authorities.

Seminar I : Shall be on state of the art topic of student's own choice approved by an authority. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute.

Important instructions:

1. **Seminar is to be presented using power point presentation.**
2. **Seminar report is to be submitted in soft and hard copy to the department.**
3. **The attendance record (signatures) of the audience must be attached and maintained with the report, clearly mentioning "Attendance Record for the ME Seminar Presentation" with Date and Topic of presentation.**

SEMESTER III

509113: Process Modeling and Simulation

Teaching Scheme
Lectures: 4 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 4

Objectives

1. To understand the underlying principles of modeling in steady state and dynamic behaviour of chemical engineering systems
2. To understand the underlying mathematical problems, and some awareness of the available analytical and numerical solution techniques
3. To understand the general theory of modeling and simulation of a chemical process systems

Basic Modelling

Introduction to modeling, Application and scope of coverage, Formulation

Modelling Of Heat, Mass And Momentum Transfer Operations

Review of heat, mass and momentum transfer operations, Modeling of exchangers, Evaporators, Absorption columns, Extractors, Distillation columns, Membrane processes.

Model Discrimination And Parameter Estimation

Rate equations, Linear and non-linear regression analysis, Design of experiments, Factorial, Central, fractional design, Evolutionary operation techniques, Case studies.

Optimization Techniques

Function, Analysis and numerical methods for single variable and multivariable system, constrained optimization problems.

Application Of Optimization

Heat transfer and energy conservation, Separation techniques, Fluid flow systems, Chemical Reactor design.

Numerical Methods

Classification of partial differential equations (PDE's), solution of PDEs by Finite difference techniques, method of weighted residuals. Orthogonal collocation to solve PDEs with their application to chemical engineering systems models.

References

1. Edgar T. F., Himmelblau D. M. and Ladson, “Optimization of Chemical Processes”, 2nd Ed., McGraw Hill, New York, 2003
2. Lubeyn W.L. “Process Modeling, Simulation and Control Engineering ", McGraw Hill Book Co., New York, 1990
3. Holland C. D., "Fundamentals and Modeling of Separation Processes",Prentice Hall., 1975

509114 : Advanced Thermodynamics

Teaching Scheme
Lectures: 4 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 4

Objectives

1. To learn advanced topics of classical thermodynamics with emphasis on basic concepts, laws, and thermodynamic relationships.
2. To familiarize students with a knowledge of advanced thermodynamics especially in chemical engineering related fields
3. To educate students to apply these thermodynamic principles to solve problems encountered in chemical engineering and related researches.

Phase Equilibrium

Liquid-Liquid Equilibrium, Corresponding Diagrams, Partially Miscible and Immiscible Systems, LCST and UCST, Excess Functions and Partial Miscibility, Excess Functions for Multicomponent Mixtures, Equations of Wilson and Renon for Multicomponent Mixtures

Chemical Reaction Equilibria

Reaction Coordinate, Application of Equilibrium Criteria to Chemical reactions, Gibb's Energy Change and Equilibrium Constant, Evaluation of Equilibrium Constants, Relation of Equilibrium Constants to Composition, Equilibrium Conversion for Single Reaction, Phase Rule and Duhem's Theorem for Reacting Systems, Multireaction equilibria

Statistical Thermodynamics

Microstates and Gibb's Ensembles, Liouville's Theorem, Thermodynamic Probability and Entropy, Boltzmann Distribution Law, Partition Function, Degeneracy, Statistical Evaluation of Helmholtz Energy

Thermodynamics for Electrolytic Solutions

Strong and Weak Electrolytes, Degree of Dissociation, Gibb's Energy and related Quantities, Measurement of Activities for Strong Electrolytes – Freezing Point Lowering, Limiting Law and Ionic Strength, Activity from Vapour Pressure of Solvent, Isopiestic Method, Activity from Electrolytic Cell Measurements, Activity from Solute Vapour Pressure, Debey-Huckel Theory

Irreversible and Non-Equilibrium Thermodynamics

Methods and Discontinuous Systems – Basic Concepts and Definitions, Uncompensated Heat and Change of Thermodynamic Functions, Chemical Variable, Chemical Affinity and First Law of Thermodynamics, Rate of Entropy Production in Heat Transfer, Open Systems and The First law of Thermodynamics, Production of Entropy in Open Systems, Onsager Equation

Applications to Typical Cases

Gibb's free energy relations for Gravitational, Centrifugal, Electric and Magnetic Fields, Surface Effects – Plane and Curved Surfaces, Conductors, Superconductors, Effect of molecular orientation, Biochemical Reactions.

