# Teaching Scheme and Syllabi of B.E. (Chemical Engineering) (2019-2023)

## First Year

### 1st SEMESTER

<table>
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<tr>
<th>S. No.</th>
<th>Course code</th>
<th>Courses</th>
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<th>End Term</th>
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**Note:**
- NSS/NCC/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)

L: Lectures/Week, T: Tutorials/Week, P: Practical Hours/Week

Assessment will consist of the following components

1. Mid-Term
   a. One best of two minor tests (50% of Mid-term marks)
   b. Assignments (20% of Mid-term marks)
   c. Class Surprise Tests/Quizzes/Presentations/Term paper (20% of Mid-term marks)
   d. Attendance (10% of Mid-term marks)

2. End-Term
## 2nd Semester

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course code</th>
<th>Courses</th>
<th>Contact hrs per week</th>
<th>Total contact hours</th>
<th>Mid Term</th>
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<th>Credits</th>
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2. End -Term
## Teaching Scheme and Syllabi of B.E. (Chemical Engineering) (2019-2023)

### 2nd Year

#### 3rd Semester

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course Code</th>
<th>Courses</th>
<th>Contact hrs per week</th>
<th>Total contact hours</th>
<th>Mid Term</th>
<th>End Term</th>
<th>Total Marks</th>
<th>Credits</th>
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   - d. Attendance (10% of Mid-term marks)

2. **End-Term**
### Teaching Scheme and Syllabi of B.E. (Chemical Engineering)

#### (2019-2023)

#### 2nd Year

**4th SEMESTER**

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<th>S. No.</th>
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<th>Mid Term</th>
<th>End Term</th>
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<th>Credits</th>
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**Note:**

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2. **End-Term**
Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
(2019-2023)

3<sup>rd</sup> Year

5<sup>th</sup> SEMESTER

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Note:

- NSS/NCC/Sports proficiency/Community services/Professional society activities/Technical activities related to the field of Engineering (1<sup>st</sup> to 3<sup>rd</sup> year, 2 credits to be earned in 7<sup>th</sup> semester)
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L: Lectures/Week, T: Tutorials/Week, P: Practical Hours/Week

Assessment will consist of the following components

3. Mid-Term
   a. One best of two minor tests (50% of Mid-term marks)
   b. Assignments (20% of Mid-term marks)
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4. End -Term
# Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
## (2019-2023)
### 3rd Year
#### 6th Semester

<table>
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<th>S. No.</th>
<th>Course code</th>
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<td>Mass Transfer Lab.</td>
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<td>Total</td>
<td>124 12</td>
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1. Mid-Term
   a. One best of two minor tests (50% of Mid-term marks)
   b. Assignments (20% of Mid-term marks)
   c. Class Surprise Tests/Quizzes/Presentations/Term paper (20% of Mid-term marks)
   d. Attendance (10% of Mid-term marks)
2. End-Term

* There will be 6-8 weeks’ compulsory industrial training after 6th semester theory examination during summer vacation. Every students 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 Officer. The Credits for the Industrial Training will be awarded in the seventh semester.
# Teaching Scheme and Syllabi of B.E. (Chemical Engineering)
## (2019-2023)
### 4th Year

#### 7th Semester

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course code</th>
<th>Courses</th>
<th>Contact hrs per week</th>
<th>Total contact hours</th>
<th>Mid Term</th>
<th>End Term</th>
<th>Total Marks</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1.</td>
<td>OEC-OL 102</td>
<td>Transport Phenomena</td>
<td>L: 3 T: - P: -</td>
<td>45</td>
<td>35</td>
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<td>2.</td>
<td>PEC-CSEL 102</td>
<td>Process Instrumentation</td>
<td>L: 3 T: 1 P: -</td>
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<td>3.</td>
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<td>Open Elective II</td>
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<td>4.</td>
<td>PEC-CSEL 103</td>
<td>Department Elective II</td>
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<td>5.</td>
<td>PEC-CSEL 153</td>
<td>Process Plant Design II</td>
<td>L: - T: - P: 3</td>
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<td>6.</td>
<td>Proj.</td>
<td>Project Work**</td>
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<td>SI</td>
<td>Industrial Training</td>
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**Note:**
- NSS/NCC/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)

L: Lectures/Week, T: Tutorials/Week, P: Practical Hours/Week

Assessment will consist of the following components

1. **Mid-Term**
   a. One best of two minor tests (50% of Mid-term marks)
   b. Assignments (20% of Mid-term marks)
   c. Class Surprise Tests/Quizzes/Presentations/Term paper (20% of Mid-term marks)
   d. Attendance (10% of Mid-term marks)

2. **End-Term**

** Marks and Credits for Project work will be awarded in 8th Semester
Teaching Scheme and Syllabi of B.E. (Chemical Engineering)  
(2019-2023)

4th Year

8th Semester

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course code</th>
<th>Courses</th>
<th>Contact hrs per week</th>
<th>Total contact hours</th>
<th>Mid Term</th>
<th>End Term</th>
<th>Total Marks</th>
<th>Credits</th>
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<tr>
<td>1.</td>
<td>OC-OL 104</td>
<td>Environmental Engineering</td>
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<tr>
<td>5.</td>
<td>Proj..</td>
<td>Project Work</td>
<td>- - 3</td>
<td>45</td>
<td>50</td>
<td>-</td>
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<td>6.</td>
<td>OEC-OL 154</td>
<td>Environmental Engineering Lab.</td>
<td>- - 3</td>
<td>45</td>
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<td>40</td>
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<tr>
<td>7.</td>
<td>OEC-OL 155</td>
<td>Process Modelling &amp; Simulation</td>
<td>- - 3</td>
<td>45</td>
<td>40</td>
<td>-</td>
<td>40</td>
<td>1.5</td>
</tr>
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</table>

Total 122 9 345 300 180 480 19

Note:
- Discipline (1st to 4th year, 1 credit to be earned in 8th semester)

L: Lectures/Week, T: Tutorials/Week, P: Practical Hours/Week

Assessment will consist of the following components

1. Mid-Term
   a. One best of two minor tests (50% of Mid-term marks)
   b. Assignments (20% of Mid-term marks)
   c. Class Surprise Tests/Quizzes/Presentations/Term paper (20% of Mid-term marks)
   d. Attendance (10% of Mid-term marks)
2. End-Term
<table>
<thead>
<tr>
<th>S. No.</th>
<th>List of Departmental Electives</th>
<th>S.No.</th>
<th>List of Open Electives</th>
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<tbody>
<tr>
<td>1</td>
<td>Petroleum Processing Engineering</td>
<td>1</td>
<td>Fuel Cell Technology</td>
</tr>
<tr>
<td>2</td>
<td>Industrial Safety and Hazards</td>
<td>2</td>
<td>Nanotechnology</td>
</tr>
<tr>
<td>3</td>
<td>Plant Utilities</td>
<td>3</td>
<td>Polymer Science and Engineering</td>
</tr>
<tr>
<td>4</td>
<td>Petrochemical Technology</td>
<td>4</td>
<td>Mathematical and Statistical Methods</td>
</tr>
<tr>
<td>5</td>
<td>Biochemical Engineering</td>
<td>5</td>
<td>Supply Chain and Logistic Management</td>
</tr>
<tr>
<td>6</td>
<td>Food Processing</td>
<td>6</td>
<td>Project Management and Entrepreneurship</td>
</tr>
</tbody>
</table>

**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 2019-2023
FIRST YEAR

1st SEMESTER

<table>
<thead>
<tr>
<th>Title</th>
<th>MATHEMATICS-I</th>
<th>Credits</th>
<th>04</th>
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<tbody>
<tr>
<td>Code</td>
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<td>Semester:-1st</td>
<td>L T P</td>
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<tr>
<td>Max.Marks</td>
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<td>Pre requisites</td>
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</table>

<table>
<thead>
<tr>
<th>Objectives</th>
<th>To make the students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Understand the behaviour of infinite series and their use.</td>
</tr>
<tr>
<td>2.</td>
<td>Learn the concepts related to functions of several variables and their applications.</td>
</tr>
<tr>
<td>3.</td>
<td>Understand the concept of Vectors and its applications.</td>
</tr>
<tr>
<td>4.</td>
<td>Learn the methods of evaluating multiple integrals and their applications to various problems.</td>
</tr>
<tr>
<td>5.</td>
<td>Learn the methods to formulate and solve linear differential equations and apply them to solve engineering problems.</td>
</tr>
</tbody>
</table>

| Note for the Examiner | The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section. The duration of End Term exam will be 3 hrs. |

SECTION- A

Infinite Series:
Infinite series and convergence, alternating series, power series and convergence. Taylor’s and Maclaurin’s Series.

