# Scheme of Teaching and Examination (2015-2016)

## Fifth Semester

<table>
<thead>
<tr>
<th>Paper</th>
<th>Subject</th>
<th>Teaching Hrs. per Week</th>
<th>End Term</th>
<th>Mid Term</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE501</td>
<td>Open Elective-I</td>
<td>L 3 1 - 4</td>
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<td>CHE502</td>
<td>Petroleum Processing Engineering</td>
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<td>CHE503</td>
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<td>3 1 - 4</td>
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<tr>
<td>CHE504</td>
<td>Mass Transfer-I</td>
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<tr>
<td>CHE505</td>
<td>Chemical Technology (Inorganic)</td>
<td>3 1 - 4</td>
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## Practicals

<table>
<thead>
<tr>
<th>Paper</th>
<th>Subject</th>
<th>Teaching Hrs. per Week</th>
<th>End Term</th>
<th>Mid Term</th>
<th>Total Marks</th>
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<td>CHE 552</td>
<td>Chemical Technology Lab (Inorganic)</td>
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<td>CHE 554</td>
<td>Chemical Engineering Computation Lab</td>
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**Total** 15 5 11 27 250 425 675

## Open Elective – I

1. Operations Research  
2. Managerial Economics
Teaching Scheme and syllabi of B.E. (Chemical Engineering) [2015-2016]

SCHEME OF TEACHING AND EXAMINATION (2015-2016)

<table>
<thead>
<tr>
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<td>SIXTH SEMESTER</td>
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<tr>
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<td>Transport Phenomena</td>
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Practicals

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<tr>
<th>Paper</th>
<th>Subject</th>
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<th>Mid Term</th>
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<tr>
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<td>Reaction Engineering Lab</td>
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<td>Process Plant Design-II</td>
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<tr>
<td>CHE 654</td>
<td>Chemical Technology Lab (Organic)</td>
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<td>CHE 753*</td>
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Total 15  5  12  28  250  450  700

*There will be 6-8 weeks’ compulsory industrial training after 6th semester theory examination during summer vacation. Every student will submit the Industrial Training report within one month from the start of teaching of the 7th Semester. After that it will be evaluated by the team of Training & Placement Officers.

Open Elective-II

1. Research Methodology
2. Introduction to Bio-chemical Engineering
3. Membrane Separation Process
### SEVENTH SEMESTER

<table>
<thead>
<tr>
<th>Paper</th>
<th>Subject</th>
<th>Teaching Hours per Week</th>
<th>End Term</th>
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<tr>
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<td>CHE 702</td>
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### Practicals

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<th>Subject</th>
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<th>Total Marks</th>
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<td>- - 3 2</td>
<td>50 50</td>
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Total 12 4 8 21 200 325 525

### Department Elective -I

1. Analytical techniques
2. Polymer Science and Engineering

### Department Elective-II

1. Alternate Energy Technology
2. Low Temperature Engineering
3. Plant Utilities
### SCHEME OF TEACHING AND EXAMINATION (2015-2016)

<table>
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<th>Paper</th>
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<th>Mid Term</th>
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<td>Industrial Safety and Hazards</td>
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<td>Process Dynamic and Control</td>
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<td>‘S’ or ‘X’</td>
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<td>Process Control Lab.</td>
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<tr>
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<td>Literature Survey, Report Writing and Seminar</td>
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<td>Viva Voce-II (Comprehensive)</td>
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</table>

*All independent/self study courses shall be graded in terms of ‘S’ (Satisfactory) or ‘X’ (Repeat).

**Departmental Elective III**

| 1. Petrochemicals Technology |
| 2. Nano Technology |
| 3. Complex Flow Hydrodynamics |
| 4. Fluidization Engineering |
| 5. Polymer Synthesis and Characterization |

**Open Elective III**

| 1. Project Management |
| 2. Financial Management |
| 3. Human Resource Management |
| 4. Industrial Relations and Labour Laws |

**Requirement** for the award of B.E. (Chemical) is 200 credits.
SYLLABUS FOR
BACHELOR OF ENGINEERING (CHEMICAL)
FOURTH SEMESTER

Paper Title: HEAT TRANSFER (Theory)
Paper Code : CHE 401  Max. Marks 50  Credits : 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Conduction: Steady state conduction in one dimensional system, general conduction equation, effect of variable thermal conductivity, steady state conduction involving internal heat generation, lagging on pipes, the critical thickness of insulation on pipes, extended surfaces of uniform thickness and fin effectiveness, fin efficiency.

Convection: Free and forced convection, concept of heat transfer co-efficient, dimensionless numbers in free and forced convection, Dimensional analysis, Determination of Heat transfer coefficient using heat and momentum transfer analogies, experimental determination of heat transfer coefficient and common working correlations.

Radiation Heat Transfer: Black Body radiation, and grey body radiation, physical mechanism, radiation properties and shape factor, heat exchange between non-black bodies, radiation shields pyrometry and effect of radiation on temperature measurement.

SECTION-B

Condensation and Boiling: Condensation heat transfer phenomenon, film condensation on vertical plates and cylinders as well as on horizontal cylinders. Effects of non-condensable gases and vapor velocity on condensation, pool boiling, forced convection boiling, working correlations for pool boiling.

Evaporation: Types of Evaporators, single and multiple effects, single and multiple effects calculations, evaporator capacity, economy, effect of liquid head and boiling point elevation, methods of feeding.

Heat Exchangers: Various types of heat exchangers, overall heat transfer coefficients, heat exchanger mean temperature differences, heat exchanger effectiveness and the number of transfer units.

Books Recommended:
Teaching Scheme and syllabi of B.E. (Chemical Engineering) [2015-2016]

Paper Title: CHEMICAL ENGINEERING THERMODYNAMICS (Theory)
Paper Code : CHE 402   Max. Marks 50   Credits : 4   Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A


SECTION-B

Phase Equilibria:
Partial molar properties, partial molar Gibbs free energy, Chemical potential and its dependence on temperature and pressure Ideal solutions (Lewis-Randel Rule).
Chemical Equilibria:
Equilibrium constant in terms of measurable properties variations of equilibrium constant with temperature and pressure. Adiabatic reactions, Gibbs phase rule, equilibria in heterogeneous reactions.