References

1. Otto Bevan J., JulianaBoerio-Goates Vol. I & II, "Chemical Thermodynamics: Advanced Applications", Academic press, 2000
2. Prausnitz J.M., "Molecular Thermodynamics of Fluid Phase Equilibria", Prentice-Hall Inc.
3. Yeremin E.N., "Fundamentals of Chemical Thermodynamics", MIR Publishers Moscow
4. Smith J.M., Van Ness H.C., Abbott M.M., "Introduction to Chemical Engineering Thermodynamics", McGraw-Hill International Editions
5. Pitzer K.S., "Thermodynamics", McGraw-Hill International Editions

509115 [Elective – III] (a): Catalysis and Surface Phenomenon

Teaching Scheme
Lectures: 5 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 5

Objectives

1. To give the students insight into advances in catalytic reaction engineering
2. To understand the mechanisms involved in catalytic reactions
3. To study the catalyst characterization techniques
4. To study the advanced industrial applications in catalysis
5. To understand the principles behind catalyst deactivation and study their models

Introduction to Catalysis

Definition of Catalytic activity, Magnitude of Turnover Frequencies and Active Site Concentrations, Evolution of Important Concepts and Techniques in Heterogeneous Catalysis, Classification of Catalysts – Homogeneous, Heterogeneous, Biocatalysts, Dual Functional Catalysts, Enzymes, Solid Catalysts, Powder Catalysts, Pellets, Composition, Active Ingredients, Supportive materials, Catalysts Activation.

Adsorption in Catalysis

Adsorption and its importance in Catalysis, Surface Reconstruction, Adsorption Isotherms and Isobars, Dynamical Considerations, Types of Adsorption Isotherms and their Derivation from Kinetic Principles, Mobility at Surfaces, Kinetics of surface Reactions.

Catalyst Characterization

Catalyst Characterization Methods – Their Working Principle and Applications – XRF, XRD, IR Spectroscopy, XPS, UPS, ESR, NMR; Infrared, Raman, NMR, Mossbauer and X-Ray Absorption spectroscopy, Surface Acidity and Toxicity, Activity, Life time, Bulk density, Thermal stability Crystal Defects, Peroviskites, Spinels, Clays, Pillared Clays, Zeolites

Significance of Pore Structure and Surface Area

Importance of Surface Area and Pore Structure, Experimental Methods for Estimating Surface Area – Volumetric, Gravimetric, Dynamic Methods, Experimental Methods for Estimating Pore Volume and Diameter – Gas Adsorption and Mercury Porosimeter Method, Models of the Pore Structure – Hysteresis Loops, Geometric Models, Wheeler's Model, Dusty Gas Model, Random Pore Model, Diffusion in Porous Catalysts – Effective Diffusivity, Knudsen Diffusion, Effect of Intraparticle Diffusion, Non-isothermal Reactions in Pores, Diffusion Control.

Catalyst Deactivation

Introduction, Effect of Mass Transfer on Catalytic Selectivity, Catalyst Deactivation, Deactivation Process and Models, Operational Consequences of Poisoning, Modern Theories of Poisoning and Promotion, Other Factors responsible for Promotion and poisoning, Methods for Preventing Deactivation.

Heterogeneous Catalysis – Case Studies

Synthesis of Methanol, Fiscer-Tropsch Catalysis, Synthesis of Ammonia, Automobile Exhaust Catalysts and Catalyst Monolith, Photocatalytic Breakdown of Water and the Harnessing of Solar Energy.