Multivariable Functions:
Limit, Continuity and Partial Derivatives; Euler’s Theorem for Homogeneous functions; Differentiability, Linearization and Differentials; Chain rule; Extreme values and Saddle Points; Lagrange multipliers; Taylor’s Formula.

Vector Deferential Calculus and Integral Theorems:
Gradient, Divergence, Curl, Statement of Green’s, Gauss and Stoke’s Theorem and their simple applications.

SECTION- B

Solid Geometry:
Cylinders and Cones, Cylindrical and Spherical Polar Coordinates

Integral Calculus:
Area between plane curves; Volumes of solids of revolution; Lengths of plane curves; Areas of surfaces of revolution. Double integrals in rectangular and Polar form, Triple integrals in Rectangular, Cylindrical and Spherical coordinates, Substitutions in Multiple Integrals.

Ordinary Differential Equations:
First order exact differential equations, Integrating factor, Orthogonal trajectories, Second and Higher order Linear Differential Equations with constant coefficients, Differential Operators, Methods of Variation of Parameters and Undetermined Coefficients, Euler Cauchy Equation, Wronskian.

Text books:

Reference Books:
3. Differential Equations, Frank Ayers, TMH
**Course Outcomes**

The students are able to

1. test the behaviour of infinite series.
2. analyze functions of several variables and their applications.
3. operate vectors and convert line integral to surface integral to volume integral.
4. evaluate multiple integrals and apply them to practical problems.
5. solve linear differential equations.

---

**Title** PHYSICS  
**Credits** 04

**Code** BS102  
**Semester:** 1st  
**L T P** 3 1 -

**Max.Marks** End term- 50  
**Mid term-** 50  
**Elective** N

**Pre requisites**  
**Contact Hours** 60

**Objectives**  
Basic concepts of optics and its applications, electromagnetism and magnetism properties, and Structural characterizations.

**Note for the Examiner**

**SECTION A**

1. **Optics and Fibre Optics** (12L + 4T)
   - Diffraction: Introduction to interference and example; concept of diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits; diffraction grating, characteristics of diffraction grating and its applications.
   - Polarisation: Introduction, polarisation by reflection, polarisation by double refraction, scattering of light, circular and elliptical polarisation, optical activity.
   - Fibre Optics: Introduction, optical fibre as a dielectric wave guide: total internal reflection, numerical apertures and various fibre parameters, losses associated with optical fibres, step and graded index fibres, application of optical fibres.

2. **Structural Characterization:** (16 hours + 5T)  
   - Crystal Lattice, points groups, Bravais lattices, crystal systems, X-ray diffraction Symmetry  
   - X-ray generation, Bragg Law, factors influencing intensity, Techniques, Indexing, precise lattice parameter determination, residual stress measurement

**SECTION B**

3. **Electromagnetism and Magnetic Properties of Materials** (17L + 6T)
   - **Dielectric Materials:** Review of basic formulas, dielectric constant and polarizability, sources of polarizability, classical treatment of dipolar, ionic and electronic polarizability, piezoelectricity, ferroelectricity.  
   - **Magnetic Materials:** Review of basic formulas, magnetic susceptibility, classification of materials, Langevin diamagnetism, paramagnetism (only classical treatment), magnetism in metals, ferromagnetism in insulators, anti-ferromagnetism and ferrimagnetism, ferromagnetism in metals, ferromagnetic domains, hysteresis  
   - **Superconductivity:** Zero resistance, occurrence of superconductivity, Meissner effect, critical field, thermodynamics of superconducting transitions, electrodynamics of superconductors, qualitative idea of BCS theory.  
   - **Nanotechnology:** Nanomaterials and its applications, chemical and physical synthesis techniques of nano-powder and thin films.
Text Books

1. Introduction to Solid State Physics: Charles Kittle 8th Ed.

Reference Books


Course Assessment Methods

Assessment will consist of the following components

1. Mid-Term
   a. One best of two minor tests (50% of Mid-term marks)
   b. Assignments (20% of Mid-term marks)
   c. Class Surprise Tests/Quizzes/Presentations/Term paper (20% of Mid-term marks)
   d. Attendance (10% of Mid-term marks)

2. End–Term

Course outcomes

Students will be familiar with
- Bragg’s Law and introduced to the principles of lasers, types of lasers and applications
- Various terms related to properties of materials such as, permeability, polarization, etc.
- Some of the basic knowledge of structural properties, crystal structure as well as magnetic and dielectric properties of materials

Title CHEMISTRY (INORGANIC) Credits 03
Code BS103 Semester: 1st L T P 3 - -
Max.Marks End term- 40 Mid term- 35 Elective N

Pre requisites

Contact Hours 45

Objectives

Note for the Examiner

Section A

Introduction to quantum theory for chemical systems: Quantum theory and atomic structure: Introduction to wave mechanics, the Schrödinger equation, as applied to hydrogen atom, the origin of quantum numbers and shapes of orbitals from the Schrödinger equation. 06 hrs

Chemical Bonding and structure Part I: Molecular orbital and valence bond theories of bond formation and application of molecular orbital theory to the formation of homonuclear and heteronuclear diatomic molecules. Bonding in Coordination Compounds: Theories of bonding i.e., Werner’s theory, effective atomic number, valence bond theory, crystal field theory, crystal fields splitting in tetrahedral, octahedral and distorted octahedral (square planar) crystal fields. Kinetic and Thermodynamic aspects of coordination compounds (crystal field stabilization energies of octahedral and tetrahedral complexes, spectrochemical series). Electronic spectra and magnetic properties of complexes. 10 hrs

Homogeneous catalysis/mechanism of industrially important reactions: Organometallic Compounds: Nomenclature, types of ligands and bonding in organometallic compounds, The catalytic properties of the organometallic compounds and the mechanism of homogeneous catalysis for important industrial processes like hydrogenation, polymerisation and hydroformylation etc. 06 hrs

SECTION B

Chemical Bonding and structure Part II: Ligand Substitution reactions in complexes with coordination numbers 4 and 6 and their mechanism. Kinetic aspects of substitution in coordination
compounds; Magnetic behaviour of complexes – Para magnetism, diamagnetism, ferromagnetism and antiferromagnetism and measurement of magnetic susceptibility of complexes by Guoy’s method. 09 hrs

**Inorganic polymers:** Types of inorganic polymers, polyphosphazenes, polysiloxanes – their structures and properties. 05 hrs

**Bio-inorganic Chemistry of Iron and cobalt** – Heme proteins, Non-Heme iron proteins, Iron Sulphur proteins and coenzyme B_{12}. 05 hrs