Books Recommended:

Teaching Scheme and syllabi of B.E. (Chemical Engineering) [2015-2016]

Paper Title: ENVIRONMENTAL ENGINEERING (Theory)
Paper Code : CHE 403   Max. Marks 50  Credits : 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A
Ambient air and water standards. Principal sources of pollution.
Inter-relationship between energy and environment pollution. Prevention of environmental pollution through conservation, raw material substitutions, process and equipment modifications. A case study on the concept of zero discharge.
Air Pollution:
- Principal air pollutants and their usual sources.
- Effect of air pollutants on human health, animals, vegetation and materials.
- Atmospheric dispersion of air pollutants, temperature inversions, Estimation of pollutants by Gaussian plume model.
- Process and equipments used for the control of particulate pollutants.

SECTION-B
Water Pollution:
- Types of water pollutants, their sources and effects.
- BOD and COD
- Waste water treatment techniques and equipments, flocculation, skimming, floatation, etc.
- Primary Treatment-through settling.
- Secondary Treatment-Aerobic and anaerobic digestion, activated sludge process, trickle filter and oxidation ponds.
Solid wastes: Control and disposal, sanitary landfill, incineration, pyrolysis gasification and recycling.

Books Recommended:

Paper Title: ENERGY TECHNOLOGY (Theory)
Paper Code : CHE 404   Max. Marks 50  Credits : 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.
SECTION-A

Fuels: Types of conventional fuels, their merits and demerits. Non-conventional/renewable energy sources, their importance for sustainable development and environmental protection.


Liquid fuels: Origin of petroleum, refining and distillation of crude oil, uses of petroleum products.

Gaseous fuels: Natural gas, manufacture of water gas and producer gas, gas cleaning methods.

SECTION-B


Furnaces: Classification of furnaces, draught, furnace atmosphere, Portland cement continuous rotary kiln, blast furnace, glass melting furnace.

Alternate sources of energy:

- Introduction to solar radiation and evaluation of radiation incident on a solar collector.
- Applications of solar thermal energy such as solar water heater, solar cooker, solar concentrators and solar thermal power generation.
- Types of solar photovoltaic systems and applications.
- Photosynthesis and biomass conversion systems.
- Other renewable energy sources such as geothermal, tidal, ocean and wave.

Books Recommended:

TEXT BOOKS


REFERENCE BOOKS


Paper Title: NUMERICAL METHODS IN ENGINEERING

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.
SECTION-A

SECTION-B
Numerical Solution of Partial Differential Equations: Finite-Difference Approximation to Laplace’s Equation, Parabolic Equations and Hyperbolic Equations

Books Recommended:

Paper Title: PROCESS EQUIPMENT DESIGN (Practical)
Paper Code CHE 451 Max. Marks 25 Credits : 1
1. General design considerations for pressure vessels: Design pressure, design temperature, materials, design stress (nominal design strength), welded joint efficiency and construction categories, corrosion allowance, design loads, minimum practical wall thickness.
2. Design of thin-walled vessels under internal pressure: Cylinders and spherical shells, heads and closures, design of flat ends, design of domes ends, conical sections and end closures.
3. Design of vessels subject to external pressure: Cylindrical shells, design of stiffening rings, vessels heads.
4. Design of vessels subject to combined loading: Weight loads, wind loads (tall vessels), torque.
5. Design of Foundation and supports.
6. Design of Bolted flanged joints and welded joints.

Books Recommended:
1. Battacharyya, B.C. : Introduction to Chemical Equipment Design Mechanical aspects, Chemical Engineering Education Development Centre.
Teaching Scheme and syllabi of B.E. (Chemical Engineering) [2015-2016]


Paper Title: PARTICLE MECHANICS LAB. (Practical)
Paper Code CHE 452 Max. Marks 50 Credits : 2

1. Pressure drop and two phase flow characteristics in packed and fluidized beds.
4. Constant pressure filtration.
5. Mixing, crushing, grinding, screening and particle size analysis.

Paper Title: ENVIRONMENTAL ENGINEERING LAB. (Practical)
Paper Code CHE 453 Max. Marks 50 Credits : 2

1. To find BOD of water sample.
2. To find COD of waste sample.
3. To find the total dissolved solids (TDS) and its volatile and non-volatile components.
4. To find the total suspended solids (TSS) and its volatile and non-volatile components.
5. To do the chromium separation by different techniques from electroplating wastes.
6. To find the phenol content of water sample and evolution of parameters.
7. To operate the electrodialysis apparatus.
8. To find the biodegradation constant (K) and the effect of timing on it.
9. To use the membrane separation techniques for salt brine and reverse osmosis process for sugar.
10. To use stack monitoring kit to find:
    (a) Efficiency of a cyclone.
    (b) Dust sampling.

Note: Any six of the above mentioned experiments are to be conducted.

Paper Title: VIVA VOCE-I (COMPREHENSIVE)
Paper Code CHE 454 Max. Marks 50 Credits : 2

The viva-voce examinations will be comprehensive and covering all subjects taught during first to fourth semesters.
SYLLABUS FOR
BACHELOR OF ENGINEERING (CHEMICAL)
FIFTH SEMESTER

Paper Title: Open Elective-1 (Theory)
Paper Code: CHE 501  Max. Marks 50  Credits: 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

1. OPERATIONS RESEARCH

SECTION-A
Linear Programming: problem formulation, graphical method, simplex method, duality sensitivity analysis.
Transportation model, Transhipment problem, traveling salesman problem, Assignment models, Sequencing model, Replacement model.

SECTION-B
Theory of Games: Pure strategy games, principle of dominance; mixed strategy games (Algebraic, Graphical & Linear programming method), 2-person, non-zero-sum games.
Queuing Theory: Introduction, elementary queuing system; single channel queuing model, queuing cost behaviour, multiple channel queuing model, Poisson arrivals and Erlang service distribution; benefits and limitations of queuing theory.

Books Recommended:

1. MANAGERIAL ECONOMICS (Theory)

SECTION-A
Introduction to Managerial Economics: Nature Scope and Importance of Managerial Economics, opportunity costs, incremental principle, time perspective, discounts and equi marginal principles.
Demand Concepts and Analysis: Individual Demand, Market Demand, Kinds of Demand, Determinants of Demand, Demand Functions, Functions, Demand Schedule and Law of Demand.
Theory of Consumer Behavior: Cardinal Utility Approach and Ordinal Utility (Indifference Curves) Approach;
Elasticity of Demand: Concept, Types, Measurement and importance.
Demand Forecasting: Sources of Data-Expert Opinions, Surveys and Market Experiments;
Time Series Analysis: Trend Projection; Barometric Forecasting-Leading Indicators, Composite and diffusion Indices.