References

1. Emmett, P.H. - “Catalysis Vol. I and II, Reinhold Corp.", New York, 1954
2. Smith, J.M. - “Chemical Engineering Kinetics ", McGraw Hill, 1971
3. Thomas and Thomas - “Introduction to Heterogeneous Catalysts ", Academic Press, London 1967

509115 [Elective – III] (b): Advanced Downstream Processes

Teaching Scheme
Lectures: 5 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 5

Objectives

1. To understand the unit processes involved in downstream processing
2. To study advanced treatment methods
3. To study the energy conservation in different separation processes
4. To understand the underlying design principles

Introduction

Introduction to Downstream processes, examples. Applications & Advantages.

Centrifugal separation

Theory, application, equipments, 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.

Downstream Processes in Petrochemical Industry

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

Advanced Distillation Processes

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

Energy conservation in separation processes

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

Non-Ideal Mixtures and Ion Exchange

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

509115 [Elective – III] (c): Computational Fluid Dynamics

Teaching Scheme	Examination Scheme
Lectures: 5 Hrs/Week	In Semester Assessment: 50 Marks
	End Semester Assessment: 50 Marks
	Credits: 5

Objectives

1. To make students understand the governing equations of fluid dynamics and their derivation from laws of conservation
2. To develop a good understanding in computational skills, including discretisation, accuracy and stability.
3. To acquaint the students with a process of developing a mathematical and geometrical model of flow, applying appropriate boundary conditions and solving system of equations.

Introduction to Fluid Dynamics

Concepts of Fluid Flow, Pressure distribution in fluids, Reynolds transport theorem, Integral form of conservation equations, Differential form of conservation equations, Different Types of Flows, Euler and Navier Stokes equations, Properties of supersonic and subsonic flows, Flow characteristics over various bodies.

Grid Generation

Basic theory of structured grid generation, Surface grid generation, Mono block, multi block, hierarchical multi block, Moving and sliding multiblock, Grid clustering and grid enhancement. Basic theory of unstructured grid generation, advancing front, Delaunay triangulation and various point insertion methods, Unstructured quad and hex generation, grid based methods, various elements in unstructured grids, Surface mesh generation, Surface mesh repair, Volume grid generation, Volume mesh improvement, mesh smoothing algorithms, grid clustering and quality checks for volume mesh. Adaptive, Moving and Hybrid Grids, Need for adaptive and, moving grids, Tet, pyramid, prism, and hex grids, using various elements in combination

Introduction to CFD

Philosophy of CFD, Governing equations of fluid dynamics and there physical meaning, Mathematical behavior of governing equations and the impact on CFD simulations, Simple CFD techniques and CFL condition.

Numerical Methods in CFD

Finite Difference, Finite Volume, and Finite Element, Upwind and downwind schemes, Simple and Simpler schemes, Higher order methods, Implicit and explicit methods, Study and transient solutions

Introduction to Turbulence Modeling

Introduction and background, Algebraic models, One equation models, Two equation models, Near wall treatment, Reynolds stress models, Eddy viscosity models (EVM), Nonlinear eddy viscosity models, LES, RANS, and, hybrids, Direct numerical simulation (DNS)

Introduction to Multiphase Modeling

Fundamentals of multiphase flows, Eulerian-Lagrangian (ELAG) approach, Eulerian-Eulerian (E2P) approach, Volume Of Fraction (VOF) approach, Solving example problems

Chemical Fluid Mixing Simulation

Stirred tank modeling using the actual impeller geometry, Rotating frame model, The MRF Model Sliding mesh model, Snapshot model, Evaluating Mixing from Flow Field Results, Industrial Examples

Post-Processing of CFD results

Contour plots, vector plots, and scatter plots, Shaded and transparent surfaces, Particle trajectories and path line trajectories, Animations and movies, Exploration and analysis of data.