**Metal Toxicology** : Toxic effects of heavy metals with special reference to Cd, Pb, Hg and As. 04 hrs

**Recommended Books:**

<table>
<thead>
<tr>
<th>Title</th>
<th>COMMUNICATION SKILLS</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Code</td>
<td>HSMC-HASS 101</td>
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<td>Semester:- 1st</td>
<td>L T P</td>
<td>1 - -</td>
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<td>Max. marks</td>
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<td>Mid term- 10</td>
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<td>Pre-requisites</td>
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</table>
| Objectives                    | 1. To inculcate effective communication skills in students for better performance in professional as well as personal life  
2. To improve personality of students with advanced techniques in verbal, non verbal and para verbal communication. |
| Note for the Examiner         | The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting at least two questions from each Section. The duration of End Term exam will be 3 hrs. |
| SECTION A                     | Advanced Communication Skills  

Speaking Skills  
Interpersonal Communication, Presentation Skills, Voice Modulation, Persuasion, Negotiation and Linguistic Programming, Public Speaking, Group Discussions, Interviews and Case Studies, Conducting Meetings and Conferences

Personality Development  
Body Language and importance of Non Verbal communication, Social and Professional etiquettes.

| SECTION B                     | Communication and Media |  |
|-------------------------------|-------------------------| |
### Social and Political Context of Communication, Recent Developments in Media

**Advanced Techniques in Speaking Skills**  
Importance of Listening/Responding to native and global accents, Telephonic Interviews and Video Conferencing

**Advanced Techniques in Technical Writing**  
Job Application, CV Writing, Business Letters, Memos, Minutes, Reports and Report Writing Strategies, E-mail Etiquette, Blog Writing, Instruction Manuals and Technical Proposals

| --- | --- |

| --- | --- |

| Course Assessment Methods | Assessment will consist of the following components  
1. Mid-Term  
   a. One best of two minor tests (50% of Mid-term marks)  
   b. Assignments (20% of Mid-term marks)  
   c. Class Surprise Tests/Quizzes/Presentations/Term paper (20% of Mid-term marks)  
   d. Attendance. (10% of Mid-term marks)  
2. End –Term |
| --- | --- |

| Course Outcomes | 1. Gain proficiency in English language as medium for communication in both professional and personal life  
2. Increase in employment prospective of students by developing technical aspects of communication.  
3. Personality development of students by thorough knowledge of effective and enhanced communication skills |
| --- | --- |

<table>
<thead>
<tr>
<th>Title</th>
<th>ENGINEERING GRAPHICS (PRACTICAL)</th>
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<td>Semester:-1(^{st})</td>
<td>L T P</td>
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<tr>
<td>Max. Marks</td>
<td>Practical- 40</td>
<td>Elective</td>
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<tr>
<td>Pre requisites</td>
<td>Contact Hours</td>
<td>45</td>
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</table>

### PRACTICAL

| Objectives | Objectives of the Engineering Drawing course are:  
1. To introduce the students to visual science in the form of technical graphics.  
2. To give general instructions related to Theory of Orthographic Projection of points, lines, planes and solids as per the BIS codes prevalent to drawing practices.  
3. To upgrade the basic understanding and visualization of geometric objects and machine parts by introducing the students to section of solids, intersection and development of surfaces, isometric projection and orthographic projection of simple solids/blocks. |
| --- | --- | --- | --- |
1. Introduction to engineering drawing, instruments, symbols and conventions in drawing practice.
2. Types of lines and BIS codes for lines, dimensioning.
4. Projection of points, lines, planes and solids on principal and auxiliary planes.
5. Sectioning of solids, Intersection of solids.
7. Drawing of threaded fasteners and assembly drawing.
8. Introduction to CAD software.

**Recommended Books:**
1. P.S. Gill: Engineering Drawing
4. Sham Tickoo: Understanding AutoCAD 2006, Wiley Publication
5. James D. Bethune: AutoCAD, Pearson Publishers

**Course Assessment Methods:**
The students will be assessed based upon the practical assignments and viva voce.

**Course Outcomes:**
Student will be able to
1. understand the basics of engineering drawing.
2. visualize the different types of geometrical objects and the assembly drawing of machine parts.

<table>
<thead>
<tr>
<th>Title</th>
<th>ENGINEERING WORKSHOP (PRACTICAL)</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>Code</td>
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<tr>
<td>Pre-requisites</td>
<td>Contact hours</td>
<td>45</td>
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</table>

**PRACTICAL**

**Objectives:**
- To make the students understand the need and importance of different manufacturing techniques.
- To introduce the different tools and equipments used in mechanical workshops and develop the skill to use the same.

**Carpentry Shop:**
Description and use of carpenter's tools, Wood and timber, defects found in wood, seasoning of wood. Different types of timber in common use, making of lap joint, Bridle joint, dovetail joint and Mitre joint.

**Electric Tools:**
Exercise of wiring in link clip and casting and causing wiring of lights with switches in parallels, series and with 2 ways switches. Connecting energy meter, main switch and distribution board, testing a wiring installation for insulation resistance, Relevant Indian Electricity Rules.

**Machine Shop:**
Classification of fabrication processes, machine tools and materials, introduction to working of lathe, shapper, milling and drilling machines, power hacksaw, shearing machine and grinding wheel. Simple turning, threading, drilling board and knurling operations on a lathe.

**Welding:**
Introduction to electric arc welding, gas welding and their use in making different types of joints e.g. lap joint, butt joint and T joint.

**Recommended Books:**

**Course Outcomes:**
Students will be able to
1. Understand the theory of different manufacturing techniques and tools.
2. Do practices by hand.
<table>
<thead>
<tr>
<th>Title</th>
<th>PHYSICS LAB.</th>
<th>Credits</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>BS152</td>
<td>Semester:</td>
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<td></td>
<td></td>
<td>L, T, P</td>
<td>- - 2</td>
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<tr>
<td>Max. marks</td>
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<td>N</td>
</tr>
<tr>
<td>Pre-requisites</td>
<td>Contact hours</td>
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<td>30</td>
</tr>
</tbody>
</table>

**Objectives**

Physics lab provides students the firsthand experience of verifying various theoretical concepts learnt in theory courses.

In a semester at least 10 experiments to illustrate the concepts learnt in Physics (Number of lab. Hrs. 2 per experiment)

1. To find the energy band gap of the given semiconductor by four probe method.
2. To study the Hall Effect of a given semiconductor.
3. To determine the dielectric constant of the given materials.
4. To study the B-H curve of the ferromagnetic materials.
5. To determine the value of e/m for electron by long solenoid (helical) method.
6. To study the variation of magnetic field with distance along the axis of a circular coil carrying current by plotting a graph.
7. To determine the velocity of ultrasonics waves in a given liquid.
8. To determine the frequency of A.C. mains using a sonometer and an electro-magnet.
9. To find the capacitance of a capacitor using flashing and quenching of a neon lamp.
10. To plot graph between current and frequency in a series LCR circuit and to find the resonant frequency.
11. To find the wavelength of sodium light using Fresnel’s biprism.(3)
12. (i) To determine the wavelength of He-Ne laser using transmission grating.
    (ii) To determine the slit width using the diffraction pattern.
13. To determine the wave length of sodium light by Newton’s rings method.
14. To determine the wave length of sodium light using a diffraction grating.
15. To find the specific rotation of sugar solution using a Bi-quartz Polarimeter.
16. To design a hollow prism and used it find the refractive index of a given liquid.
17. To synthesize the nanoparticles by chemical methods and structural characterization through X-ray diffraction.
18. To investigate the optical band gap of nanomaterial using UV-vis spectroscopy.
19. Fabrication of thin films by spray pyrolysis technique.
20. Fabrication of thin films using spin coater technique.

**Text Books**

1. Practical Physics by CL Arora, S Chand & Co.
2. Engineering physics by S.K. Srivastva

**Reference Books**

A text book of practical physics by William & Watson

**Course Assessment Methods**

One *project out of 6 carries 40% marks, 20% for respective viva and 20% for external exams and 10% for attendance.