SECTION-B
Production Function: Concept and types, Returns to Factor and Returns to Scale, Law of Variable
Teaching Scheme and syllabi of B.E. (Chemical Engineering) [2015-2016]

Proportions.
**Cost concepts and Analysis:** Concept of Cost, Short run and Lung-run Cost Curves, Relationships among various costs, Break-even Analysis.
**Revenue Curves:** Concept and Types.
**Perfect Competition:** Characteristics, Equilibrium Price, Profit Maximizing output in Short Run and Long Run;
**Monopoly:** Characteristics, Equilibrium Price, Profit Maximizing output in Short Run and Lung Run; Price Discrimination;
**Imperfect Competition:** Monopolistic Competition, oligopoly and Barriers to Entry.

References:
8. Mote, Paul Gupta: Managerial Economics, Vikas Publisher, New Delhi, 1st ed.

**Paper Title: PETROLEUM PROCESSING ENGINEERING (Theory)**
**Paper Code : CHE 502**          **Max. Marks 50**          **Credits : 4**          **Time: 3 hours**
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**
Introduction to petroleum industry, world petroleum resources, petroleum industry in India. Origin, exploration & drilling of petroleum crude. Transportation of crude and products.
Crude pretreatment: Refining and distillation of petroleum crude, composition and classification of petroleum crude, methods of evaluation: ASTM, TBP and EFV distillation. Properties and specifications of petroleum products such as LPG, gasoline,naphtha, kerosene, diesel, lubricating oils and waxes.

**SECTION-B**
Separation Processes: Design and operation of topping and vacuum distillation units and tube still furnaces. Solvent extraction processes for lube oil base stock and for aromatics from naphtha and kerosene steams, solvent dewaxing.
Conversion Processes: Thermal cracking: visbreaking and coking processes, catalytic cracking, thermal reforming and catalytic reforming, alkylation, polymerization, isomerisation and hydroprocessing.
Safety and pollution considerations in refineries.
Teaching Scheme and syllabi of B.E. (Chemical Engineering) [2015-2016]

**Books Recommended:**


Paper Title: CHEMICAL REACTION ENGINEERING–I (Theory)
Paper Code : CHE 503   Max. Marks 50  Credits : 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**

- Introduction and a brief review of the kinetics of homogeneous reactions.
- Interpretation of rate data from constant volume and constant pressure systems.
- Single Ideal reactors.
- Design for single reactions.

**SECTION-B**

- Design for multiple reactions.
- Thermal characteristics of reactors: temperature and pressure effects.
- Non-ideality in reactors and its effects on chemical conversion. One parameter models to represent the behaviour of chemical reactors.

**Books Recommended:**


Paper Title: MASS TRANSFER – I (Theory)
Paper Code : CHE 504   Max. Marks 50  Credits : 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**

- Mass transfer operations, classification of mass transfer operations, choice of separation methods, methods of conducting mass transfer operations, design principles.
- Introduction to mass transfer and diffusion, molecular diffusion in gases and liquids, diffusion coefficients for gases and liquids, diffusion in solids, types of solid diffusion.
- Mass transfer coefficients, types of mass transfer coefficients, mass transfer coefficients in laminar flow, theories of mass transfer.
- Interphase mass transfer, concept of overall mass transfer coefficient.
SECTION-B

Working principle, construction and industrial applications of various gas liquid contacting equipments like sparged vessels, mechanically agitated vessels, tray towers, packed towers, spray chambers, venturi scrubbers.

Humidification operations, psychometric chart, adiabatic saturation temperatures, wet bulb temperature, adiabatic operations, types of cooling towers.

Principle of drying, batch drying, drying curve, constructional details and working of different dryers.

**Books Recommended:**


Paper Title: CHEMICAL TECHNOLOGY (INORGANIC) (Theory)

Paper Code : CHE 505  Max. Marks 50  Credits : 4  Time: 3 hours

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**

Chlor-Alkali Industry: Voltage efficiency, Current efficiency, Current density, Decomposition efficiency, Manufacture of soda ash by Solvay and Modified Solvay process, Manufacture of caustic soda.

Sulphuric Acid: Introduction, Manufacture of sulphuric acid by Chamber and Contact process, Material of construction, Storage and handling.


Ceramics: Introduction, Properties of ceramics, Classification of refractories, Important steps involved in the manufacture of refractories.

**SECTION-B**

Industrial gases: Manufacture and uses of carbon dioxide, oxygen and nitrogen, acetylene.

Paints: Introduction, Classification of paints, Manufacture of paints, Requirement of a good Paint.

Books Recommended:


Paper Title: PROCESS PLANT DESIGN –I (Practical)

Paper Code CHE 551     Max. Marks 50     Credits : 2

2. Selection, specification & power requirements of process pumps, fans and blowers.
3. Design of settling equipments like Dor thickeners, dust chambers, cyclone separators and centrifuges.
4. Design of agitated vessels using various types of impellers.
5. Design of Conveyor system for solids.

Books Recommended:


Paper Title: CHEMICAL TECHNOLOGY LAB (INORGANIC) (Practical)

Paper Code CHE 552     Max. Marks 50     Credits : 2

1. Fertilizers (i) Determination of N-P-K Values
(ii) Determination of micronutrients
2. Cement: Loss of ignition, silica, insolubles, estimation of Mg, Ca, Fe.
3. Water

Paper Title: PETROLEUM PROCESSING ENGINEERING LAB. (Practical)

Paper Code CHE 553     Max. Marks 50     Credits : 2

1. To plot ASTM distillation curve for gasoline, diesel oil.
2. To determine Flash point (Closed – cup) and smoke point for kerosene.
3. To determine Aniline point, Diesel Index and cetane number for diesel oil.
4. To determine pour point and cloud point for furnace oil and diesel oil.
5. To determine viscosity at different temperatures using Ostwald viscometer for hydrocarbon solvents.
6. To determine softening point and penetration number for asphalt and grease samples.
7. To determine viscosity index of lubricating oil by Redwood viscometer.
8. To determine water content in petroleum products by Dean and Starks method.
Errors analysis, Solution of linear and non-linear algebric equations.
Numerical differential & integration.
Interpolation.
Least squares approximation.
Ordinary and partial differential equations.
Development of computer programs based on the above topics using Matlab and their applications in chemical process computations.

**Books Recommended:**

SYLLABUS FOR
BACHELOR OF ENGINEERING (CHEMICAL)
SIXTH SEMESTER

Paper Title: CHEMICAL REACTION ENGINEERING-II (Theory)

Paper Code: CHE 601  Max. Marks 50  Credits: 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A
Heterogeneous catalyses: A brief review of catalyses catalytic specificity. Preparation testing and characterisation of catalysts, catalyst poisoning and catalyst regeneration
Fluid Solid catalytic reaction: Kinetics; external transport processes, Reaction -and diffusion within porous catalysts. Effective diffusivity, thermal conductivity and effectiveness factors.

SECTION-B
Fluid - fluid reactions rate equations and their application to the design of reactors.
Fluid Solid non-catalytic reactors rate equations and their application to the design of reactors.
Analysis of rate data design outline and selection of fixed bed, fluidised bed and slurry reactors for fluid solid catalytic reactions.

Books Recommended:
1. Levenspiel, O : Chemical Reaction Engg., John Wiley

Paper Title: MASS TRANSFER-II (Theory)

Paper Code: CHE 602  Max. Marks 50  Credits: 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

**SECTION-B**

_Liquid-Liquid Extraction_: Ternary Equilibria and its representation on various plots. Selection criteria for solvent, Multistage extraction using partially miscible & immiscible solvents. Stagewise contact for countercurrent and crosscurrent extraction. Constructional details of equipment like mixer-settler, packed columns, pulsed extractor, sieve-tray extractor and centrifugal extractor.

_Leaching_: Preparation of solid, countercurrent and crosscurrent multistage contact Shank’s system. Constructional details of equipment like Rotocel extractor, Hildebrandt extractor, Bollman extractor, Kennedy Extractor & Beet-Sugar Diffusion battery extractor.

_Adсорption_: Types of adsorption, nature of adsorbents, equilibria for adsorption systems. Brief manufacture and commercial applications and characteristics for common adsorbents. Stagewise & continuous contacting of fluid and solid phase. Description of contact filtration adsorption system. Hypersorber Ion-exchange system.


**Books Recommended:**


Paper Title: Open Elective-II (Theory)  
Paper Code: CHE 603 Max. Marks 50 Credits: 4 Time: 3 hours  
Course Duration: 45 Lectures of one hour each.  
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

1. **RESEARCH METHODOLOGY**

**SECTION-A**

_**Introduction**_: Meaning, Features, Objectives/Motives & types of Research; Attributes of good Research, Research Methods and Research Methodology; Research Process, Significance of Research in Managerial decision making.

_**Research Design**_: Meaning, Characteristics and various concepts relating to research design and
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classification of research design, Importance.

**Measurement and Scaling:** Data Types Nominal, Ordinal and Ratio scale; scaling techniques.

**Formulation of Hypothesis:** Meaning, Characteristics and concepts relating to testing of Hypothesis (Parameter and statistic, Standard error, Level of significance, type-I and Type-II errors, Critical region, one tail and two tail tests); Procedure of testing Hypothesis. Numerical problems based on chi-square test and Ftest (variance ratio test only).

**SECTION – B**

**Data Collection:** Sources of Data-Primary/Secondary Methods of collecting data; direct personal interview, indirect oral interview, information through local agencies, mailed questionnaire method, schedule sent through enumerators; questionnaire and its designing and characteristics of a good questionnaire.

**Sampling Design:** Meaning and need of Sampling, Probability and non-probability sampling design, simple random sampling, systematic sampling, stratified sampling, cluster sampling and convenience, judgement and quota sampling (non-probability), determination of sample size.

**Data Analysis & Interpretation:** Introduction to Multivariate analysis- Multiple and partial correlation, multiple regression analysis (with two independent variables), specification of regression models and estimation of parameters, interpretation of results. Analysis of Variance (ANOVA)-One way and Two way ANOVA. Introduction to discriminant analysis and Factor Analysis (Numerical not to be asked)

**Report writing:** Style/format, contents and essential steps for report writing.

**Suggested Readings:**
2. Ranjit Kumar: Research Methodology, Pearson Education 2009-02-20
3. Donald R. Cooper Pamela S. Schindler: Business Research Methods, Tata McGraw Hill
5. R. Pannerselvam: Research Methodology, Parentice Hall of India Limited.
7. William G. Zikmund : Business Research Methods, Thomson South Western Publication

2. INTRODUCTION TO BIOCHEMICAL ENGINEERING


**Books Recommended:**
3. MEMBRANE SEPARATION PROCESSES (Theory)

SECTION-A

Fundamental, Mechanism of Membrane Transport, gaseous diffusion, separation in liquid phase, dialysis, reverse osmosis, ultra filtration liquid membrane.

SECTION-B


Books Recommended:

Paper Title: CHEMICAL TECHNOLOGY (ORGANIC) (Theory)

Paper Code : CHE 604  Max. Marks 50  Credits : 4  Time: 3 hours

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A


Soaps and Detergents: Introduction, Raw materials, Manufacture of soap, Classification of detergents, finishing of detergents.

Water: Sources and Constraints, Consumption patterns; Impurities: dissolved, suspended, colloidal; Hardness of water; Water softening; Lime soda, Ion exchange.

Desalination: Classification of processes; Evaporative processes, Multieffect evaporation, multistage flash, vapour compression; Membrane processes, Reverse osmosis, electrodialysis.

SECTION-B


Sugar: Introduction; Sugar extraction, defacation, sulphitation, carbonation, concentration, crystallization, drying, refining; Uses of molasses and bagasse.

Carbon Technology: Introduction, Classification of activated carbons, raw materials and manufacture of activated carbons, precursors for carbon fibres, manufacture of carbon fibres from polyacrylonitrile, manufacture of carbon black by furnace black process, applications.

Nanotechnology: Introduction and synthesis of nano particles by RF plasma process.

Books Recommended
Paper Title: TRANSPORT PHENOMENA (Theory)

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

**SECTION-A**

Transport of momentum, heat and mass by molecular motion-Newton’s law of Viscosity, Fourier’s law of heat conduction, Fick’s law of diffusion.

Transport properties – Viscosity, thermal conductivity and mass diffusivity.

Emphasis on the analogy between momentum, heat and mass transfer with respect to transport mechanism and governing equations.

Development of mathematical models of transfer process through shell momentum balance, shell energy balance and shell mass balance for solving specific problems of transport of momentum, heat and mass in laminar flow or in solids in one dimension.

**SECTION-B**

Development of general differential equations of fluid flow, heat transfer and mass transfer and their applications in solving one-dimensional steady state and unsteady state problems of momentum, heat and mass transfer.

Interphase transport of momentum, heat and mass and dimensionless correlation for each one of them.

Momentum, heat and mass transfer analysis.

**Books Recommended:**


Paper Title: HEAT TRANSFER LAB. (Practical)

Paper Code CHE 651 Max. Marks 50 Credits : 2

1. Determination of heat transfer coefficient for different types of heat transfer equipment. Wilson plots.
2. Unsteady state heat transfer in jacketed vessels. (Open pan evaporator)
3. Correlation of instantaneous heat transfer coefficients with time study deposition of scale on a heating surface.
4. Determination of heat losses for insulated pipes
5. Study of double pipe heat exchanger and to determine overall heat transfer coefficient
6. Study the performance characteristics of a 1,2 - shell and tube heat exchanger
7. Study and operation of long tube, forced circulation and multiple effect evaporators.
8. Duhring plot for solutions involving nonvolatile solutes.
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Paper Title : REACTION ENGINEERING LAB. (Practical)
Paper Code CHE 652     Max. Marks 50  Credits : 2
1. Kinetic studies in a batch reactor.
2. Kinetic studies in a plug flow reactor.
3. Kinetic studies in a CSTR.
4. Kinetic studies in a semi batch reactor.
5. RTD studies in CSTR.
6. Dispersion number for packed bed reactor.
7. Adiabatic batch reactor.

CHE 653   PROCESS PLANT DESIGN–II     Max. Marks 50  Credits : 2
1. Process design and specifications of double pipe heat exchanger, shell and tube heat exchanger, plate type heat exchanger, condensor and reboiler.
2. Equilibrium procurement techniques – experimental and use of thermodynamics for its evaluation and then use in design height of distillation column. Calculations using McCabe Thiele, Plate-to-Plate calculation methods for fractionators, design of batch fractionating columns, design of fractionator internals for sieve-tray.
3. Absorber/Stripper design of stage-wise and continuous contact equipment (packed column), height of column and diameter calculation, design of various internals of absorber/stripper.
4. Process flow sheets, material and energy balance flow sheeting analysis.

Books Recommended:

Paper Title : CHEMICAL TECHNOLOGY LAB. (ORGANIC) (Practical)
Paper Code CHE 654     Max. Marks 50  Credits : 2
1. Oils & Fats: Determination of Acid value, Iodine value, Saponification value.
2. Carbohydrates: Reducing and non reducing sugars by (i) Fehlings method (ii) Pavy’s method.
3. Soaps: Determination of free and combined alkali, total fatty matter, moisture and insoluble.
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SEVENTH SEMESTER

Paper Title: PROCESS ENGINEERING ECONOMICS (Theory)
Paper Code: CHE 701 Max. Marks 50 Credits: 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A


Interest and Investment Costs: Simple and compound interest. Nominal and effective rates of interest. Continuous interest ordinary annuity. Perpetuities and capitalized costs.

Taxes and Insurance: Types of taxes and tax returns, types of insurance and legal responsibility.

Depreciation: Types of depreciation. Service life salvage value, present value and methods of determining depreciation, single unit and group depreciation.

SECTION-B


Optimum Design: Procedure with one variable, optimum reflux ratio in distillation and other examples.


Books Recommended:

General Concept: Need and classification of measurements and instruments, Basic and auxiliary functional elements of a measurement system.

Static and Dynamic Characteristics of Instruments:
Static Characteristics: Range and span, accuracy and static error, reproducibility and drift, sensitivity and dead zone.
Dynamic Characteristics: Speed of response and lag, fidelity and dynamic error, dead time.

Temperature measurement:
Thermocouples, metal resistance thermometers and thermistors, optical and radiation pyrometers, radiation receiving elements.

Pressure measurement:
Use of manometers, Bourdon gauge, bellows type gauge. Vacuum measurement–McLeod gauge, thermoionic type ionization gauge, pirani vacuum gauge. Measurement of pressure in corrosive fluids: Diaphragm seal, liquid seal and purge system.

Liquid level measurement:
Direct measurement of liquid level –Float & tape liquid level gauge, float and shaft liquid level unit, hydraulic remote transmission of liquid level.
Level measurement in open vessels: Bubbler system, diaphragm box system, air trap system. Level measurement in pressure vessels – Differential pressure manometer, use of liquid seals with a manometer, displacement float liquid level gauge.
Measurement of viscosity, conductivity, humidity and pH.
Density measurement – liquid level method, displacement meter and hydrometer.
Measurement of weight – spring scale, pneumatic force meter and hydrostatic force meter.

Process Instrumentation–Recording instruments, indicating and signaling instruments, control centre, transmission of instrument reading, instrumentation diagrams.

Books Recommended:
1. Eckman, Donald P. : Industrial Instrumentation, CBS Publisher and Distributors, Indian Reprint 2004.
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Paper Title: Department Elective -1 (Theory)
Paper Code: CHE 703  Max. Marks: 50  Credits: 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

1. ANALYTICAL TECHNIQUES (Theory)

Section A
1. **Complexometric titrations**: Complexes-formation constants; chelates – EDTA, Chelone Effect, EDTA equilibria, effect of pH on EDTA equilibria, EDTA titration curves, endpoint – detection and indicators; Importance of complexometric titrations.
2. **Solvent Extraction**: Distribution law, extraction process, factors effecting extraction, technique for extraction, quantitative treatment of solvent extraction equilibria, classification of solvent extraction systems. Advantages and applications of solvent extraction.
4. **Thermoanalytical methods**: Principle, classification of methods.
   - TGA – Instrumentation, factors affecting results and analysis of data. applications.
   - DTG – Instrumentation, analysis of data and applications.
   - DTA – Principle, Instrumentation and applications.

Section B
7. **NMR**: Principle, chemical shift, spin-spin coupling shift reagents, instrumentation, spectra and molecular structure, identification of organic compounds on the basis of NMR.

**Electron Microscopy**:
- Introduction to electron microscopy, classification of electron microscopy methods, Scanning electron microscopy, Instrumentation and applications. Scanning Tunnelling microcopy –Principle and comparison with SEM
- **Atomic force microscopy (AFM)** - Principle Instrumentation and its basic application

**Books Recommended**:
2. POLYMERIC SCIENCE AND ENGINEERING (Theory)

SECTION-A

Chemistry of polymers:
Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness,
Polymerization methods: addition and condensation; their kinetics, copolymerization, monomer reactivity ratios and its significance, kinetics, different copolymers, random, alternating, azeotropic copolymerization, block and graft copolymers, techniques for copolymerization-bulk, solution, suspension, emulsion.

Polymer Characterization:
Solubility and swelling, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, polymer crystallinity, analysis of polymers using IR, XRD, thermal (DSC, DMTA, TGA), microscopic (optical and electronic) techniques.

SECTION-B

Polymer Technology:
Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, crosslinking and vulcanization

Polymer processing:
Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer

Books Recommended:

Paper Title: Department Elective -I (Theory)
Paper Code : CHE 704 Max. Marks 50 Credits : 4 Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.
1. Alternate Energy Technology

SECTION-A

Solar Energy Fundamentals, Solar Radiation Characteristics and Measurements. Low temperature energy collection, high temperature energy collection, solar thermal power generation systems, Domestic industrial and agricultural applications of solar energy.

SECTION-B


Books:
Energy Technology, S. Rao, Dr. B.B. Parulekar, Khanna Publisher, 2000.
Non Conventional Energy Sources, G.D. Rai, Khanna Publisher, 1997

2. LOW TEMPERATURE ENGINEERING

SECTION-A


SECTION-B


Books Recommended:
3. PLANT UTILITIES (Theory)

SECTION-A

Importance of Process utilities in Chemical Plant.
Compressed air and Vacuum: Reciprocating air compressors, vacuum pumps, air receivers, piping systems.
Steam: Boiler, steam handling and distribution steam nozzles.

SECTION-B

Refrigeration: Air refrigeration cycle, vapour compression cycle, liquification processes.
Power Generation: Internal Combustion engines. Gas turbines, steam power plants.

Books Recommended:

Paper Title : PROCESS PLANT DESIGN-III (Practical)
Paper Code CHE 751        Max. Marks 50        Credits: 2
1. Design of liquid-liquid and liquid-solid extraction equipment (stagewise and continuous contact).
2. Design of Heterogeneous catalytic Reactors.
   2.1 Fixed-bed reactors
      (i) Isothermal and adiabatic
      (ii) Non-isothermal non-adiabatic
   2.2 Fluidized-bed reactors
      (i) Two-phase fluidized bed model
      (ii) Slurry reactors and
      (iii) Trickle-bed reactors.
3. Layout of chemical plant equipment, safety and hazard aspects of layout.

Books Recommended:
Paper Title: MASS TRANSFER LAB. (Practical)
Paper Code CHE 752   Max. Marks 50   Credits: 2
1. Determination of mass transfer coefficients for naphthalene-air system.
2. To determine drying rate curves for different wet solids in a batch drier under constant drying conditions.
3. Fractional approach to equilibrium for liquid-liquid extraction from single drop.
4. Verification of Rayleigh’s equation for differential distillation.
5. Determination of flooding velocities in packed columns.
6. Determination of HETP for packed distillation columns.
7. Study and operation of a pilot sized distillation column under total reflux.
8. Study of different mass transfer equipments.

Paper Title: PROJECT WORK
Paper Code CHE 851
Each student is required to submit a project report on the design of a chemical plant, selecting the best process with optimum equipment size and operating conditions. The object is to test the ability of the student to apply his entire knowledge of Chemical Engineering principles to conceptualize, analyze and solve the problems. To judge his knowledge and originality and capacity for application of laboratory data in designing chemical plants and to determine the level of his proficiency at the end of the course.
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SYLLABUS FOR
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EIGHTH SEMESTER

Paper Title: INDUSTRIAL SAFETY & HAZARDS (Theory)
Paper Code: CHE 801  Max. Marks 50  Credits: 4  Time: 3 hours

Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Definition, identification, classification and assessment of various types of hazards in work-place environment, protective and preventive measures in hazard control. 
Toxic Chemicals: maximum allowable concentrations and other standards. Biological threshold limit values. 

SECTION-B


Books Recommended:

Paper Title: PROCESS DYNAMICS & CONTROL (Theory)
Paper Code: CHE 802  Max. Marks 50  Credits: 4  Time: 3 hours

Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

SECTION-A

Incentives for chemical process control, design aspects of a process control system. Difference between feedback and feed forward control configuration. Hardware elements of a control system, Block Diagrams.

Laplace transform and transfer functions. Difference between lumped and distributed parameter systems, Dynamic behaviour of first and higher order systems, interacting and non-interacting systems, dead time.
Different modes of control actions and their basic characteristics, controllers and their characteristics, control valve.

SECTION-B

Closed-loop transfer functions, transient response of simple control systems, Routh stability criterion, Root Locus.

Introduction to frequency response: Bode diagrams, control system design by frequency response: Ziegler-Nichols controller settings, stability using frequency response, gain margin and phase margin.

Introduction to advanced control techniques such as cascade control, feed forward control, ratio control, inferential control.

Books Recommended


Paper Title: Open Elective-III (Theory)

Paper Code: CHE 803       Max. Marks 50       Credits : 4       Time: 3 hours
Course Duration: 45 Lectures of one hour each.
Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

1. PROJECT MANAGEMENT

SECTION-A

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

Feasibility studies: Preparation of techno-economic feasibility report, feasibility analysis technical economic, commercial and financial planning: Network analysis, PERT/CPM Bar chart.
Preconstruction Planning. Project Scheduling control and Monitoring: Resource Scheduling, manpower scheduling, multi project scheduling, cost scheduling, PERT/Cost scheduling optimisation, crash costing and updating and leveling of resources, Implementation of Project schedules. Financial Control: Budgeting and cost control, sources of long term funds for business, Planning and capital structure, problems of working capital management and liquidity.

Books Recommended:


2. FINANCIAL MANAGEMENT

SECTION-A

Introduction to Financial Management: Meaning; Scope; Finance Function; Financial Goals; Agency Problem; Relationship of Finance with Accounts and Economics.

Sources of Finance: Features; Advantages and Limitations of Equity Shares; Preference Shares;Debentures; Term-Loans; Right Issue, Venture Capital, Private Equity GDR, ADR.

Cost of Capital: Meaning; Calculation of Cost of Debt Capital; Equity Capital; Preference Capital; Retained Earnings; Weighted Average Cost of Capital.

Capital Structure: Meaning; Determinants; Assumptions; Net Income and Operating Income Approach; Traditional Position; M-M Position; EBIT and EPS Analysis; Capital Structure and Taxation.

Leverage Analysis : Meaning; Types; Estimation of Financial; Operating and Combined Leverage; Relation of Financial Leverage with Risk and Return.

Management of Working Capital : Meaning of WC; Need of WC Management; Determinants of WC; Operating Cycle; Estimation of WC; Working Capital Financing; Trade Credit, Bank finance, commercial paper, factoring, money market instruments.

SECTION-B

Cash Management: Meaning; Facets of Cash Management; Motives for Holding Cash; Optimal Cash Balance; Short-term and Long-Term Cash Forecasting.

Receivable Management: Meaning; Credit Policy Variable; Credit Evaluation; Credit Decisions; Control of Account Receivable.

Inventory Management: Meaning; Need to hold Inventory; Objective of Inventory Management; Inventory Investment Analysis; Inventory Control System.

