### Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
**[2020-2021]**

#### Fifth Semester

<table>
<thead>
<tr>
<th>S No.</th>
<th>Course code</th>
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<th>P</th>
<th>Credits</th>
<th>Practic al</th>
<th>Mid term</th>
<th>End term</th>
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|   | Total       | 15 | 5 | 12 | 24 | 100 | 250 | 250 | 600 |

**Total contact hours/week**

32

**Note:**

- Sports proficiency/Community services/ Professional society activities/Technical activities related to the field of Engineering (1st to 3rd year, 2 credits to be earned in 7th semester)
- Discipline (1st to 4th year, 1 credit to be earned in 8th semester)
### Sixth Semester

<table>
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**Note:**

- Sports proficiency/Community services/ Professional society activities/Technical activities related to the field of Engineering (1st to 3rd year, 2 credits to be earned in 7th semester)
- Discipline (1st to 4th year, 1 credit to be earned in 8th semester)
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<th>End term</th>
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**Note:**
- Sports proficiency/Community services/ Professional society activities/Technical activities related to the field of Engineering (1st to 3rd year, 2 credits to be earned in 7th semester)
- Discipline (1st to 4th year, 1 credit to be earned in 8th semester)
**Eighth Semester**

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**Total contact hours/week** 23

*‘S’ (Satisfactory) or ‘X’ (Repeat)*

**Note:**
- Discipline (1st to 4th year, 1 credit to be earned in 8th semester)
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<td>Industrial Safety and Hazards</td>
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<td></td>
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<td>6</td>
<td>Project Management and Entrepreneurship</td>
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**Note:**

1. Mid term evaluation shall be as per the format already approved by the competent authority (as indicated in the scheme already approved for the first year).
2. Departmental electives (I, II and III) shall be offered amongst the list indicated above depending on the available resources.
3. Open electives (I, II and III) shall be offered amongst the list indicated above depending on the available resources.
4. List of electives (open and departmental) is subject to change and as approval of the competent authority from time to time.
## SYLLABUS OF B.E. CHEMICAL ENGINEERING 2020-2021
### Fifth Semester

<table>
<thead>
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<th>Title</th>
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### THEORY

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**


### Recommended Books

**THEORY**

**Note for the Examiner:**
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.

*Solid Fuels:* Origin of coal, proximate and ultimate analysis of coal, coal preparation and washing methods, safe storage of coal. Low and High temperature carbonization, products of carbonization, By product coke ovens. Synthetics fuels from coal –Bergius process and Fischer Tropsch process.

*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**

*Principles of combustion:* Combustion calculations, waste heat utilization.

*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.

**Recommended Books**

### CHEMICAL REACTION ENGINEERING–I

<table>
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<td>Mid term 50</td>
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<td>Practical: 25</td>
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<td>Hours</td>
<td>42 (Theory) 14 (Practical Sessions)</td>
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**THEORY**

**Note for the Examiner**

**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.

**Practical**

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.

**Recommended Books**


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### MASS TRANSFER – I

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<td>End term 50</td>
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**THEORY**

**Note for the Examiner**

**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.
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

**Recommended Books**


**Title**  
**CHEMICAL TECHNOLOGY**  
**Credits**  
5

<table>
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<td>Mid term 50</td>
<td>Practical-25</td>
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**THEORY**

Note for the Examiner: 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**

Chloralkali industry: Electrochemistry of brine electrolysis, current efficiency, energy efficiency, diaphragm, mercurcy and dow Cells, caustic soda, chlorine.

Soda Ash: Manufacture of soda ash by Solvay and Modified Solvay process., handling and safety.
**Sulphuric Acid:** Introduction, Manufacture of sulphuric acid by Chamber and Contact process, Material of construction, Storage and handling.

**Cement:** Types of cement, Constituents of cement, Manufacture of Portland cement.

Glass-Introduction, Types of glass, Raw materials, Manufacture of glass.

### 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.

**Fertilizers:** Nitrogenous fertilizers- Manufacture of Ammonia, Nitric acid, Urea, CAN, Ammonium Sulphate. Phosphatic fertilizers- superphosphate and triple superphosphate. Potassic fertilizers- Potassium Chloride and Potassium Sulphate, Safety aspects.