**Course outcomes**

The student will gain

- Proficiency in technical aspects of performing the experiments.
- Proficiency in designing scientific projects.

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<table>
<thead>
<tr>
<th>Title</th>
<th>CHEMISTRY (INORGANIC) LAB.</th>
<th>Credits</th>
<th>1.5</th>
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</thead>
<tbody>
<tr>
<td>Code</td>
<td>BS153</td>
<td>Semester:</td>
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</tr>
<tr>
<td></td>
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<td>L, T, P</td>
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<td>Max. marks</td>
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<tr>
<td>Pre-requisites</td>
<td>Contact hours</td>
<td></td>
<td>45</td>
</tr>
</tbody>
</table>

1. Volumetric Analysis :
   (i) Redox Titrations :-Titrations involving
(i) Redox Titrations

a) KMnO₄ (Estimation of C₂O₄⁻²) 0₂
b) K₂Cr₂O₇ (Estimation of Fe⁺²/Fe⁺³) 0₂
c) Iodine [Iodometry&Iodimetry] (Standardisation with Sodium Thiosulphate, Estimation of Cu⁺², AsO₃⁻³ and Sb⁺³) 0₄

(ii) Complexometric Titrations - Determination of Zn²⁺ by EDTA titration. 0₂

II Gravimetric Analysis

a) Estimation of Ba⁺²/SO₄⁻² as BaSO₄
b) Estimation of Fe⁺²/Fe⁺³ as Fe₂O₃ 0₄

Text Book: Vogel’s Qualitative Inorganic Analysis, 7th Ed. By G. Svehla, Pearson Education.

Course Outcomes

The student will be able to

1. apply the concept of normality, molarity and oxidation and reduction and apply redox titrations involving potassium dichromate and Iodine
2. use Complexometric Titrations to determine metal ions by EDTA method.
3. use gravimetric procedures for estimation (Estimate Ba⁺²/SO₄⁻², and Fe⁺³)


<table>
<thead>
<tr>
<th>Title</th>
<th>COMMUNICATION SKILLS LAB.</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Code</td>
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<tr>
<td>Objectives</td>
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<tr>
<td></td>
<td>1. To develop better pronunciation and communication skills.</td>
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<td></td>
<td>2. To be able to face interviews and participate in conferences or any personal or professionals discussions with confidence.</td>
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<tr>
<td></td>
<td>3. To develop technical writing skills.</td>
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<tr>
<td></td>
<td>4. To be able to articulate ones voice and overcome stage fright.</td>
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</tbody>
</table>

Organizational Communication

Verbal and Non-Verbal Communication at different levels of organization, Role Play, Interaction with Bosses and Co-employees

Speaking Techniques

Preparation of Interviews, Participation in Group Discussions and Case Studies, Making and Presenting Power Point Lectures.

Advanced Speaking Techniques

Conducting Meetings and Conferences, Exposure to different Accents, Listening and responding in the global scenario, Telephonic Interviews/Conversations, Video Conferencing

Technical Writing

Writing Letters, Memos, Minutes, Notes, CV, Job Applications, Reports and e-mails, Preparing Instruction Manuals and Technical Proposals

Course outcomes

1. English Speaking skills of students will be enhanced.
2. Students will become self confident in handling both professional and personal meetings/discussions.
3. Students will be able to demonstrate improved technical writing skills.
4. Overall personality of students as well as their communication skills will be developed.
## 2nd SEMESTER

<table>
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<th>MATHEMATICS-II</th>
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<tr>
<td>Contact hours</td>
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</table>

### Objectives
- Learn to expand various functions in terms of Fourier series.
- Learn the methods to formulate and solve partial differential equations.
- Be taught to apply the method of separation of variables to solve partial differential equations of engineering interest.
- Learn to find Laplace transforms and inverse transforms and apply these to solve differential equations.
- Understand the concept of Complex functions and their applications to various problems.

### Note for examiner
The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting at least two questions from each Section. The duration of End Term exam will be 3 hrs.

### SECTION A

#### Fourier Series
Euler’s Formulae, Dirchietle’s Conditions for Expansion, Change of interval, Odd and Even Functions, Expansion of Odd and Even Periodic Functions, Introduction to Harmonic Analysis.

#### Partial Differential Equations (Pde’s)
Formation and classification of partial differential equations, first order linear equations, standard forms of non linear equations, Charpit’s method, homogeneous linear equations with constant coefficients.

#### Engineering Applications Of Pde’s
Method of separation of variables, Solution of partial differential equations of engineering interest by the method of separation of variables.

### SECTION B

#### Laplace Transforms

#### Calculus Of Complex Functions
Functions of complex variables, analytic functions, Cauchy-Riemann equations, Cauchy’s theorem, Cauchy’s integral formula, introduction to Tayler’s series and Laurent’s series, Residues, Residue theorem and its simple applications.

### Text Books

### Reference Books
3. Differential Equations, Frank Ayers, TMH

### Course Outcomes
The students are able to:
1. expand functions in terms of Fourier series.
2. formulate and solve partial differential equations.
3. solve partial differential equations of engineering interest.
4. find Laplace transforms, inverse transforms and apply these to solve various...
differential equations.
5. evaluate complex integrals and apply these to various problems.

<table>
<thead>
<tr>
<th>Title</th>
<th>CHEMISTRY (ORGANIC)</th>
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<td>Pre-requisites</td>
<td></td>
<td></td>
<td>Contact hours</td>
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</tbody>
</table>

**SECTION A**

**Reactivity of organic molecules**: Shapes and Molecular orbital structures of compounds containing C, N and O. Conformations of cyclic and acyclic systems, structures of dienes, pyridine, pyrrole, aromatic compounds. Factors affecting acidity, basicity and nucleophilicity of molecules (Kinetic as well as thermodynamic aspects) 08hrs

**Delocalisation**: Concept of aromaticity, stability of cycloalkanes, resonance concept, inductive and mesomeric effects, directive effects, activating and deactivating groups. 06hrs

**Stereochemistry**: Enantiomers, Diastereomers, Meso-and Racemic compounds, Resolution of racemic mixture. Asymmetric synthesis, Walden Inversion, Configuration (D and L nomenclature), Absolute configuration (R, S, E and Z nomenclature) 08hrs

**SECTION B**

**Organic Reagents and Reaction Intermediates**: free radicals, carbonium and carbanions and the mechanism of important substitution, elimination as well as important rearrangement reactions--: House synthesis, halogenation of alkanes, free radical mechanism, orientation, reactivity and selectivity; catalytic hydrogenation, dehydration of alcohols, dehydrohalogenation, Saytzeff rule, electrophilic addition reactions, peroxide effect, mechanism of allylic substitution, acidity of 1-alkynes, conjugated dienes, 1,2-and 1,4- additions, free radical and ionic mechanisms of addition polymerisation reactions, ringopening reactions of cyclopropane and cyclobutane, chemistry of benzene and alkylbenzenes, aromatic electrophilic substitution reactions, nucleophilic substitution Friedel-Crafts reactions, Anisole nucleophilic addition, Aldol condensation 18hrs

Synthetic utility of diazonium salts, synthetic utility of Grignard reagents and alkyllithiumsk, basicity of amines, multistep synthesis. 05hrs

**Books Recommended:**
5. Mukherji & Singh: Reaction mechanism in organic chemistry, Macmillan India Ltd.

<table>
<thead>
<tr>
<th>Title</th>
<th>ELECTRICAL AND ELECTRONICS ENGINEERING</th>
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<td>Pre-requisites</td>
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<td>Contact hours</td>
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</table>
| Objectives                   | • To provide students about basic knowledge of A.C and D.C circuits, theorems, laws.  
• Introduce to the students about difference between single phase and three phase system.  
• To teach the students basic principle of operation of transformers and other |
## Electrical Machines
- To make them aware of the difference between analog and digital systems and study diodes, rectifiers, digital circuits.

### Note for Examiner
The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting at least two questions from each Section. The duration of End Term exam will be 3 hrs.

### SECTION A

#### DC Circuits and Single Phase A.C. Fundamentals
General introduction to Electrical Engineering, Kirchoff’s Laws, Mesh and Node analysis, Superposition theorem, Thevenin Theorem, Norton Theorem, Maximum power transfer theorem. Generation of alternating voltages and currents, Equations for AC quantities, cycle, time period, frequency, amplitude, calculation of R.M.S values, Average values for different waveforms, solution and phasor diagram of single phase AC circuit with sinusoidal source of excitation, series and parallel combination of R-L-C circuits.

#### Three Phase AC Fundamentals
Disadvantages of single phase system, star and delta connection in three phase circuits, relation between line and phasor quantities, power in three phase system, solution of three phase balanced circuits, power and power factor measurement by two wattmeter method.

#### Electrical Machines

### SECTION B

#### Semiconductor Diodes and Transistors
General introduction to Electronics. Concept of stiff Voltage and Current Source. PN Junction, Depletion layer, Barrier Potential, Forward and Reverse Bias, Breakdown voltage, V-I characteristics, Half wave and full wave rectifiers, Zener diode. Introduction to junction transistors, Transistor amplifying action, CB, CE, CC-configuration characteristics.

#### Digital Electronics
Binary and Hexadecimal number system, conversion of numbers from one system to other, OR, Relations: Commutative, Associative and Distributive Laws. Concept of flip-flops, RS, JK flip flops, shift register.

### Text Books

### Reference Books

### Course Outcomes
1. The student will understand how various loads are connected in circuits and difference between single and three phase system.
2. The students will know the principles and working of different types of electrical machines used in industry.
3. The students will have the basic knowledge of digitalization and conversion of physical quantity to digital quantity.
**SECTION-A**

Review: Stoichiometric and composition relationship gas laws; Gaseous mixtures, vapor pressure, humidity, etc.

Material Balances for Non-reaction systems including balances involving recycle and by-pass streams.

**SECTION-B**

Material Balances for Reacting systems including balances involving recycle and purge streams.

Combustion Calculations.

Energy balances on nonreactive and reactive systems.

**Books Recommended:**

### Operators And Expression:

### Statements:
Decision making structures: if, if-else, nested if and if-else, switch-Case. Loop control structures: for, while, do-while. Role of statements like break, continue, go to.

### SECTION- B

### Arrays:
Concept and use of arrays, declaration and usage of 1-dimensional arrays and 2-dimensional arrays.

### Functions:
Advantage of modularizing C++ program into functions, function definition and function invocation. Methods of passing parameters to a function: call-by-value, call-by-reference; Passing arrays to functions, Recursion, Library functions.

### Introduction To User-Defined Data Types:
Structures- definition, declaration, use. Unions: definition, declaration, use, introduction to classes and Properties of object oriented programming.

### Introduction to Numerical Methods And Spreadsheet Calculations:
Developing programs to solve engineering computation problems and working with spreadsheets.

### Text books:
1. Arora, Sumita”Computer Science with C++” Dhanpat Rai & Co.

### Reference Books:
2. Lafore ,Robert “Object Orients Programming in C++”

### Course Assessment Methods
Assessment will consist of the following components
1. Mid-Term
   a. One best of two minor tests (50% of Mid-term marks)
   b. Assignments (20% of Mid-term marks)
   c. Class Surprise Tests/Quizzes/Presentations/Term paper (20% of Mid-term marks)
   d. Attendance (10% of Mid-term marks)
2. End -Term

### Course Outcomes
1. The student will demonstrate proficiency in C++ programming language.
2. The student will be able to solve basic engineering computation problems using C++

### Title
ELECTRICAL AND ELECTRONICS ENGINEERING LAB.

<table>
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<th>Contact Hours</th>
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<tbody>
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<td></td>
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### Objectives
Students will be able
- to design electric circuits.
- To use voltmeter, ammeter and wattmeter
- Perform open circuit test and short circuit test on a single phase transformer and draw equivalent circuit
- To identify diode characteristics and transistor characteristics and perform experiments related to rectifiers (half-wave and full-wave)
- To verify various logical gates and networking theorems through
<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Students will</th>
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<tbody>
<tr>
<td></td>
<td>- have hands on knowledge about the design, purpose and working of R-L-C and parallel circuits</td>
</tr>
<tr>
<td></td>
<td>- become confident in taking accurate readings of voltmeter, ammeter and wattmeter</td>
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<tr>
<td></td>
<td>- have in depth knowledge about transformers, transistors, diodes and rectifiers and will be able to understand their applications in industry.</td>
</tr>
<tr>
<td></td>
<td>- have knowledge about networking theorems and their utility in industry.</td>
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**Title:** CHEMISTRY (ORGANIC) LAB.  
**Code:** BS155  
**Semester:** 2nd  
**Max. Marks:** Practical- 40  
**Contact Hours:** 45  

2. Identification of unknown organic compounds through group detection, physical constants and preparation of derivatives – Hydrocarbons, Phenols, Aldehydes, Ketones, Carboxylic acids, Amides and Amines.

**Course outcomes:**  
List steps for identifying simple organic compounds  
Use different analytical procedures

**Title:** COMPUTER LAB.  
**Code:** ESC-GES 154  
**Semester:** 2nd  
**Max. Marks:** Practical- 25  
**Contact Hours:** 25  

1. To develop programs using C++  
2. To make the students design programs by using logic and become
confident in handling numerical problems.

<table>
<thead>
<tr>
<th>Course Outcomes</th>
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</thead>
<tbody>
<tr>
<td>1. The students will be able to demonstrate proficiency in C++</td>
</tr>
<tr>
<td>2. The student will become confident in solving any computation problem using his programming skills.</td>
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</table>

<table>
<thead>
<tr>
<th>Course Assessment Methods</th>
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<tbody>
<tr>
<td>The students will be assessed based upon the practical assignments and viva voce</td>
</tr>
</tbody>
</table>

| 1. Programs based on input & output in C++ |
| 2. Programs using Decision Statements if-else, CASE |
| 3. Programs using while statements, do-while and for Loops |
| 4. Array based programs |
| 5. Developing user defined Functions with and without recursion |
| 6. How to create and access user defined data types |
| 7. Implementation of engineering computation programs using MATLAB and EXCEL spreadsheet |
# SYLLABUS OF B.E. CHEMICAL ENGINEERING 2019-2023
## SECOND YEAR
### 3rd SEMESTER

| Title                  | PHYSICAL CHEMISTRY | Credits | 3 |
|------------------------|---------------------|---------|
| **Code**               | BS 106              | **Semester:-3rd** | L T P | 3 -- |
| **Max.Marks**          | End term- 40 Mid term- 35 Practical - | **Practical -** | Elective | N |
| **Pre requisites**     |                      | **Contact Hours** | 45 |

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<td>The semester question paper of the subject will be of 40 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting atleast two questions from each Section.</td>
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</tbody>
</table>

### SECTION A

**UNIT- 1 Solutions and Colligative Properties:** (8 Lectures)
Dilute solutions; lowering of vapour pressure, Raoult’s and Henry’s Laws and their applications.
Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution

**UNIT-2: Chemical Kinetics** (7 Lectures)
Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism.

### SECTION B

**UNIT-3: Catalysis & Surface chemistry** (7 Lectures)

**UNIT 4: Electrochemistry** (8 Lectures)
Faraday’s laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry.
Chemical cells, reversible and irreversible cells with examples.
Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining(i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb₂O₃ electrodes.

### Reference Books
FLUID FLOW

Title: FLUID FLOW  
Credits: 4

Code: PCC-CS 102  
Semester: 3rd  
L T P: 3 1 -

Max.Marks: End term- 50  
Mid term- 50  
Practical- Elective  
N

THEORY  
Time: 3 Hours

Note for the Examiner: The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting at least two questions from each Section.

SECTION- A

Fluid Statics: Normal forces in fluids, Pressure Measurements, Forces on Submerged bodies, Buoyancy and Stability.


SECTION- B

Dimensional analysis and its Applications to Fluid Flow.

Flow of compressible fluids: Compressible flow and flow through nozzles.

Flow Measurements: Pilot tube, Orifice, Venturi, Rotameter and Notches, wet gas metre etc.

Fluid Machinery: Classification and Performance of Pumps, Turbines, Compressors, and Blowers, Selection and Specification, Net positive Suction Head.

Books Recommended:

ENERGY TECHNOLOGY

<table>
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<td>Elective</td>
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<td>Pre requisites</td>
<td>Contact Hours</td>
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</table>

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

**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

### Theory Time

<table>
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<tr>
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<th>Time</th>
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<tbody>
<tr>
<td>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>
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</table>

#### SECTION-A

**Stresses and Strains**: Concept of simple stress and simple strain, mechanical properties of solids, types of load, Tensile stress, compressive stress, shear stress, complementary shear stress, thermal stresses, tensile test, stress strain curve, Hooke’s law, modulus of elasticity, modulus of rigidity, Principle of St. Venant strain, factor of safety, compound bars, Compound Stresses and Compound Strains in two-dimensional stress system, Stresses on oblique plane due to pure shear, principle planes and principle stresses, maximum shear stress, Mohr’s circle of stress, Poisson’s ratio, volumetric strain, elastic constants and relations between them.

**Shearing Force and Bending Moments in Beams**: Shearing force, bending moment, types of beams, types of load on beams, types of supports, sign-conventions for shearing force and bending moment, point of inflection, relations between bending moment and shearing force shearing force and bending moment diagrams for beam under different loads. Concentrated loads, uniformly distributed loads, numerical problems.

**Bending Stresses and Shearing Stresses in Beams**: Pure bending, graphical determination of moments of inertia, bending stress, composite beams, reinforced concrete beams, General eccentric loading, combined direct and bending stresses, eccentric longitudinal loads, Shear stress distribution in rectangular section and circular section, numerical problems.

**Deflection of Beam**: Introduction, Macauly’s integration method, simply supported beam with load at mid-span and beam with eccentric load, moment area method, deflection due to shear, numerical problems.

#### SECTION-B

**Torsion of Shafts**: Torsion of thin circular shaft, composite shaft, combined bending and torsion, equivalent torque, equivalent bending moment, numerical problems.

**Struts and Columns**: Definition of strut and column, Euler’s Column theory and assumptions made, Strut with both ends pinned, strut with one end fixed and one end free, strut with both ends free, Slenderness ratio, limitations of Euler theory, Rankine’s Empirical formula, strut with eccentric loading, numerical problems.

**Stresses and Strains in Thin Shells**: Thin cylinder under internal pressure, thin spherical shell under internal pressure, volumetric strain, modifications for built-up shells, numerical problems.

**Stresses and Strains in Springs**: Types of Springs, stresses in Close coiled helical springs, open coiled helical springs, leaf springs, springs in parallel and in series, numerical problems.

**Strain Energy and Theories of Elastic Failure**: Strain energy and resilience, Strain energy in tension and compression due to suddenly applied load and impact loads, strain energy due to shear, strain energy due to bending, strain energy due to torsion, theories of elastic failure and their graphical representation, numerical problems.

### Books Recommended:


<table>
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<th>Title</th>
<th>PROCESS EQUIPMENT DESIGN</th>
<th>Credits</th>
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</tr>
<tr>
<td>Pre requisites</td>
<td>Contact</td>
<td>Hours</td>
<td>45</td>
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**PRACTICAL**

**LIST OF PRACTICALS**

1. Study of factors influencing the design of vessels; classification of pressure vessels, applications, method of fabrications, fundamental principles and equations.
2. Study of pressure vessel codes specifications and standards; Review of code and its development, ASME codes, API-ASME code, Section VIII of ASME codes.
3. General design considerations for pressure vessels; Design pressure, design temperature, materials, design stress (nominal design strength), corrosion allowance, design loads, minimum practical wall thickness.
4. 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.
5. Design of vessels subject to external pressure; Cylindrical shells, design of stiffening rings, vessels heads.
6. Design of vessels subject to combined loading: Weight loads, wind loads (tall vessels), torque.
7. Design of welded joints and Bolted flanged joints.
8. Design of Foundation and supports.

**Books Recommended:**


**Paper Title : PHYSICAL CHEMISTRY LAB.**

**Paper Code BS 156**

| Max. Marks | Credits | 40 |
|-----------|--------|    |
| 1. Surface tension of liquids using Stalagmometer and calculation of Parachor values. |
| 2. Distribution of iodine between water and carbon tetrachloride. |
| 3. Kinetics of the hydrolysis of methyl acetate in the presence of hydrochloric acid. |
| 4. Adsorption of acetic acid on activated charcoal. |
| 5. Viscosity of liquids and composition of a binary solution. |
| 6. Conductometry |
|   • Variation of equivalent conductance and specific conductance on dilution. |
|   • Dissociation constant of acetic acid. |
|   • Solubility of sparingly soluble salts. |
|   • Conductometric titrations of HCl vs NaOH and acetic acid vs. NaOH. |
| 7. Potentiometric titration of HCl vs NaOH and acetic acid vs NaOH and determination of dissociation constant of acetic acid. |
| 8. Colorimetry |
|   • Verification of Lambert-Beer Law. |
|   • Determination of concentration of solution of KMnO₄/K₂Cr₂O₇. |
|   • Determination of composition of Fe-Salicylic Acid Complex by Job’s Method. |
Books Recommended:


Paper Title: FLUID FlowLab.

Paper Code PCC-CS 152 Max. Marks 40 Credits: 1.5

1. General study of pipe fittings, valves and other equipments in the unit operations laboratory.
2. Pressure drop for flow through pipelines, valves & fittings.
3. Characteristics of pumps.
4. Flow measurement by the use of orifice meter, venturimeter, rotameter & pitot tube.
5. Flow over weirs and notches.
6. Flow measurement of compressible fluids.
### Title
HEAT TRANSFER

#### Credits
4

#### Code
PCC-CS 104

#### Semester
4th

#### L T P
3 1 -

#### Max. Marks
End term- 50 Mid term- 50 Practical- 1

#### Elective
N

#### Contact Hours
60

#### THEORY
3 Hours

#### Time
3 Hours

### Note for the Examiner
The semester question paper of the subject will be of 50 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting at least two questions 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:

THE SEMESTER QUESTION PAPER OF THE SUBJECT WILL BE OF 50 MARKS HAVING 8 QUESTIONS OF EQUAL MARKS. THE PAPER WILL BE DIVIDED INTO TWO PARTS HAVING FOUR QUESTIONS EACH FROM SECTION A AND SECTION B. THE CANDIDATE IS REQUIRED TO ATTEMPT TOTAL 5 QUESTIONS SELECTING ATLEAST TWO QUESTIONS FROM EACH SECTION.

SECTION- A


SECTION- B

Phase Equilibria:
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:

### MECHANICAL OPERATIONS

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**THEORY**  
**Time**  
3 Hours

**Note for the Examiner**  
The semester question paper of the subject will be of 60 marks having 8 questions of equal marks. The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting at least two questions from each Section.

### SECTION- A


- Motion of particle through a fluid: Stoke’s Newton’s law. Free and hindered settling.
- Setting tank and double cone classifiers
- Batch and continuous thickeners

Settling chamber, cyclone, filter bag and electrostatic precipitators.

### SECTION- B

**Filtration:** Plate and frame filter press, continuous rotary vacuum filter, filter aids, theory of filtration for non-compressible cakes.

**Centrifugation:** Tubular bowl centrifuge, disk centrifuge and batch basket centrifuge.

**Fluidization:** Conditions for fluidization: Aggregate and particulate fluidization. Ergun’s and Carman-Kozeny equations.

**Mixing and Agitation:** Basic ideas and characteristics of mixing equipment power consumptions scale-up.

**Conveying:** Mechanical and pneumatic conveying systems, storage & handling of materials.

### Books Recommended:

1. Mc Cabe, Warren L., Smith, Juluain C. and Harroit, Peter  

2. Foust, Alan S., Wenseli, Leonard A., Clump, Curtis W., mans, Louis and Anersen, L. Bryce  

3. Coulson, J.M. and Richardson, J.F.  

4. Gupta, Santosh K.  

5. Badger, Walter L. and Banchero, Julius T.  

6. Brown, C.G.  

7. Chattopadhyay, P.  
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<tr>
<th>Title</th>
<th>NUMERICAL METHODS IN CHEMICAL ENGINEERING</th>
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</table>

**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**


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

**Recommended Books**


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</table>

**THEORY**

The paper will be divided into two parts having four questions each from Section A and Section B. The candidate is required to attempt total 5 questions selecting at least two questions from each Section.
SECTION-A

**Atomic Structure:** Review of bonding in solids, Bonding forces and energies, Primary and Secondary bonds, structure – property – processing relationships

**Crystal Structure:** Space lattice, crystal systems, close packed morphology (Hexagonal and cubic close packing), interstitial spaces, Miller indices, linear and planar densities in crystals, single and polycrystalline structures, structure of ceramics (NaCl, Zinc blende, CsCl, silica and silicates, diamond crystal), effect of radius ratio on co-ordination

**Imperfections in atomic arrangement:** various defects in atomic arrangement, diffusion phenomenon in solids, Fick’s first and second law of diffusion, solid solution, slip systems, various methods of strengthening materials (grain size reduction, solid-solution strengthening, strain hardening), Schmid’s law.

SECTION-B

**Phase diagrams and phase transformation:** binary phase diagrams – Fe-Fe₃C, Cu-Ni, Pb-Sn. microstructure development, TTT diagrams, heat treatment processes-hot and cold working, hardening and softening processes.

**Materials:** Standards and specifications, unified alloy numbering system, ferrous metals and alloys, nonferrous metals and alloys; overview of ceramic, polymeric and composite materials;

**Mechanical tests:** standard test procedures for mechanical property determination-strength, toughness, fracture toughness, hardness, impact, fatigue, creep etc.

**Corrosion:** Types and mechanism of corrosion, factors influencing corrosion, combating corrosion, selection of materials of construction for handling different chemicals.

**Books Recommended:**

4. Raghavan, V. : Material Science & Engineering, Prentice Hall of India

**Paper Title:** HEAT TRANSFER Lab.

**Paper Code PCC-CS 154**   **Max. Marks 40**   **Credits : 1.5**

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
Paper Title: MECHANICAL OPERATIONS Lab.

Paper Code: PCC-CS 155  
Max. Marks: 40  
Credits: 1.5

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 (Anderson Pipette)
### CHEMICAL REACTION ENGINEERING–I

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<th>Title</th>
<th>CHEMICAL REACTION ENGINEERING–I</th>
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<td>Note for the Examiner</td>
<td>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>
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</table>

#### 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.

#### Recommended Books

### MASS TRANSFER – I

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#### 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 (INORGANIC) | Credits | 4
--- | --- | --- | ---
Code | PCC CS 109 | Semester:-5th | 3 1 -
Max.Marks | End term 50 | Mid term 50 | Practical- | Elective | N
Pre requisites | - | Contact Hours | 60

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

Chloralkali industry: Electrochemistry of brine electrolysis, current efficiency, energy efficiency, diaphragm, mercury 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.


Books Recommended:

CHEMICAL REACTION ENGG.-I LAB.
PCC-CS 159    Marks: 40    Credit: 1.5

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.

CHEMICAL TECHNOLOGY (INORGANIC) LAB.
PCC-CS 157    Marks: 40    Credit: 1.5

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

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<th>PROCESS PLANT DESIGN –I</th>
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Practical
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.
Recommended Books


Title: CHEMICAL ENGINEERING COMPUTATION

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<td>Elective</td>
<td>Contact Hours</td>
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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:

SYLLABUS OF B.E. CHEMICAL ENGINEERING 2019-2023
THIRD YEAR

6th SEMESTER

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THEORY

Note for the Examiner
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SECTION- A
Heterogeneous catalyses: A brief review of catalyses catalytic specificity. Preparation of catalysts, catalyst poisoning and catalyst regeneration.
Fluid Solid catalytic reaction: Kinetics; external transport processes, Reaction -and diffusion within porous spherical catalyst pellet. 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.

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

Title                          | MASS TRANSFER-II | Credits |
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THEORY

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SECTION- A
&extractive distillation preliminaries and molecular distillation.

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.

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.


Recommended Books
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.

Recommended Books

<table>
<thead>
<tr>
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<td>Note for the Examiner</td>
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<tr>
<td>Soaps and Detergents: Introduction, Raw materials, Manufacture of soap, Classification of detergents, finishing of detergents.</td>
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<tr>
<td>Water: Sources and Constraints, Impurities: dissolved, suspended, colloidal; Hardness of water; Water softening; Lime soda, Ion exchange.</td>
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<tr>
<td>Desalination: Classification of processes; Evaporative processes, Multieffect evaporation, multistage flash, vapour compression; Membrane processes, Reverse osmosis, electrodialysis.</td>
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<tr>
<td>SECTION-A</td>
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<td>Sugar: Introduction; Sugar extraction, defacation, sulphitation, carbonation, concentration, crystallization, drying, refining; Uses of molasses and bagasse.</td>
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<td>Polymers: Introduction, Degree of polymerisation, Classification of polymers, Polyethylene, Polyster</td>
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<td>Petroleum Refining: Introduction, composition of crude oil, typical refinery operations like thermal cracking, catalytic cracking</td>
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</tbody>
</table>

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.
Books Recommended


Mass Transfer Lab.
PCC-CS 158 Marks: 40 Credit: 1.5
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.

Process Dynamics & Control Lab.
PCC-CS 162 Marks: 40 Credit: 1.5
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 behavior 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.
Chemical Technology (Organic) Lab.
PCC-CS 163    Marks: 40     Credit: 1.5

Practicals

3. *Soaps*: Determination of free and combined alkali, total fatty matter, moisture and insoluble.
SYLLABUS OF B.E. CHEMICAL ENGINEERING 2019-2023
FOURTH YEAR

7th SEMESTER

Title: Transport Phenomena
Credits: 3
Code: OEC-OL 102
Semester: 7th
L T P: 3 - -
Max. Marks: End term 40, Mid term 35, Practical, Elective, N
Pre requisites: -
Contact Hours: 45

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

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 transport with respect to transport mechanisms and governing equations.