Capital Budgeting: Meaning; Basic Principles of Costs and Benefits; Investment Criteria; Pay back Method; Accounting Rate of Return method; Net Present Value Method; Benefit-Cost Ratio; Internal Rate of Return; Capital Rationing; Introduction to Basic Techniques of Risk Analysis in Capital Budgeting.

Dividend Decisions: Meaning and Types of Dividend; Issues in Dividend Policy; Traditional Model; Walter Model; Gordon Model; Miller and Modigliani Model; Bonus Shares and Stock Splits.
Corporate Restructuring: Meaning and forms of corporate restructuring, merger and amalgamation takeover and acquisition, types or forms of mergers and takeovers, their benefits and motives.

Suggested Readings:

3. HUMAN RESOURCE MANAGEMENT (Theory)

SECTION-A

Introduction: Meaning, scope, objectives and functions of HRM; Importance of Human Resource Management; HRM & HRD a comparative analysis;

Environment of HRM: Role of government, internal and external forces; Human Resource Management practices in India.

Human Resource Planning: Definition, objectives, process and importance; Job analysis, description, specification & job evaluation; Recruitment, selection, placement and induction process;

Human Resource Development: Concept, Employee training & development; Career Planning & development; Promotions, demotions, transfers, separation, absenteeism & turnover;

SECTION-B

Job Compensation: Wage & salary administration, incentive plans & fringe benefits.

Performance Management: Concept & process, performance appraisal, Potential appraisal;

Quality of work life (QWL): Meaning, techniques for improving QWL.

Industrial Relations: Concept and theories, trade unions; Health, Safety & Employee welfare measures; Employee grievances and discipline, participation & empowerment; Introduction to collective bargaining.

Books Recommended:
SECTION – A

Overview of Industrial Relations: Concept of IR, Nature of IR, Objectives of IR, Evolution of IR in India, Theories of IR, Systems approach to IR.
Trade Unionism: Concept of Trade Unions, Functions of Trade Unions, Approaches, Structures of Trade Unions.
The Trade Unions Act, 1926: Trade Union, Registration of Trade Unions, Rights and Liabilities of registered trade unions.
Grievance Handling: Grievance, Causes/Sources of Grievances, Grievance Redressal Machinery, Legislative Aspects of the Grievance Redressal Procedure in India, Domestic enquiry.

SECTION – B

The Workmen's Compensation Act, 1923: Workman, employer’s liability to pay compensation, disablement, amount of compensation.
Tripartite and bipartite bodies: Workers Participation in Management.
Industrial Relations and emerging scenario: Industrial Relations and technological change, International Labour Organisation (ILO): Objectives and Structure, Future of Industrial Relations
Standing Orders Act, 1948: Standing orders, certification of draft standing orders, duration and modification of certified orders.
Employee’s State Insurance Act, 1948: Contribution, principle employer, immediate employer, different benefits.

Suggested Readings:
6. S.N. Dhayani: Industrial Relations System, Sultan Chand and Sons

Paper Title: Departmental Elective-III (Theory)
Paper Code: CHE 804  Max. Marks 50  Credits: 4  Time: 3 hours
Course Duration: 45 Lectures of one hour each.
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Note for the Paper setter: The question paper should be divided into Section A and Section B Total of 8 questions. 4 questions from section A and 4 questions from section B are to be set. The students will be required to attempt 5 questions selecting at least 2 from each section.

1. PETROCHEMICAL TECHNOLOGY

SECTION-A

*General Introduction:* Definition, history and economic perspective of petrochemical industry, raw materials for petrochemical industry-petroleum, natural gas, coal, bio-mass, agro-residues, etc.

*First Generation Petrochemicals:* Petrochemicals based on aliphatic, olefinic, acetylene, aromatics, etc. Hydrocarbons-processing and applications.


SECTION-B

Nylon Monomers, Polyester Monomers, Styrene, Other Monomers - Bisphenol A, Epichlorophydrin, diisocyanates, Pentaerythritol, etc. - properties, process technologies and applications.

*Third Generation Petrochemicals:* Important Polymers such as Polyethylene, Polypropylene and their Copolymers and other Derivatives Rubbers, Diene Polymers, Styrene Polymers, Vinyl Polymers and Condensation Polymers - properties, process technologies and applications.

**Books Recommended:**

2. NANO TECHNOLOGY (Theory)

SECTION-A

*Introduction:* Plenty of room at the bottom-Feynman’s concept, evolution of ultra-fine materials, the missing link between conventional laws in physics and chemistry and new theories.

*Building Blocks of Nanotechnology:* covalent architecture, coordinated architecture and weakly bound aggregates, Interactions and topology

*Chemical Properties:* The effect of nanoscale metals on chemical reactivity, effect of nanostructure on mass transport, metal nanocrystallites support on oxides, supported nanoscale catalysts.

**General principles for synthesis** of monodispersed nanoparticles, metals and intermetallics, Ceramics, composites, nanoparticles, colloids/Micelles/vesicles/Polymers/glasses, Crystalline, and zeolite hosts.
Review of fundamental behaviour of 0-D(nanoclusters), 1-D(nanowires), 2-D(thin film multilayers), and 3-D(bulk nanostructures) materials. Introduction to size dependent phenomenon in nanostructure for various applications, specific production techniques like chemical vapor deposition, arc ignition etc. Formation of clusters and nanoparticles from supersaturated vapor and selected properties, sputtering and thermal evaporation and laser methods. Synthesis of nanoparticles by chemical routes.

SECTION-B

Approaches to production: Top down and bottom up, Mechanical attrition, high energy ball milling, and mechanical attrition, nanocomposites by mechano-chemistry, mechanism of grain size reduction, property of microstructure relationships.

Characterization techniques: Tools in nanotechnology: Scanning electron microscopy(SEM), Transmission electron microscopy and high resolution(TEM), energy dispersive spectroscopy (EDX), Atomic force microscopy(AFM), Magnetic force microscopy(MFM), Chemical Force Microscopy(CFM), Focused ion beam, nanolithography, powder x-ray diffractometry, UV visible.

Nanomaterials: CNTs, Polymer Nanocomposites nanoceramics, nanometals, nanopolymers, structures-properties-applications, Quantum dots. Concepts Bio-Nanotechnology.

Applications: Nanotherapeutics, Molecular diagnostics, tissue engineering, nanopumps, nanorobotoics cells, molecular motors, nanomembranes, Organic molecular based computers, bionanodevices (sensors & actuators).