**Books Recommended:**


### Practical

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

<table>
<thead>
<tr>
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<th>PROCESS PLANT DESIGN –I</th>
<th>Credits</th>
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<td>Semester:-5th</td>
<td>L T P</td>
<td>- - 3</td>
<td>N</td>
</tr>
</tbody>
</table>

### Recommended Books

4. Peters, M.S. and Timmerhaus, K.D. : Plant Design and Economics for Chemical Engineers
### CHEMICAL ENGINEERING COMPUTATION LAB. (Practical)

<table>
<thead>
<tr>
<th>Title</th>
<th>Credits</th>
<th>Max.Marks</th>
<th>Pre requisites</th>
<th>Practical</th>
<th>Elective</th>
<th>Contact Hours</th>
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<tbody>
<tr>
<td>CHE 307</td>
<td>1</td>
<td>End term</td>
<td>Mid term</td>
<td>Practical: 25</td>
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<tr>
<td>Semester: 5th</td>
<td>L T P</td>
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<td>Mid term</td>
<td>Practical: 25</td>
<td>Elective</td>
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<tr>
<td>Contact Hours</td>
<td>14 Practical Sessions</td>
<td></td>
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</tbody>
</table>

#### Practical

- Errors analysis, Solution of linear and non-linear algebraic 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.

#### Recommended Books:

Sixth semester

<table>
<thead>
<tr>
<th>Title</th>
<th>CHEMICAL ENGINEERING-II</th>
<th>REACTION</th>
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<tbody>
<tr>
<td>Code</td>
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<td>Max.Marks</td>
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<td>Mid term 50</td>
<td>Practical</td>
<td>Elective</td>
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<tr>
<td>Pre requisites</td>
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<td>Contact Hours</td>
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<tr>
<td>THEORY</td>
<td></td>
<td>Note for the Experimenter: 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.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SECTION- B</td>
<td>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.</td>
<td></td>
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<table>
<thead>
<tr>
<th>Title</th>
<th>MASS TRANSFER-II (Theory)</th>
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<td>Max.Marks</td>
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<td>Pre requisites</td>
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<tr>
<td>THEORY</td>
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<td>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.</td>
<td></td>
</tr>
<tr>
<td>Distillation: Limitations and applications, prediction of VLE using thermodynamic &amp; experimental</td>
<td></td>
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</tbody>
</table>

**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, pulse 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.

**Adsorption:** 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.


**Practical**
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.

**Recommended Books**

<table>
<thead>
<tr>
<th>Book</th>
<th>Title</th>
<th>Edition</th>
</tr>
</thead>
</table>
Title | PROCESS DYNAMICS & CONTROL  
Code | CHE 310  
Credits | 5  
Semester: | 6th  
L T P | 3 1 3  
Max. Marks | End term Mid term Practical: Elective  
50 | 50 | 25 | N  
Pre requisite | Contact Hours  
- | 42 (Theory)  
14 (Practical Sessions)  
THEORY  
Note for the Examiner | 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.  
Practical  
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 bahaviour 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.

**Recommended Books**


<table>
<thead>
<tr>
<th>Title</th>
<th>CHEMICAL TECHNOLOGY</th>
<th>Credits</th>
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</thead>
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<td>Max. Marks</td>
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<td>Mid term 50</td>
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<tr>
<td>Pre requisites</td>
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<td>Contact Hours</td>
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</table>

**THEORY**

*Note for the Examiner: 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**

*Oils & Fats:* Introduction, Extraction of oils from vegetable oils, refining of oils and fats, hydrogenation of oils.

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

*Water:* Sources and Constraints, 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**

*Pulp & paper:* Introduction, Raw Materials, types of pulp, Manufacture of paper.

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

*Polymers:* Introduction, Degree of polymerisation, Classification of polymers, Polyethylene, Polyster.
Petroleum Refining: Introduction, composition of crude oil, typical refinery operations like thermal cracking, catalytic cracking

<table>
<thead>
<tr>
<th>Books Recommended</th>
</tr>
</thead>
</table>

Practicals

| 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. |
SEVENTH SEMESTER

<table>
<thead>
<tr>
<th>Title</th>
<th>Transport Phenomena</th>
<th>Credits</th>
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<td>Pre requisites</td>
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<td>Contact Hours</td>
<td>42</td>
</tr>
</tbody>
</table>

THEORY

Note for the Examiner

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

Unit-1

Introduction – mechanisms of momentum transport and their transport properties. Development of mathematical modeling and differential equations through shell momentum balance for solving problems of momentum transport in one dimension and solve these problems by using equation of change-flow of a falling film, flow through circular tube, annulus, couette viscometer.

Unit-2

Interphase momentum transport- definition of friction factor for flow in tubes, around spheres.

Section-B

Unit-3


Unit-4


Unit-5

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

Books Recommended:

2. Weity, J.R. Wilson, R.E. and Wicks, C.E.: Fundamentals of Momentum Heat and


<table>
<thead>
<tr>
<th>Title</th>
<th>Environmental Engineering</th>
<th>Credits</th>
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<tr>
<td>Code</td>
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<td>Semester::-7th</td>
<td>L T P</td>
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<td>Max.Marks</td>
<td>End term 50</td>
<td>Mid term 50</td>
<td>Practical: 25</td>
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<td>Pre requisites</td>
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<td>Contact Hours</td>
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</table>

THEORY

Note for the Examiner: 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


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:

Environment Engineering Laboratory (PRACTICALS)
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.