Books Recommended:


<table>
<thead>
<tr>
<th>Title</th>
<th>Process Instrumentation</th>
<th>Credits</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>PEC-CSEL 102</td>
<td>Semester: 7th</td>
<td>L T P</td>
</tr>
<tr>
<td>Max.Marks</td>
<td>End term 50</td>
<td>Mid term 50</td>
<td>Practical</td>
</tr>
<tr>
<td>Pre requisites</td>
<td>-</td>
<td>Contact Hours</td>
<td>60</td>
</tr>
</tbody>
</table>

**THEORY**

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**SECTION-A**


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:**

2. Eckman, Donald P.: Industrial Instrumentation, CBS Publisher and Distributors

---

**Title** | **Process Plant Design-II** | **Credits**
---|---|---
**Code** | PEC-CSEL 153 | 1.5
**Semester:** | 7th | 
**L T P** | - | 3
**Max.Marks** | End term | Mid term | Practical:40 | Elective | N
**Pre requisites** | - | **Contact Hours** | 45

**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- sievetray.
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:**

5. Shell and Tube Type Heat Exchangers, Indian Standards.

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**Title** | **Literature Survey, Report Writing & Seminar** | **Credits**
---|---|---
**Credits** | 1.5 |
<table>
<thead>
<tr>
<th>Code</th>
<th>Proj.</th>
<th>Semester: 7th</th>
<th>L T P</th>
<th>-</th>
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<tbody>
<tr>
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<td>End term</td>
<td>Mid term</td>
<td>Practical: 40</td>
<td>Elective</td>
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</tr>
<tr>
<td>Pre requisites</td>
<td>-</td>
<td></td>
<td>Contact Hours</td>
<td>45</td>
<td></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. Sottle, R.T. : The Use of Chemical Literature, Butter Worths.
SYLLABUS OF B.E. CHEMICAL ENGINEERING 2019-2023
FOURTH YEAR

8th SEMESTER

<table>
<thead>
<tr>
<th>Title</th>
<th>Environmental Engineering</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>OCE-OL 104</td>
<td>Semester: 8th</td>
<td>- -</td>
</tr>
<tr>
<td>Max. Marks</td>
<td>End term 40</td>
<td>Mid term 35</td>
<td>Practical: Elective</td>
</tr>
<tr>
<td>Pre requisites</td>
<td>-</td>
<td>Contact Hours</td>
<td>45</td>
</tr>
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</table>

THEORY

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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:

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:

PROJECT WORK
Proj. Marks: 50 Credit: 2
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.

Environment Engineering Lab.

**OEC-OL 154**    Marks: 40    Credit: 1.5

To find BOD of water sample.
1. To find COD of waste sample.
2. To find the total dissolved solids (TDS) and its volatile and non-volatile components.
3. To find the total suspended solids (TSS) and its volatile and non-volatile components.
4. To do the chromium separation by different techniques from electroplating wastes.
5. To find the phenol content of water sample and evolution of parameters.
6. To operate the electrodialysis apparatus.
7. To find the biodegradation constant (K) and the effect of timing on it.
8. To use the membrane separation techniques for salt brine and reverse osmosis process for sugar.
9. 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>
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</thead>
<tbody>
<tr>
<td>Code</td>
<td>OEC-OL 155</td>
<td>1.5</td>
</tr>
<tr>
<td>Max.Marks</td>
<td>End term: 8th</td>
<td>L T P</td>
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<tr>
<td>Pre requisites</td>
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<td></td>
<td>Practical: 40</td>
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<td>Elective</td>
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</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:*

Paper Title: Open Elective (Theory)

Course Duration: 45 Lectures of one hour each.

<table>
<thead>
<tr>
<th>FUEL CELL TECHNOLOGY (Theory)</th>
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<tbody>
<tr>
<td><strong>THEORY</strong></td>
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<tr>
<td>Note for the Examiner</td>
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</tbody>
</table>

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

Reference

<table>
<thead>
<tr>
<th>NANO TECHNOLOGY(Theory)</th>
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<td><strong>THEORY</strong></td>
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<td>Note for the Examiner</td>
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</tbody>
</table>

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 nanocermics, nanometals, nanopolymers, structures-properties-applications, Quantum dots. Concepts Bio-Nanotechnology.

Applications: Nanotherapeutics, Molecular diagnostics, tissue engineering, nanopumps, nanorobtics 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. Nanostructures and Nanomaterials by G. Cao, Imperial College Press, 2004
6. Introduction to Nanotechnology by Owen and Poole, Wiley

<table>
<thead>
<tr>
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</table>

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.

**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:**

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**MATHEMATICAL & STATISTICAL METHODS**

<table>
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<tr>
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<table>
<thead>
<tr>
<th>SECTION A</th>
</tr>
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<tbody>
<tr>
<td><strong>Hrs</strong></td>
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<tr>
<td><strong>Difference equations:</strong> Solution of difference equations with constant coefficients, Complementary function and Particular solution.</td>
</tr>
</tbody>
</table>

<p>| <strong>Z-Transforms:</strong> | Introduction, Some standard Z-transforms, Linearity property, Damping rule, Some standard results, Shifting rules, Initial and Final value theorems, Evaluation of inverse transforms: Power series method, Partial fractions method, Inversion integral method, Applications in the solution of difference equations. | 12 |</p>
<table>
<thead>
<tr>
<th>SECTION B</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Statistical Methods:</strong> Correlation, Coefficient of correlation, Lines of regression, Standard error of estimate and Rank correlation.</td>
<td>6</td>
</tr>
<tr>
<td><strong>Probability Distributions:</strong> Binomial distribution, Poisson distribution and Normal distribution, Test of significance for large samples, Comparison of large samples, Means of two large samples, Student’s t-distribution, chi²-test, Goodness of fit.</td>
<td>12</td>
</tr>
<tr>
<td><strong>Text Books</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Reference Books</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Course Assessment Methods</strong></td>
<td></td>
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<tr>
<td>Assessment will consist of the following components</td>
<td></td>
</tr>
<tr>
<td>1. Mid-Term</td>
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<tr>
<td>a. One best of two minor tests (50% of Mid-term marks)</td>
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<tr>
<td>b. Assignments (20% of Mid-term marks)</td>
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<tr>
<td>c. Class Surprise Tests/Quizzes/Presentations/Term paper (20% of Mid-term marks)</td>
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<tr>
<td>d. Attendance. (10% of Mid-term marks)</td>
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<tr>
<td>2. End - Term</td>
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<tr>
<td><strong>Course Outcomes</strong></td>
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<tr>
<td>The students are able to:</td>
<td></td>
</tr>
<tr>
<td>• solve difference equations with constant coefficients.</td>
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<tr>
<td>• find Z-transforms and inverse Z-transforms and apply these to solve difference equations.</td>
<td></td>
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<tr>
<td>• find correlation, coefficient of correlation, rank correlation, regression and standard error of estimate.</td>
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<tr>
<td>• apply various probability distributions, test of significance and goodness of fit.</td>
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</tbody>
</table>
SUPPLY CHAIN & LOGISTIC MANAGEMENT (Theory)

<table>
<thead>
<tr>
<th>THEOR Y</th>
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</table>

**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)

<table>
<thead>
<tr>
<th>THEORY</th>
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</table>

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: 60 Lectures of one hour each.

Petroleum Processing Engineering (Theory)

<table>
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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
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.

Books Recommended:

Industrial Safety & Hazards (Theory)

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Section-A
Definition, Hazards identification, Hazards and operability studies (HAZOP), Failure mode and effect analysis (FMEA), classification and assessment of various types of hazards in work-place environment and Industrial Hygiene, protective and preventive measures in hazard control.
Toxic Chemicals: maximum allowable concentrations and other standards. Biological threshold limit values.

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.


Case Studies of typical hazardous industries.

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.


Books Recommended:

PETROCHEMICAL TECHNOLOGY (Theory)

<table>
<thead>
<tr>
<th>THEORY</th>
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<th>3 Hours</th>
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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, Epichlorohydrin, 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:*


**BIOCHEMICAL ENGINEERING (Theory)**

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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:


**FOOD PROCESSING (Theory)**

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**SECTION A**


**SECTION B**


**Reference Books**


Department Elective Lab.
Code: PEC-CSEL 152  
Marks: 40  
Credit: 1.5

Petroleum Processing Engineering

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.