References

1. Anderson John D., “Computational Fluid Dynamics: The Basics with Applications”, Mc Graw Hill, 1995
2. Ranade V.V., “Computational Flow Modeling for Chemical Reactor Engineering”, Process Engineering Science, Volume 5, 2001
3. Knupp Patrick and Steinberg Stanly, “Fundamentals of Grid Generation”, CRC Press, 1994
4. Wilcox D.C., “Turbulence Modelling for CFD”, 1993
5. Wesseling Pieter, “An Introduction to Multigrid Methods”, John Wiley & Sons, 1992
6. Thompson J.F., Warsi Z.U.A. and Mastin C.W., “Numerical Grid Generation: Foundations and Applications”, North Holland, 1985
7. Patankar S.V., “Numerical Heat Transfer and Fluid Flow”, McGraw-Hill,1981
8. Gatski Thomas B., Hussaini M. Yousuff and Lumley John L., “Simulation and Modelling of Turbulent Flows”, Oxford University Press, 1996
9. Laney, C. B., “Computational Gas Dynamics”, Cambridge Uni. Press, 1998

509115 [Elective – III] (d): Bioprocess Engineering

Teaching Scheme
Lectures: 5 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
End Semester Assessment: 50 Marks
Credits: 5

Objectives

1. To learn the principles of bioprocessing for traditional chemical engineering in the design and development of processes involving biocatalyst
2. To study engineering principles in the development of products based on living cells or subcomponents of such cells
3. To learn and develop quantitative models and approaches related to bioprocesses
4. To learn mechanisitic models for enzyme catalyzed reactions for large scale production of bioproducts

Advance Enzyme Kinetics

Models for complex enzyme kinetics, modeling of effect of pH and temperature, models for insoluble substrate, modelsfor immobilized enzyme systems, diffusion limitations in immobilized enzyme system, electrostatic and steric effects.

How Cells Work

The central dogma, DNA replications, sending the messages, genetic code, translation, posttranslational processing, sensing of extra cellular environment, roll of cell receptors.
Major metabolic pathways, bioenergetics, Glucose metabolism, metabolism of nitrogenous compounds, respiration, metabolism of hydrocarbons, anaerobic metabolism, autotrophic metabolism.

Bioreactors

Modifications of batch and continuous reactors, chemostat with recycle, multistage chemostat, fed-batch operation, perfusion system, active and passive immobilization of cells, diffusional limitations in the immobilized system, solid state fomenters.

Homogeneous and heterogeneous reactions in bioprocesses

Reaction thermodynamics, growth kinetics with Plasmid instability, The Thiele Modulus and effectiveness factor, diffusion and reaction in waste treatment lagoon. Reactors and choice of reactors.

Biological waste water treatment

Microbial participation in natural cycle of matter, activated sludge process, design and modeling of activated sludge process, Nitrification, anaerobic digestion, mathematical modeling of anaerobic digester, anaerobic denitrification, phosphate removal.

References

1. Bailey J.E. and Ollis D.F., “Biochemical Engineering Fundamentals”, McGraw-Hill
2. Doran P.M., “Bioprocess Engineering Principles”, Academic Press
3. Shuler M.L., Kargi F., ”Bioprocess Engineering”, Prentice -Hall

509116: Seminar – II

Teaching Scheme	**Examination Scheme**
Lectures: 4 Hrs/Week	**Term Work: 50 Marks**
	Oral/Presentation: 50 Marks
	Credits: 4

Objectives:

1. To make the student aware of recent advances in the area of polymer science and engineering.
2. To train the student to carry out literature survey to collect the technical information.
3. To develop the oral and written presentation skills amongst the students.
4. To develop technical writing skills through report preparation.

Seminar II : Shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected by him/her approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

Important instructions:

1. **Seminar is to be presented using power point presentation.**
2. **Seminar report is to be submitted in soft and hard copy to the department.**
3. **The attendance record (signatures) of the audience must be attached and maintained with the report, clearly mentioning "Attendance Record for the ME Seminar Presentation" with Date and Topic of presentation.**

509117: Project Work Stage I

Teaching Scheme	Examination Scheme
Lectures: 8 Hrs/Week	Term Work: 50 Marks
	Oral/Presentation: 50 Marks
	Credits: 8

Objectives:

1. The student should be able to choose and evaluate the problem based on current interest of research at national and international level.
2. To train the student to acquire the technical data.
3. To develop analyzing ability amongst the students.
4. To train the students to make use of available resources and to procure the resources to carry out his/her project work.
5. To initiate and orient the students with R & D skills.
6. To give the students the exposure of recent advances at national and international level.