Books Recommended
2. Nanotechnology – An introduction to nanostructure of technique by Michel Kohler and Wolfgang Frittsche 2004- Wiley VCH
3. Springer Handbook of Nanotechnology by Bharat Bhushan
5. Nanostuctures and Nanomaterials by G. Cao, Imperial College Press, 2004
6. Introduction to Nanotechnology by Owen and Poole, Wiley

4. Complex Flow Hydrodynamics

Section-A

Shell balance for momentum transfer: Velocity profiles; Residence time distribution measurement techniques; RTD for single phase flow in tubes, coils, packed beds, stirred vessels;

Rheology of Fluids and Suspensions.

Motion of particles, drops and bubbles through quiescent Newtonian and non-Newtonian fluids. Drop/Bubble shapes characterization. Drag and terminal velocity of particles, bubbles and drops.
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Section-B

Operational hydrodynamic characteristics of: Packed beds, fluidised beds, trickle beds, bubble columns, spray columns, plate columns.

Prediction of pressure drop; friction factor; drag coefficient, single phase flow, multiphase flow; Lockhart Martinelli approach.

Reference Books


4. Fluidization Engineering

SECTION-A

Introduction to fluidisation, Industrial applications, Behaviour of fluidised beds----classification of particles, regimes of fluidization, minimum fluidization velocity, particulate and aggregative fluidization, Bubbling fluidization, Bubbling bed models for catalytic reactions.

SECTION-B

Turbulent and fast fluidization, dilute and dense phase transport, cyclone, stand pipes, circulating fluidized beds, spouted beds, three phase fluidization, performance modeling of multiphase fluidized systems.

Reference Books:

5. POLYMER SYNTHESIS AND CHARACTERIZATION

Section A

Step reaction (condensation) polymerization – Mechanism of step reaction polymerization, carbonyl addition elimination, carbonyl addition – substitution, nucleophilic substitution, and aromatic electrophilic substitution. Kinetics of step reaction polymerization, reactivity and molecular size. Kinetic expressions for polymerization in absence and in presence of a catalyst. Statistics of linear step reaction polymerization – number distribution and weight distribution functions, molecular weight control, Polyfunctional step reaction polymerization, prediction of gel point, its experimental observation, molecular wt. distribution

Free radical vinyl polymerization: free radical initiators, techniques for free radical polymerization (bulk, suspension, solution, and emulsion), kinetics and mechanism of polymerization, monomer reactivity, and copolymerization, Controlled/”living” radical vinyl polymerization: ATRP (Atom Transfer Radical Polymerization) and RAFT (reversible addition-fragmentation chain transfer radical polymerization)

Vinyl polymerization with ionic initiators: cationic polymerization and anionic polymerization, Vinyl polymerization with complex coordination catalysts: Ziegler-Natta catalysts

Copolymerization – types of copolymerization- the copolymer composition equation, monomer reactivity rations, rate of copolymerization, composition of copolymers, variation of copolymer composition with conversion, mechanisms of copolymerization, block and graft copolymers.

Section B

Chemical analysis: Introduction, Physical tests, burning characteristics, Density, refractive index, chemical tests. Qualitative and quantiative elementary analysis, Solubility and acid numbers, acetyl number, iodine number end group analysis

Other Polymer Characterization Techniques; Differential Scanning Calorimetry, Dynamic Mechanical Analysis, Thermogravimetric Analysis, Gel Permeation Chromatography Viscosity, Nuclear Magnetic Resonance spectroscopy, Infrared spectroscopy,

5. Polymer Characterization, E.Schröder, G.Müller , K.F.Arnt, Hanser Publishers
Teaching Scheme and syllabi of B.E. (Chemical Engineering) [2015-2016]

Paper Title: PROCESS MODELING & SIMULATION LAB. (Practical)
Paper Code CHE 852       Max. Marks 25        Credit: 1

Functional design, property estimate as inputs for design. System concepts for computer aided design, computer aided flow sheet design. Process analysis. Process variables selection, equipment design through the selection of free parameters subject to constraints and other parameters, modular design. Simulation optimality. Dynamic design including control stability.
Typical equipments to be considered: heat exchangers, distillations columns, reactor and process equipments.

Books Recommended:

Paper Title: PROCESS CONTROL LAB. (Practical)
Paper Code CHE 853       Max. Marks 50        Credits: 2

1. U-Tube manometer
   (a) To plot the response curve for a given input to a U-tube manometer.
   (b) To determine the transfer function from the response curve obtained in part (a).
2. Time constant of a mercury thermometer
   To study the dynamics of the given thermometer and compare the theoretical value of its time constant with the experimental value.
3. Analysis of valve
   Develop a block diagram representing the dynamic behaviour of the given globe valve.
4. (a) Liquid level measurement
   With the given Bubbler System for Liquid Level Measurement, evaluate liquid height in the tank and compare it with actual values.
   (b) Calibration of Pressure Gauge
   Calibrate a pressure gauge in the range 0 psi to 60 psi.
5. Temperature control system
   To maintain the temperature of the fluid at the set point value.
6. Time constant of liquid level tank
   To study the dynamics of liquid level in a tank and compare the analytical value of the time constant with the experimental value.
7. Liquid level control
   (a) To carry out the closed loop experiment on the given liquid level control system and record its response for step change in the inlet flow.
   (b) To plot the experimental response curve and comment on the response obtained.
8. Compurec
   Pressure control simulation with step input and sinusoidal input.

Paper Title: LITERATURE SURVEY, REPORT WRITING AND SEMINAR
Paper Code CHE 854       No Credit       Qualifying

Forms of technical reports: aims and forms according to type of readership and extent of circulation. Abstracts, extended abstracts, tables, graphs. Visual representation of data: slides, microfilms, other techniques including those of audio-visual representation. Correct use of audio equipment.
Teaching Scheme and syllabi of B.E. (Chemical Engineering) [2015-2016]

Research papers and their presentation and publication. Information retrieve direct and through abstracts.
Practical training in writing and presentation of technical reports through audio-visual means. Technique of effective public speaking organized and imprompt discussions.
Preparation of technical report on an assigned topic after survey of scientific, technical and commercial literature, using card indexes, microfilms and other information retrieval methods.
Use of Computer softwares for report writing.

**Books Recommended:**

2. Sittle, R.T. : The Use of Chemical Literature, Butter Worths.

**Paper Title : VIVA VOCE-II (COMPREHENSIVE)**
**Paper Code** CHE 855  **Max. Marks** 50  **Credits:** 2

The viva-voce examinations will be comprehensive and covering mainly chemical engineering and technology subjects covered during all the semester including the Eight Semester.