<table>
<thead>
<tr>
<th>Title</th>
<th>Process Modelling &amp; Simulation</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>CHE 403</td>
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<td>Max.Marks</td>
<td>End Mid Practical:25</td>
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<tr>
<td>Pre requisites</td>
<td>Contact Hours</td>
<td>14 (Practical Sessions)</td>
</tr>
</tbody>
</table>

**Practical**

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:**

<table>
<thead>
<tr>
<th>Title</th>
<th>Process Plant Design-II</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Code</td>
<td>CHE 405</td>
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<td>Max.Marks</td>
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</tr>
<tr>
<td>Pre requisites</td>
<td>Contact Hours</td>
<td>14 (Practical Sessions)</td>
</tr>
</tbody>
</table>

**Practical**

1. Process design and specifications of double pipe heat exchanger, shell and tube heat exchanger,
plate type heat exchanger, condenser and reboiler.

2. Design of distillation column, calculation of number of plates, height and design of fractionator internals- sieve tray.

3. Absorber/Stripper design of stage-wise and continuous contact equipment (packed column), height of column and diameter calculations. HTU and NTU.

4. Design aspects of fixed bed reactors and fluidized bed reactors.

**Books Recommended:**


EIGHT SEMESTER

<table>
<thead>
<tr>
<th>Title</th>
<th>Process Instrumentation</th>
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<tr>
<td>THEORY</td>
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</table>

Note for the Examiner: 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

**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:** Bimetallic thermometers, filled-in system thermometers. Thermocouples, metal resistance thermometers and thermistors, optical and radiation pyrometers, radiation receiving elements.

**Pressure measurement:** 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.

SECTION-B

**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.

**Weight measurement:** 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:

| Title | Process Engineering Economics | Credits | 4 |
|-------|-----------------------------|---------|
| Code  | CHE 408 | Semester: 8th | L T P | 3 1 - |
| Max.Marks | End term 50 | Mid term 50 | Practical | Elective | N |
| Pre requisites | - | | Contact Hours | 42 |

THEORY

Note for the Examiner: 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:

Paper Title: PROJECT WORK

Paper Code CHE 406

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.

<table>
<thead>
<tr>
<th>Title</th>
<th>COMPREHENSIVE VIVA</th>
<th>Credits</th>
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<tr>
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<td>Max. Marks</td>
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<td>Mid term -</td>
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<tr>
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<td>Contact Hours</td>
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</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Title</th>
<th>Literature Survey, Report Writing &amp; Seminar</th>
<th>Credits</th>
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<tr>
<td>Code</td>
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<td>Mid term</td>
<td>Practical: or x</td>
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<tr>
<td>Pre requisites</td>
<td>-</td>
<td>Contact Hours</td>
<td>14 (Practical Sessions)</td>
</tr>
</tbody>
</table>

Practical

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, others techniques including those of audio-visual representation. Correct use of audio equipment.

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. Sattle, R.T. : The Use of Chemical Literature, Butter Worths.
Paper Title: Open Elective (Theory)

Course Duration: 42 Lectures of one hour each.

FUEL CELL TECHNOLOGY (Theory)

<table>
<thead>
<tr>
<th>Time</th>
<th>3 Hours</th>
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</table>

Note for the Examiner

- 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
Overview of fuel cells: Low and high temperature fuel cells;
Fuel cell thermodynamics - heat, work potentials, prediction of reversible voltage, fuel cell efficiency.
Fuel cell reaction kinetics - electrode kinetics, overvoltages, Tafel equation, charge transfer reaction, exchange currents,
Electrocatalyses - design, activation kinetics,
Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte.

Section-B
Fuel cell characterization: - in-situ and ex-situ characterization techniques, i-V curve, frequency response analyses; Fuel cell modeling and system integration: - 1D model - analytical solution and CFD models. Balance of plant; Hydrogen production from renewable sources and storage; safety issues, cost expectation and life cycle analysis of fuel cells.

Books Recommended

Text books:

NANO TECHNOLOGY (Theory)

<table>
<thead>
<tr>
<th>Time</th>
<th>3 Hours</th>
</tr>
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</table>

Note for the Examiner

- 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: 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/Polymer/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, nanoroboctics 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 Fritzsche 2004- Wiley VCH
3. Springer Handbook of Nanotechnology by Bharat Bhushan
5. Nanostructures and Nanomaterials by G. Cao, Imperial College Press, 2004
6. Introduction to Nanotechnology by Owen and Poole, Wiley

POLYMER SCIENCE AND ENGINEERING (Theory)

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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:**

**OPERATIONS RESEARCH (Theory)**

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**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:


SUPPLY CHAIN & LOGISTIC MANAGEMENT (Theory)