PROJECT WORK:

The project work shall be based on the knowledge acquired by the student during the coursework and preferably it should meet and contribute towards the needs of the society. The project aims to provide an opportunity of designing and building complete system or subsystems based on area where the student likes to acquire specialized skills.

Project Work Stage – I

Project work Stage – I is an integral part of the project work. In this, the student shall complete the partial work of the project which will consist of problem statement, literature review, project overview, scheme of implementation (Mathematical Model/SRS/UML/ERD/block diagram/ PERT chart, etc.) and Layout & Design of the Set-up. As a part of the progress report of Project work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic. The student shall submit the duly certified progress report of Project work Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

The assessment will be done jointly by the pair of internal and external examiners along with the oral/presentation examination of the same.

Important instructions:

1. **The ME candidate is required to work on <u>Original Topic</u>.**
2. **It should not be the repetition earlier reported work.**
3. **The student is required to carry out broad literature survey in the area of work.**
4. **The justification for selection of project topic and originality of the topic is to be mentioned in the Project Report.**
5. **The student will make presentation of his project work for assessment purpose.**
6. **All supporting documents, samples, products, soft copies to be preserved and presented at the time of examination.**

SEMESTER IV

509118: Seminar III

Teaching Scheme	**Examination Scheme**
Lectures: 4 Hrs/Week	**Term Work: 50 Marks**
	Oral/Presentation: 50 Marks
	Credits: 4

Objective:

1. To make the student aware of recent advances in the area of polymer science and engineering.
2. To train the student to carry out literature survey to collect the technical information.
3. To develop the oral and written presentation skills amongst the students.
4. To develop technical writing skills through report preparation.

Seminar III: Shall preferably an extension of **seminar II.** The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

Important instructions:

1. **Seminar is to be presented using power point presentation.**
2. **Seminar report is to be submitted in soft and hard copy to the department.**
3. **The attendance record (signatures) of the audience must be attached and maintained with the report, clearly mentioning "Attendance Record for the ME Seminar Presentation" with Date and Topic of presentation.**

509119: Project Work Stage II

Teaching Scheme	**Examination Scheme**
Lectures: 20 Hrs/Week	**Term Work: 150 Marks**
	Oral/Presentation: 50 Marks
	Credits: 20

Objective:

1. The student should be able to choose and evaluate the problem based on current interest of research at national and international level.
2. To train the student to acquire the technical data.
3. To develop analyzing ability amongst the students.
4. To train the students to make use of available resources and to procure the resources to carry out his/her project work.
5. To initiate and orient the students with R & D skills.
6. To give the students the exposure of recent advances at national and international level.

Project Work Stage - II

In Project Work Stage – II, the student shall complete the remaining part of the project which will consist of the fabrication of set up required for the project, work station, conducting experiments and taking results, analysis & **validation of results and conclusions**. The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

It is mandatory for every student that his Project Outcomes (results and conclusion) are 'validated' in the form of minimum one Publication (published or accepted) in a refereed and peer reviewed journal of international repute till the date he/she appears for the Project Work Stage II examination. (Communicated papers will not be considered as publication)

The assessment will be done jointly by the pair of internal and external examiners along with the oral examination of the same.

Important instructions:

1. **The ME candidate is required to work on <u>Original Topic</u>.**
2. **It should not be the repetition earlier reported work.**
3. **The student is required to carry out broad literature survey in the area of work.**

4. **The justification for selection of project topic and originality of the topic is to be mentioned in the Project Report.**
5. **The student will make presentation of his project work for assessment purpose.**
6. **The project report is to be submitted in Standard Hard Bound format.**
7. **It is mandatory for the candidate to participate and present his work at any (national/international) conference/seminar or publish his/her work in any (national/international) journal during the tenure till oral exam is conducted. (In some cases paper accepted (before the date of oral examination) for presentation or publication in conference or journal will be considered.**
8. **All supporting documents to be maintained.**

Non Credit Course (mandatory)

Note: Refer R-2.7 for Examination Rules of "Rules and Regulations for M.E. Programs under faculty of Engineering effective from June 2013". Non-credit courses are mandatory for the grant of the term and shall be completed by the students as a self study under the guidance of PG teacher either by referring to the Hand books, Journal/Conference papers (at least 25 in number), open source software, tools and in addition may be by organizing educational visits to the technological/professional centers in the subject, if any. Each student is required to produce in own words, one 10 pages innovative, technical paper to be submitted as a part of the semester course work of non-credit courses.

Term I, Sem I: Yoga and Meditation

Teaching Scheme	**Examination Scheme**
Lectures: 2 Hrs/Week	**In Semester Assessment: 50 Marks**
	Credits: 2

Yoga: Sukshma (subtle) yoga techniques, Difference between physical exercises and yogasans, Impact of yogasans on human body, benefits of yogasans, Patanjali yoga sutras, technique of different yogasans like, Trikonasan, Ardhachandrasan, Padmasan, Akarnadhanurasan, Ardhamatsendrasan, Vajrasan, Pachhimottasan, Bhujangasan, Shalbhasan, Dhanurasan, Naukasan, Makrasan, Pawanmuktasan, Halasan, Sarvangasan, Shavasan, Suryanamaskar(Sun Salutation), Yoga and Food.

Meditation: Breathing technique, Pranayama, Benefits of pranayama, Prcautions for pranayama, Kumbhak, Bandh(Locks), Chakras, Mudra, Technique of pranayama,Anulom- VilomPranayam, UjjayiPranayam, BhramariPranayam, BhastrikaPranayam, AgnisarPranayam, KapalbhatiPranayam, Meditation(Dhyan).

References Books:

1. Light on Yoga: by B.K.S. Iyengar, Harper Collins Publishers India
2. Light on Pranayama: by B.K.S. Iyengar, Harper Collins Publishers India
3. Yoga for Dummies by Georg Feuerstein and larry Payne, Wiley India publishing
4. Yoga, Pilates, Meditation & Stress Relief By Parragon Books Ltd
5. The Yoga Sutrasby Patanjali, Swami Satchidananda, Integral Yoga Publications
6. Meditation - Science and Practice by N. C. Panda, Publisher: D. K. Printworld

Other Source:

7. http://www.artofliving.org/in-en/yoga
8. http://www.artofliving.org/in-en/yoga/sri-sri-yoga/sukshma-yoga-relaxation
9. http://www.yogsansthan.org/
10. http://www.yogapoint.com/
11. http://www.divyayoga.com/
12. http://www.yogaville.org/about-us/swami-satchidananda/
13. www.yogaVision.net
14. http://www.swamij.com/

Term I , Sem II: Human Rights and World Peace

Teaching Scheme
Lectures: 3 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
Credits: 3

Human Rights – Concept, Development, Evolution
- Philosophical, Sociological and Political debates, Benchmarks of Human Rights Movement.

Human Rights and the Indian Constitution
- Constitutional framework, - Fundamental Rights & Duties, - Directive Principles of State Policy, - Welfare State & Welfare Schemes

Human Rights & State Mechanisms
- Police & Human Rights, - Judiciary & Human Rights, - Prisons & Human Rights, - National and State Human Rights Commissions

Human Rights of the Different Sections and contemporary issues
- Unorganized Sector, Right to Environment, particularly Industrial sectors of Civil Engineering and Mechanical Engineering, Globalization and Human Rights, - Right to Development,

Citizens' Role and Civil Society
- Social Movements and Non-Governmental Organizations, Public Interest Litigation, Role of Non Government organizations in implementation of Human rights, Right to Information.

Human Rights and the international scene –Primary Information with reference to Engineering Industry, UN Documents, International Mechanisms (UN & Regional), International Criminal Court,

World Peace:
Peace; Meaning, Nature , philosophy of peace, Theories of Peace: Democratic peace theory, Active Peace theory, Game Theory, Religious Beliefs and Peace theories: Buddhism, Islam, Christianity, Hinduism, Economic equality, Social Justice, and Social Values.

Durable Peace: Challenges and Methods, Methods for Conflict Resolutions, Global Conflict and Peace Initiatives, Religious Philosophy and Conflict Resolution, Globalization and Growing Conflict, Globalization, Civil Society and World Peace, Gandhian Understanding of Peace.

References:

1. Study material on UNESCO,UNICEF web site
2. HUMAN RIGHTS IN INDIA A MAPPING, Usha Ramanathan: free download from http://www.ielrc.org/content/w0103.pdf
3. Introduction to International Humanitarian Law **by** Curtis F. J. Doebbler - CD Publishing**,** 2005.
4. Freedom of Information**,**by Toby Mendel - UNESCO **,** 2008

Term II, Sem I: Cyber Security/Information security

Teaching Scheme
Lectures: 3 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
Credits: 3

Security principles, threats and attack techniques
• Introduction to security • Information security • Security triad: Confidential, Integrity, Availability • Focus of control • Security threats and attacks • Security management
Authentication and access control
• Identification • Authentication • Authentication by passwords • Protecting passwords • Access control structures • Types of access control
Lattice and reference monitors
• Security levels and categories • Lattice diagram • Reference monitors • Security kernel • Hardware security features • Protecting memory
Security models
• Bell-LaPadula • Biba • Non-deducibility • Non-interference • Other models
Cryptography
• Cryptographic mechanisms • Digital signatures • Encryption • Certificates
Authentication in distributed systems
• Key establishments and authentication • Kerberos • Public key infrastructures • Single sign-on
Network security
• Protocol design principles • ISO architecture • IP security • SSL/TLS • Firewalls • Intrusion detection
Unix security and Windows security
• Subjects, objects and access control • General security principles • Access components • Access decisions • Administration and management issues
Software security and database security
• Memory management • Data and code • Relational databases • Access control in databases
• Statistical database security
Java Security, Mobile Security
• GSM security • Wireless LAN security
Protection measures
• Business risk analysis • Prevention, detection and response • Information classifications • Security evaluation

Reference Books:

1) Bakshi P M and Sri R K, Cyber and E-commerce Laws, Bharat Publishing House, 1st Edn, 2002
2) Syed shakil Ahmed, Rajiv Raheja, A handbook on Information technology: Cyber law and ECommerce, Capital Law House, 2004
3) Rodney D Ryder, Business Process Outsourcing, Date Protection and Information Security, Wadhwa & Co., 1st Edn, 2001
4) Vakul Sharma, Information Technology Law and Practice, Delhi Law House, 3rd Edn, 2011

5) Lipton, K., Cyberspace Law Cases and Materials, 2nd edition. Aspen Publishers. NY: New York, 2006
6) Michael E Whitman and Herbert J Mattord, Principles of Information Security, Vikas Publishing House, New Delhi, 2003
7) Micki Krause, Harold F. Tipton, Handbook of Information Security Management, Vol 1-3 CRC Press LLC, 2004.
8) Michael E Whitman and Herbert J Mattord, Principles of Information Security, Vikas Publishing House, New Delhi, 2003

Term II, Sem II: Industrial Safety and Equipment Maintenance
(Skill Development)

Teaching Scheme
Lectures: 2 Hrs/Week

Examination Scheme
In Semester Assessment: 50 Marks
Credits: 2

Machine Operation and Guarding :
Principles in machine guarding. Ergonomics of machine guarding. Type of guards, their design and selection. Guarding of different types of machinery including special, paper, rubber and printing machinery, machine, tools etc. Built-in-safety devices, maintenance and repairs of guards, incidental safety devices and tools. Safety in the use of Machines : Safety in the use of 1) power presses (all types), 2) shearing, 3) bending, 4) rolling, 5) drawing, 6) turning, 7) boring, 8) milling, shaping, 9) planning broaching, planting, 10) grinding, 11) CNCS. Need for selection and care of cutting tools. Preventive maintenance, periodic checks for safe operation. Associated hazards and their prevention

Material Handling and Storage of Materials :
Kinetics of manual handling. Maximum loads that could be carried. Lifting and carrying of objects of different shapes, size and weight. Safe use of accessories for manual handling Storage of materials. Safety in stacking and unstacking, floor loading conditions. Layout condition for safety in storage, ergonomics of manual handling and storage. Lifting machinery, lifts and hoists; safety aspects in design and construction, testing, use and care, signaling, inspection and maintenance. Safety in design and construction, operation, inspection and maintenance of industrial trucks, lifting tackles and loose gears, conveyors. Safety features, safe locations, testing, inspection and maintenance of lifting tackles,safe working load for all mechanical material handling equipment. The competent persons in relation to safety legislation – duties and responsibilities.

Hand Tools and Power Tools : Main causes of accidents, prevention and control of accidents.
Centralised and personal tool issues System. Purchase, storage and supply of tools. Inspection, maintenance and repair of tools. Detectable causes of tool failures. Tempering, safe end in and dressing of certain tool**.** Safe use of various types of hand tools used for metal cutting,

Electrical Hazards
Hazards of electrical energy. Safe limits of amperages, voltages. Safe distance from lines. Capacity and protection of conductor. Joints and connections. Means of cutting off power. Overload and short circuit protection. No load protection. Earth fault protection. Earth insulation and continuity tests. Earthing Standards. Protection against sure and voltage fluctuation. 14.1.2 Hazards arising out of 'borrowed' neutrals. Others precautions. Types of protection for electrical equipment in hazardous atmosphere. Electrical area classification. Criteria in their selection, installation, maintains and use. Safety Check list for buying new machinery for the Plant Classification of Hazardous materials. Safety in chemical industry, Criteria for sitting and layout

of Chemical and Petrochemical Plants Plant Area classification. Instrumentation for safe plant operations. Hazard in Unit Processes and Unit Operations, Control, precautions and prevention, specific safety measures for certain chemical industry like fertiliser, insecticide, pesticides-choler-alkali, explosives, polymer plants. Sampling technique for toxic and flammables, pharmaceuticals, petro-chemical etc. 3.1 Precautions in the process and operations involving explosives, flammables, toxic substances, dusts, gases, vapour cloud formations and combating.
5.1 Transportation of Hazardous material .Safety Precautions for transporting hazardous / toxic / flammable /explosive/ radioactive substances by all modes.
Colour coding identification of contents. Safety Precautions for working on pipelines, safe entry procedures to confined spaces including reaction vessels. Safe procedure of start up and shut down procedures. Safety in preventive and emergency maintenance operations.

Fire & Explosion :
Chemistry of fire, Factors contributing towards fire, Classification of fires. Common causes of industrial fires. Determination of fire load.. Design of building plant, exists, etc. for fire safety and Fire resistance of building materials. Prevention of fire. Portable extinguishers. Hydrant system, sprinkler system, introduction to. Carbon-di-oxide systems. Foam extinguisher system. Dry chemical Extinguishing systems Halon replacement of fire fighting products. Fire detection and alarms system. Special safety precautionary measures for control of fire and explosion in handling / processing flammable liquids, gases, vapors, mists and dusts etc. BLEVE (Boiling liquids expanding vapor Explosion , Vapor Cloud Explosion) including pesticides. Fire emergency action plan. Deflagration and detonation.

References:

1. Accident Prevention Manual for Industrial Operations National Safety Council, 444, North Michigan Avenue, Chicago, I 11 – 60611
2. Safety code for Scaffolds and Ladders, (Part II) – Ladders IS : 3696 , (Part II) - 1966
3. Safety in Construction Work : Scaffolding H.M.S.O London, 1977.