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Section-A

Introduction to Supply Chain Management: Definition; Scope & Importance of Supply Chain Management; Key drivers Of the SCM; Features of Supply Chain Management; Supply Chain Network – 1st Tier, 2nd Tier; Network decisions in SCM; Suppliers and Customers; Customer Service Dimension (Seven “R” Principles, Service after sale, Customer delight)

Role of Logistics in Supply Chains: Definition of Logistics Management; Scope and role of Transportation, Traffic & transportation; Relationship between transportation and other business functions, Transport Economics: Distance – volume-density, Freight Cost, Handling, Liability, market factors; Third party logistics (3 PL) & fourth party logistics service provider (4 PL), Logistics equipment; Reverse Logistics, Government rule & regulations related to Logistics; Purchase Cycle, Make or Buy, Price analysis, Negotiations.

Section-B

Inventory Management: Inventory Control, Planning & Managing Inventories; Warehouse Management (Receipt, issue, storage and preservation, stock verification, In bound and out bound distribution operations); Order Management; Competitive advantage through logistics and supply chain management; Responsive Supply Chain; Supply chain process integration, performance measurement; Value Chain, Value System and Supply Chain.

Planning demand and supply: Planning & Sourcing in Supply Chain, Demand forecasting, Type and Time horizon of forecast and category of forecasting, aggregate planning; Financial issues in Supply Chain - Macro and micro view, Asset management, Du Pont Model, Supply Chain Costing; Decision environment in SCM; Global supply chain perspectives - New business models, role of IT in SCM.

Books Recommended:

4. RP Mohanty: Supply Chain Management-Theories and Practice, Biztantra.
5. Robert B. Handfield, Ernest L. Nicholas, Jr.: Introduction to Supply Chain Management, Pearson Education.
PROJECT MANAGEMENT AND ENTREPRENEURSHIP (Theory)

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Section-A

**Introduction to Projects:** Meaning & Definition of Project, Attributes of a Project, Difference among Projects, Routine Activities and Programs; Project Life Cycle

**Project Planning:** Work Breakdown Structure, Types of Work Breakdown Structure, Planning Framework and Its Importance

**Project Feasibility:** Marketing, Technical & Financial Feasibility

**Social Cost Benefit Analysis:** Rationale, UNIDO and Little Mirrlees Approaches

Project Schedule Planning; Network Analysis Techniques; Project Implementation; Project Monitoring & Control

Section-B


Entrepreneurship: Concept, Policies Governing Entrepreneurs, Entrepreneurial Development Programmes, Contribution of Entrepreneurship to Economic Development

Institutions for Entrepreneurial Development; Role of Various Commercial Banks and Development financial Institutions.

Books Recommended:

4. IMD little and J.A. Mirrlees: Project Apraisal and Planning in Developing Countries, 1975.
5. Prasanna Chandra: Projects: Preparation, Appraisal Budgeting and Control, 7th edition, TMH.
8. Peter F. Drucker: Innovation and development.

Paper Title: Departmental Elective (Theory)

Course Duration: 45 Lectures of one hour each.

PETROLEUM PROCESSING ENGINEERING (Theory)

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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


Practicals
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.

Books Recommended:

INDUSTRIAL SAFETY & HAZARDS (Theory)

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Section-A


Section-B

Fire prevention, design to prevent fire and explosion (inverting static electricity, sprinkler system), boiling liquid expending vapour explosion (BLEVE). Fire triangle, Dow’s Fire and explosion index, dilution and ventilation.

**Books Recommended:**

**PLANT UTILITIES (Theory)**

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**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.

**Water:** Water Resources, storage & distribution of water reuse & conservation of water.

**Books Recommended:**

**PETROCHEMICAL TECHNOLOGY (Theory)**

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**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, disocyanates, 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:

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Section-A
Isolation and Utilization of Enzymes: Purification, immobilization, application of enzyme technology.

Kinetics of Enzyme-Catalyzed Reactions: The substrate, enzyme kinetics, factors affecting enzymatic activity and enzymatic reactions in heterogeneous reactions.

Metabolic Pathways and Energetics of the Cell: The concept of energy coupling, aerobic and anaerobic metabolism, photosynthesis and biosynthesis, transport across cell membranes.

Cellular Genetics and Control: Growth and reproduction of a single cell, alteration of cellular DNA, commercial applications.

Section-B

Transport Phenomena in Microbial Systems: Gas-liquid mass transfer, determination of oxygen transfer rates, mass transfer, surface-area correlations for mechanically agitated vessels, scaling of mass transfer equipment, particulate mass transfer, heat transfer.

Design and Analysis of Biological Reactors: The ideal continuous-flow stirred-tank reactor (CSTR), residence time distribution, different types of reactors, relationship between batch and continuous biological reactors. Fermentation technology, product manufacture by fermentation, reactors for biomass production.
Books Recommended: