SCHEME AND SYLLABI

FOR

THIRD TO EIGHTH SEMESTERS

OF

BACHELOR OF TECHNOLOGY

IN

CHEMICAL ENGINEERING

FROM 2009 ADMISSION ONWARDS

CALICUT UNIVERSITY (P.O), THENHIPALAM
### 3rd Semester

<table>
<thead>
<tr>
<th>Code</th>
<th>Subject</th>
<th>Hours/week</th>
<th>Marks</th>
<th>End-sem duration-hours</th>
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<tbody>
<tr>
<td>EN09 301</td>
<td>Engineering Mathematics III</td>
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<td>Chemical Process Principles</td>
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<td>Material Science &amp; Engineering</td>
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### 4th Semester

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<th>Subject</th>
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<td>Engineering Mathematics IV</td>
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<td>Fluid and Particle Mechanics</td>
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<td>Physical and Analytical Chemistry</td>
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<td>CH09 405</td>
<td>Chemical Engineering Thermodynamics II</td>
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<td>Materials Technology and Engineering Lab</td>
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### 5th Semester

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<tr>
<td>CH09 501</td>
<td>Chemical Reaction Engineering</td>
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<tr>
<td>CH09 502</td>
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<td>3</td>
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<td>Process Heat Transfer</td>
<td>3</td>
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<td>CH09 504</td>
<td>Mass Transfer Operations I</td>
<td>3</td>
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<td>Environmental Engineering</td>
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<td>Process Instrumentation</td>
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<td>Fluid &amp; Particle Mechanics Lab</td>
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### 6th Semester

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<td>Chemical Process Industries</td>
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<tr>
<td>CH09 602</td>
<td>Process Dynamics &amp; Control</td>
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<td>CH09 603</td>
<td>Mass Transfer Operations II</td>
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<tr>
<td>CH09 604</td>
<td>Economics and Management of Chemical Industries</td>
<td>3</td>
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<td>CH09 605</td>
<td>Energy Engineering</td>
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<tr>
<td>CH09 Lxx</td>
<td>Elective I</td>
<td>3</td>
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<td>CH09 607(P)</td>
<td>Heat Transfer Operations Lab</td>
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<td>CH09 608(P)</td>
<td>Process Design Software Lab/ Mini Project</td>
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**Elective I**

- CH09 L01 High Polymer Engineering
- CH09 L02 Water Treatment Technology
- CH09 L03 Essentials of Management
- CH09 L04 Numerical Analysis
- CH09 L05 Computational Fluid Dynamics
### 7th Semester

<table>
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<tr>
<th>Code</th>
<th>Subject</th>
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<tbody>
<tr>
<td>CH09 701</td>
<td>Chemical Engineering Design &amp; Drawing I</td>
<td>2 1 2</td>
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<td>CH09 702</td>
<td>Transport Phenomena</td>
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<td>Safety Engineering in Process Plants</td>
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<td>CH09 704</td>
<td>Biochemical Engineering</td>
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<td>CH09 Lxx</td>
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<td>CH09 Lxx</td>
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<td>CH09 708(P)</td>
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### 8th Semester

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<tr>
<td>CH09 801</td>
<td>Chemical Engineering Design&amp; Drawing II</td>
<td>4 1 -</td>
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<td>CH09 802</td>
<td>Optimization of Chemical Processes</td>
<td>2 1 -</td>
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<td>CH09 Lxx</td>
<td>Elective IV</td>
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<td>CH09 Lxx</td>
<td>Elective V</td>
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<tr>
<td>CH09 805 (P)</td>
<td>Seminar</td>
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<td>CH09 806 (P)</td>
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<td>CH09 807 (P)</td>
<td>Viva-Voce</td>
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**Electives**

CH09 L06 Software Engineering
CH09 L07 Advances in Bioprocess Engineering
CH09 L08 Computer Aided Design
CH09 L09 Unconventional Separation Techniques
CH09 L10 Micro Electronics Processing
CH09 L11 Food Technology
CH09 L12 Process Modeling and Simulation
CH09 L13 Marketing Management
CH09 L14 Petroleum Exploration and Storage
CH09 L15 Composite Materials
CH09 L16 Catalysis- Theory and Practice
CH09 L17 Surface Coatings
CH09 L18 Ceramic Technology
CH09 L19 Rubber Technology
CH09 L20 Mathematical Methods in Chemical Engineering
CH09 L21 Solid Waste Management
CH09 L22 Nuclear Engineering
CH09 L23 Nanomaterial and Nanotechnology
CH09 L24 Industrial Pollution Control
CH09 L25 Project Engineering

Global Electives
PE09 L23 Total Quality Management
PE09 L24 Industrial Psychology
PE09 L25 Entrepreneurship
BT09 L23 Bio-nanotechnology
BT09 L24 Bio-ethics and Intellectual Property Rights
BT09 L25 Biomaterials
BM09 L23 Operation Research
EC09 L23 Data Structures and Algorithms
CE09 L23 Experimental Stress Analysis
CE09 L25 Finite Element Analysis
EE09 L22 Soft Computing Techniques
CS09 L24 Computer Based Numerical Methods
IC09 L24 Non-linear Dynamics and Chaos
IT09 L24 Management Information Systems
PT09 L24 Digital Photography

For Laboratory
Internal Continuous Assessment (Maximum Marks-50)
60% - Laboratory practical and record
30% - Test/s
10% - Regularity in the class

End Semester Examination (Maximum Marks-50)
70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record

For Theory Subjects
Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class
University Examination Pattern (for all Subjects except CH09 701 and CH09 801)

**PART A:** Short answer questions (one/two sentences)  
5 x 2 marks = 10 marks  
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions  
4 x 5 marks = 20 marks  
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions  
4 x 10 marks = 40 marks  
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

University question pattern (for CH09 701 Chemical Engineering Design & Drawing I and CH09 801 Chemical Engineering Design & Drawing II)

Part A - Analytical/Problem solving questions  
1 x 20 marks = 20 marks  
2 question of 20 marks from first module with choice to answer one.

Part B - Analytical/Problem solving questions  
1 x 25 marks = 25 marks  
2 question of 25 marks from second module with choice to answer one.

Part C - Analytical/Problem solving questions  
1 x 25 marks = 25 marks  
2 question of 25 marks from third module with choice to answer one.

Maximum Total Marks: 70

**Grading**

The university shall award the letter grade to students based on the marks secured by them in both internal assessment and end-semester examinations taken together in the subjects registered. Each letter grade indicates a qualitative assessment of the student’s performance and is associated with a specified number of grade points. The grading system along with the grade points for each grade, applicable to passed candidates is shown below. All passed candidate will be allotted a grade S, A, B, C, D, or E according to the total marks scored by him/her.

<table>
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<tr>
<th>Total marks scored by the passed candidate</th>
<th>Corresponding Grade allotted</th>
<th>Grade Points</th>
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<tr>
<td>86 - 100</td>
<td>S</td>
<td>10</td>
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<tr>
<td>76 - 85</td>
<td>A</td>
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<td>66 - 75</td>
<td>B</td>
<td>7.5</td>
</tr>
<tr>
<td>56 - 65</td>
<td>C</td>
<td>6.5</td>
</tr>
<tr>
<td>46 - 55</td>
<td>D</td>
<td>5.5</td>
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<tr>
<td>40 - 45</td>
<td>E</td>
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If a candidate does not a pass a subject as per the conditions given in Section (9), he/she will be assigned an Unsatisfactory grade ‘U’ irrespective of his/her total marks. If a student does not pass a subject in two attempts, the maximum grade he/she can get is ‘C’ when he/she passes the subject in any subsequent examination, whatever be the marks scored by him/her. A student is considered to have completed a subject successfully and earned the credits if he/she secures a letter grade other than ‘U’ in that course. Letter grade ‘U’ has zero grade point and the candidate has to write the examination again to improve the grade. A student's performance is measured by the number of credits that he/she has earned and by the cumulative grade point average (CGPA) maintained by him/her.
Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

(a) A Semester Grade Point Average (SGPA) shall be computed for all the students for each semester, as follows:

$$\text{SGPA} = \frac{C_1 G_1 + C_2 G_2 + C_3 G_3 + \ldots + C_n G_n}{C_1 + C_2 + C_3 + \ldots + C_n}$$

where, $n$ is the number of subjects registered during the semester, $C_i$ is the number of credits allotted to $i$th subject as per the scheme, and $G_i$ is the grade points corresponding to the grade awarded to the student for the subject.

(b) A Cumulative Grade Point Average (CGPA) shall be computed for all the students at the end of each semester by taking into consideration their performance in the present and the past semesters as follows:

$$\text{CGPA} = \frac{C_1 G_1 + C_2 G_2 + C_3 G_3 + \ldots + C_m G_m}{C_1 + C_2 + C_3 + \ldots + C_m}$$

where, $m$ is the number of courses registered up to that semester, $C_i$ is the number of credits allotted to $i$th subject as per the scheme, and $G_i$ is the grade points corresponding to the grade awarded to the student for the subject. An up-to-date assessment of overall performance of a student is obtained by calculating CGPA. CGPA is weighted average of the grade points obtained in all the subjects registered by the students since he entered the B.Tech. course.

(c) Both the SGPA and CGPA shall be rounded off to the second place of decimal and recorded as such for ease of presentation. Whenever the CGPAs are to be used for the purpose of determining the merit ranking in a group of students, only the rounded off values shall be made use of.
University of Calicut

Scheme and Syllabus

B.Tech.
CHEMICAL ENGINEERING

III to VIII Semester
FROM 2009 ADMISSION ONWARDS
Module 1: Functions of a Complex Variable (13 hours)
Functions of a Complex Variable – Limit – Continuity – Derivative of a Complex function –
Analytic functions – Cauchy-Riemann Equations – Laplace equation – Harmonic Functions –

Module 2: Functions of a Complex Variable (14 hours)
Definition of Line integral in the complex plane – Cauchy’s integral theorem (Proof of existence
of indefinite integral to be omitted) – Independence of path – Cauchy’s integral formula – Derivatives of analytic functions (Proof not required) – Taylor series – Laurent
series – Singularities and Zeros – Residues – Residue Integration method – Residues and
Residue theorem – Evaluation of real integrals.

Module 3: Linear Algebra (13 hours) - Proofs not required
Vector spaces – Definition, Examples – Subspaces – Linear Span – Linear Independence –
Linear Dependence – Basis – Dimension – Ordered Basis – Coordinate Vectors – Transition
Matrix – Orthogonal and Orthonormal Sets – Orthogonal and Orthonormal Basis – Gram-

Module 4: Fourier Transforms (14 hours)
Fourier Integral theorem (Proof not required) – Fourier Sine and Cosine integral
representations – Fourier Transforms – Fourier Sine and Cosine Transforms – Properties of
Fourier Transforms.

Text Books:
Module I:
Erwin Kreysig, Advanced Engineering Mathematics, 8e, John Wiley and Sons, Inc.
Sections: 12.3, 12.4, 12.5, 12.6, 12.7, 12.9

Module II:
Erwin Kreysig, Advanced Engineering Mathematics, 8e, John Wiley and Sons, Inc.
Sections: 13.1, 13.2, 13.3, 13.4, 14.4, 15.1, 15.2, 15.3, 15.4

Module III:
Bernard Kolman, David R Hill, Introductory Linear Algebra, An Applied First Course,
Pearson Education.
Sections: 6.1, 6.2, 6.3, 6.4, 6.7, 6.8, Appendix.B.1
Module IV:

References:

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
**PART A:** Short answer questions (one/two sentences)  
5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions  
4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.
PART C: Descriptive/Analytical/Problem solving questions  
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

EN09 302  HUMANITIES AND COMMUNICATION SKILLS  
(Common for all branches)

Teaching scheme  
2 hours lecture & 1 hour tutorial per week  

Credits: 3

Objectives
- To identify the most critical issues that confronted particular periods and locations in history
- To identify stages in the development of science and technology
- To understand the purpose and process of communication
- To produce documents reflecting different types of communication such as technical descriptions, proposals, and reports
- To develop a positive attitude and self-confidence in the workplace and
- To develop appropriate social and business ethics.

Module 1 (14 hours)

Module 2 (16 hours)
Concept of communication: The speaker/writer and the listener/reader, medium of communication, barriers to communication, accuracy, brevity, clarity and appropriateness. Reading comprehension: Reading at various speeds, different kinds of text for different purposes, reading between lines. Listening comprehension: Comprehending material delivered at fast speed and spoken material, intelligent listening in interviews. Speaking: Achieving desired clarity and fluency, manipulating paralinguistic features of speaking, task oriented, interpersonal, informal and semi formal speaking, making a short classroom presentation. Group discussion: Use of persuasive strategies, being polite and firm, handling questions and taking in criticisms on self, turn-taking strategies and effective intervention, use of body language.

Module 3 (16 hours)
Written Communication: Note making and taking, summarizing, notes and memos, developing notes into text, organization of ideas, cohesion and coherence, paragraph writing, ordering information in space and time, description and argument, comparison and contrast, narrating events chronologically. Writing a rough draft, editing, proof reading, final draft and styling text. Technical report writing: Synopsis writing, formats for reports. Introductory report, Progress report, Incident report, Feasibility report, Marketing report, Field report and Laboratory test report. Project report: Reference work, General objective, specific objective, introduction, body, illustrations using graphs, tables, charts, diagrams and flow charts. Conclusion and references. Preparation of leaflets, brochure and C.V.

Module 4 (14 hours)

References:
3. Subrayappa, *History of Science in India*, National Academy of Science, India
11. Encyclopedia Britannica, *History of Science, History of Technology*

**Internal Continuous Assessment (Maximum Marks-30)**

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

*PART A: Short answer questions (one/two sentences)*

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

*PART B: Analytical/Problem solving questions*  

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

*PART C: Descriptive/Analytical/Problem solving questions*  

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

**CH09 303 CHEMICAL PROCESS PRINCIPLES**

**Teaching scheme**

3 hours lecture & 2 hour tutorial per week

**Objectives**

- To impart the basic concepts of Chemical Engineering
• To develop understanding about material balance and energy balance for analysis of unit processes and unit operations

**Module 1** (16 hours)
Introduction to chemical engineering, chemical process industries and role of chemical engineer, unit operations and unit processes, fundamental concepts, units and dimensions, conversion of units, dimensional analysis, conversion of empirical equations, mole concept and mole fraction, weight fraction and volume fraction, concentration of liquid solutions—molarity, molality, normality, ppm, density and specific gravity, specific gravity scales, use of mole concept in chemical reaction stoichiometry, concept of limiting and excess reactants, conversion and yield, ideal gases and gas mixtures, ideal gas law, Dalton and Amagat laws, real gas laws, Composition of gases on dry basis and on wet basis. average molecular weight and density of gases

**Module 2** (17 hours)
Material balances: typical flow sheet, batch, stagewise and continuous operation, Material balance without chemical reactions, Basic material balance principles- Material balance in unit operations such as Evaporation, Crystallization, Drying, Absorption, Distillation etc. Material balance with chemical reaction; Bypass, Recycle and Purge Operations with and without reactions.

**Module 3** (16 hours)

**Module 4** (17 hours)
Vapor pressure: Vapor pressure of pure liquids, Effect of temperature on vapor pressure, Clapeyron equation, Antoine equation, Reference substance vapor pressure plots, Vapor pressure of immiscible liquids. Ideal solutions and Raoult’s law. Non-volatile solutes. Humidity: Humidity and saturation, Percentage saturation. Relative saturation or relative humidity, Enthalpy of humid air, and humid heat capacity, Dew point, Wet and dry bulb temperatures, Adiabatic vaporization and adiabatic saturation temperature, psychrometric charts, material and energy balance problems involving Vaporization and Condensation. fuels and combustion, heating value of fuels, proximate and ultimate analysis, orsat analysis of flue gases, percent excess air from flue gas analysis, heat loss calculation in combustion of fuels

**References:**
1. K.V.Narayanan & B.Lakshmikutty  Stoichiometry and Process Calculations, Prentice Hall Of India
3. David M Himmelblau, Basic principles and calculations in chemical engineering, Prentice Hall.
4. Richard M Felder & Ronald W. Rousseau Elementary Principles of Chemical Processes, Wiley India

**Internal Continuous Assessment (Maximum Marks-30)**

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A: Short answer questions (one/two sentences)**

5 x 2 marks = 10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B: Analytical/Problem solving questions**

4 x 5 marks = 20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C: Descriptive/Analytical/Problem solving questions**

4 x 10 marks = 40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

**CH09 304 ORGANIC CHEMISTRY**

**Teaching scheme**

Credits: 4
3 hours lecture & 1 hour tutorial per week

**Objectives**

- To impart the basic concepts of organic chemistry
- To develop understanding about concepts on organic reactions for analysis of unit processes

**Module 1** (13 hours)
Electron displacements in organic molecules – inductive, electromeric, mesomeric and hyper conjugative effects – types of reagents, nucleophilic, electrophilic and free radicals – types of reactions, substitution, addition and rearrangements – Mechanism, Kinetic and stereochemistry of SN<sub>1</sub>, SN<sub>2</sub>, E<sub>1</sub> and E<sub>2</sub> reactions.

**Module 2** (13 hours)
Proteins, nucleic acids – Aminoacids – Classification and biological importance – Synthesis of glycine and alanine by Gabriels method and Sorensen’s method – Synthesis of Leucine (Strecker’s method) and tryptophan by Azlactone method – Isolation of amino acids from natural sources – Properties and reactions of glycine and alanine – Action of heat on amino acids – Sorensen’s formal titration – Carbohydrates – Classification – Preparation and properties of glucose – Oxidation, reduction, acetylation, osazone formation – Conversion of an aldose to ketose and vice versa – Mutarotation – epimerization – anomers – Structure of
glucose – Pyranose and Furanose structure of D-glucose – Manufacture of fructose and sucrose – Preparation and properties of starch and cellulose.

**Module 3** (13 hours)

**Module 4** (13 hours)

**References:**
4. Sony, P.L., Organic Chemistry, S. Chand
5. Lehninger, Biochemistry

**Internal Continuous Assessment** *(Maximum Marks-30)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences)  
5 x 2 marks = 10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions  
4 x 5 marks = 20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions  
4 x 10 marks = 40 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*
CH09 305 CHEMICAL ENGINEERING THERMODYNAMICS I

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
- To impart the basic concepts of thermodynamics for chemical engineers

Module 1 (12 hours)
Fundamental concepts and definitions - closed, open and isolated system - intensive and extensive properties - path and state functions - reversible and irreversible process - temperature - Zeroth law of thermodynamics - First law of thermodynamics - internal energy - enthalpy - heat capacity - first law for cyclic, non-flow and flow processes - applications - P-V-T behaviour of pure fluids - ideal gases and ideal gas processes - equations of state - vander Waals equation, Redlich-Kwong equation, Virial equation - principle of corresponding states - critical and pseudo critical properties - Compressibility charts.

Module 2 (12 hours)

Module 3 (13 hours)

Module 4 (15 hours)

References:
5. Y.V.C. Rao, Chemical Engineering Thermodynamics, Universities Press

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences)  
5 x 2 marks = 10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions  
4 x 5 marks = 20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions  
4 x 10 marks = 40 marks

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

**CH09 306 MATERIAL SCIENCE & ENGINEERING**

**Teaching scheme**

3 hours lecture & 1 hour tutorial per week

**Credits:** 4

**Objectives**

- To impart the basic concepts of material science
- To develop understanding about selection based on properties for various applications

**Module 1** (13 hours)

Structure of atom-present concept of atom-Rutherford’s and Bhor’s model-Bonding in solids-Types of solids-crystalline and amorphous solids-crystal systems-Bravais lattices-miller indices-coordination number-crystal defects-determination of crystal structure-X-ray diffraction-electron diffraction methods-properties of engineering materials-mechanical properties -isotropy and anisotropy-elasticity, plasticity, toughness, resilience, tensile strength, ductility, malleability, brittleness, hardness, fatigue, creep, wear resistance-Poisson’s ratio-stress-strain relation-true stress and true strain-electrical and magnetic properties-resistivity-conductivity-ionic and electrical conductivity, semiconductors, superconductivity, insulators, ferroelectricity, piezoelectricity, magnetization, paramagnetism, ferromagnetism, and diamagnetism -technological properties-castability, machinability, weldability, solderability, workability, formability

**Module 2** (13 hours)


**Module 3** (13 hours)

Module 4 (13 hours)
Corrosion-different types, mechanism and factors influencing corrosion-corrosion prevention-inhibitors and their applications-oxidation-aging of rubber-oxidation of metals and radiation damage-factors affecting the selection of materials for engineering purposes-selection of suitable materials for construction in chemical industry.

References:
1. Van Vlack, Elements of Material Science
3. Hajra Choudhary, Material Science & Processes
4. Chilton &Perry, Chemical Engineers Handbook
5. Nanocomposite science and technology, Pulikel M. Ajayan, Wiley-VCH 2005

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 307(P) CHEMISTRY LAB II
Teaching scheme 3 hours practical per week
Credits: 2

Objectives
- To provide experience on analysis, estimation and preparation of few organic chemical.
- To acquaint the students with the handling and analyzing chemicals.

Experiments in organic chemistry
1. Analysis of simple organic compounds (minimum 4 numbers)
2. Estimation of phenol
3. Estimation of aromatic primary amine
4. Preparation of Aspirin
5. Preparation of Benzanimide
6. Preparation of m-dinitrobenzene
7. Preparation of Benzoic acid
8. Preparation of Phthalimidate
9. Preparation of Methyl Orange
10. Preparation of Parabenzoquinone
11. Preparation of Acetanilide
12. Preparation of Phenolphthalein
13. Preparation of Methylene Blue
14. Preparation of Erichrome Black T
15. Preparation of nerolin

References
1. Srivastava T. N. & Kamboj P. C., Systematic Analytical Chemistry

Internal Continuous Assessment (Maximum Marks-50)
60% - Laboratory practical and record
30% - Test/s
10% - Regularity in the class

End Semester Examination (Maximum Marks-50)
70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record

CH09 308(P) CHEMICAL TECHNOLOGY LAB
Teaching scheme

Objectives
- To provide experience on preparation, analysis and testing of chemicals used for industrial raw materials and end uses.

1. Acid value of oils
2. Iodine value of oils
3. Saponification value of oils
4. Preparation and analysis of soap
5. Preparation of copper pigment
6. Preparation of chrome yellow pigment
7. Analysis of saw dust: Estimation of total cellulose
8. Determination of sucrose content in sugar
9. Analysis of lime, alum, activated carbon and coal
10. Determination of available chlorine in bleaching powder and hypochlorite
11. Determination of flash and fire point
12. Calibration of refractometer
13. Calorific value of gas using gas calorimeter
14. Redwood viscosimeter
15. Conductivity meter
16. Bomb Calorimeter

Internal Continuous Assessment (Maximum Marks-50)
60% - Laboratory practical and record
30% - Test/s
10% - Regularity in the class

End Semester Examination (Maximum Marks-50)
70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record
FOURTH SEMESTER

EN09 401 A ENGINEERING MATHEMATICS IV
(Common for ME, CE, PE, CH, BT, PT, AM, and AN)

Teaching scheme

3 hours lecture & 1 hour tutorial per week

Objective

- The use of probability models and statistical methods for analyzing data has become common practice in virtually all scientific disciplines.
- Two modules of this course attempt to provide a comprehensive introduction to those models and methods most likely to be encountered and used by students in their careers in engineering.
- A broad introduction to some important partial differential equations is also included to make the student get acquainted with the basics of PDE.

Module 1: Probability Distributions (13 hours)

Module 2: Theory of Inference (14 hours)

Module 3: Series Solutions of Differential Equations (14 hours)

Module 4: Partial Differential Equations (13 hours)
Introduction – Formation of PDE – Complete Solution – Equations solvable by direct integration – Linear PDE of First order, Lagrange’s Equation: Pp + Qq = R – Non-Linear PDE of First Order, F(p,q) = 0, Clairaut’s Form: z = px + qv + F(p,q), F(z,p,q) = 0, F_1(x,q) = F_2(y,q) – Classification of Linear PDE’s – Derivation of one dimensional wave equation and one dimensional heat equation – Solution of these equation by the method of separation of variables – D’Alembert’s solution of one dimensional wave equation.

Text Books:
1. Richard A Johnson, CB Gupta, Miller and Freund’s Probability and statistics for Engineers, 7e, Pearson Education- Sections: 4.1, 4.2, 4.3, 4.4, 4.6, 4.8, 5.1, 5.2, 5.5, 5.7
3. Erwin Kreysig, Advanced Engineering Mathematics, 8e, John Wiley and Sons, Inc.- Sections: 4.1, 4.3, 4.4, 4.5


**References:**


**Internal Continuous Assessment (Maximum Marks-30)**

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences) 5 x 2 marks=10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions 4 x 5 marks=20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*
EN09 402  ENVIRONMENTAL SCIENCE  
(Common for all branches)  

Teaching scheme  
2 hours lecture & 1 hour tutorial per week  

Credits: 3  

Objectives  
- To understand the problems of pollution, loss of forest, solid waste disposal, degradation of environment, loss of biodiversity and other environmental issues and create awareness among the students to address these issues and conserve the environment in a better way.  

Module 1 (8 hours)  
The Multidisciplinary nature of environmental science, Definition-scope and importance-need for public awareness. Natural resources, Renewable and non-renewable resources: Natural resources and associated problems-forest resources: Use and over exploitation, deforestation, case studies. Timber extraction, mining, dams and their defects on forests and tribal people.-water resources: Use and over utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.- Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.-Food resources: World food problems, changes caused by agriculture over grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.-Energy resources: Growing energy needs, renewable and non-renewable energy resources, use of alternate energy resources, Land resources: Land as a resource, land degradation, man induced land slides, soil erosion and desertification.  

Module 2 (8 hours)  

Module 3 (10 hours)  
Environmental pollution: Definition-Causes, effects and control measures of Air pollution-m Water pollution –soil pollution-Marine pollution-Noise pollution-Thermal pollution-Nuclear hazards-Solid waste management: Causes, effects and control measures of urban and industrial wastes-Role of an individual in prevention of pollution-pollution case studies-Disaster management: floods, earth quake, cyclone and landslides-Environmental impact assessment  

Module 4 (10 hours)  
Environment and sustainable development-Sustainable use of natural resources-Conversion of renewable energy resources into other forms-case studies-Problems related to energy and Energy auditing-Water conservation, rain water harvesting, water shed management-case studies-Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents
and holocaust-Waste land reclamation-Consumerism and waste products-Reduce, reuse and recycling of products-Value education.

**Text Books:**

**References:**
2. Bharucha Erach, Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad
4. Down to Earth, Centre for Science and Environment
5. Hawkins, R.E. Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay

**Internal Continuous Assessment (Maximum Marks-30)**
60% - Tests (minimum 2)
30% - Assignments (2 minimum) such as Report of field work, literature survey, seminars, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A: Short answer questions (one/two sentences)**
5 x 2 marks = 10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B: Analytical/Problem solving questions**
4 x 5 marks = 20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C: Descriptive/Analytical/Problem solving questions**
4 x 10 marks = 40 marks
Two questions from each module with choice to answer one question.

**Maximum Total Marks: 70**

**CH09 403 FLUID AND PARTICLE MECHANICS**

**Teaching scheme**
3 hours lecture & 2 hour tutorial per week
Objectives

- To impart the basic concepts of fluid and particle mechanics
- To develop understanding about viscosity, fluid flow and machinery

MODULE 1 (16 Hour)
Introduction to fluid mechanics-Definition of fluid-Physical properties of fluid-Variation of viscosity and density with temperature and pressure. Rheology of fluids-Classification of fluids-Fluid Statics and application-Pascals law-Hydrostatic equilibrium in gravity and centrifugal field-Barometric equation-Lapse rate-Principle of Manometer-Simple manometer and Inclined tube manometer-Principles of continious gravity and centrifugal decanter. Introduction to fluid flow phenomenon-Reynolds experiment-Reynolds number-Classification of flow-Turbulence-Different types-Reynolds stress-Flow in boundary layer-Boundary layer separation and wake formation-Boundary layer separation in straight tubes-Potential flow

MODULE 2 (17 Hour)
Basic equations of fluid flow-Continuity, Bernoullis and Momentum equation-Toricelli equation. Kinetic energy and Momentum correction factors-Correction for fluid friction and pump work for Bernoullis equation. Laminar flow of incompressible fluids in pipes and conduits.Shear stress and Velocity distribution-Maximum and average velocity-Hagen Poiseuille and Darcy wiesbach equation-Definition of Friction factor on Reynolds number in laminar flow. Turbulent flow of incompressible fluids in pipes and conduits-Universal velocity distribution equation-Friction factor and Reynolds number relation ship-Nikuradse and Karman equation-Blasius equation (derivation not required) Prantl one seventh power law-Friction factor chart-Friction from changes in velocity or direction-Sudden expansion and contraction-Fittings and valves. Flow through Non circular cross section-Equivalent length.

MODULE 3 (16 Hour)

MODULE 4 (16 Hour)

References:
1. McCabe W.L. & Smith J.C., Unit Operations of Chemical Engg, McGraw Hill
4. Foust, Wenzel, Clump, Maus & Anderson, Principles of Unit Operation
CH09 404 PHYSICAL AND ANALYTICAL CHEMISTRY

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
- To impart the basic concepts of physical and analytical chemistry

Module 1 (13 hours)

Module 2 (13 hours)

Module 3 (13 hours)

Module 4 (13 hours)

References:
1. Atkins & de Paula, Atkin’s Physical Chemistry, 7th Edn., Oxford University Press
2. S. Glasston, A Textbook of Physical Chemistry, McMillan India
3. S. Usharani, Analytical Chemistry, McMillan India
4. Mason, Sonochemistry, Oxford University Press

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.
PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.
PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 405 CHEMICAL ENGINEERING THERMODYNAMICS II
Teaching scheme
3 hours lecture & 1 hour tutorial per week

Objectives
- To impart the detail concepts of thermodynamics

Module 1 (13 hours)
property changes on mixing - heat effects of mixing processes - enthalpy composition diagrams - excess properties - relation between excess Gibbs free energy and activity coefficient

**Module 2 (13 hours)**

**Module 3 (13 hours)**
Applied phase equilibrium - vapour-liquid equilibrium at high pressures - vaporisation equilibrium constants - bubble point, dew point and flash calculations in multi component systems - computer programs for these calculations - vapour-liquid equilibrium in partially miscible and immiscible systems - phase diagrams - principles of steam distillation - phase equilibrium considerations in steam distillation - liquid-liquid equilibrium - binary and ternary equilibrium diagrams - use of triangular diagrams for ternary equilibrium - Different types of ternary systems and their representation on triangular coordinates. Thermodynamic analysis of processes - rate of entropy generation in steady flow processes - calculation of ideal work and lost work - thermodynamic analysis of steady state flow processes.

**Module 4 (13 hours)**
Chemical reaction equilibria - reaction stoichiometry - criteria of chemical equilibrium - equilibrium constant - standard free energy change - standard state - feasibility of reaction - effect of temperature on equilibrium constant - presentation of free energy data - evaluation of K - equilibrium conversion in gas-phase reactions - effect of pressure and other parameters on conversion - liquid-phase and heterogeneous reaction - reactions in solutions - pressures of decomposition in gas-solid reaction - simultaneous reactions - phase-rule for reacting systems

**References:**
1. Narayanan K. V., A Textbook of Chemical Engineering Thermodynamics, Prentice-Hall of India
5. Y.V.C. Rao, Chemical Engineering Thermodynamics, Universities Press

**Internal Continuous Assessment** *(Maximum Marks-30)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**
**PART A: Short answer questions (one/two sentences)**
5 x 2 marks = 10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.
PART B: Analytical/Problem solving questions  
4 x 5 marks = 20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions  
4 x 10 marks = 40 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 406 PARTICLE TECHNOLOGY

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
- To impart the basic concepts of mechanical operations
- To develop understanding about size analysis, size reduction and solid handling

Module 1 (13 hours)
Particle diameter and shape factor - particle size analysis - sieve analysis - particle size distribution - cumulative and differential methods of analysis - mean diameters - specific surface area and number of particles - sub-sieve analysis - pipette analysis - beaker decantation - photo sedimentation - sedimentation balance - ICI sedimentation - elutriation - microscopic counting - permeability and adsorption - screening - effectiveness and capacity of screens and factors affecting them - types of industrial screens

Module 2 (13 hours)
Principles of free and hindered settling - equal settling particles - classifiers - types of classifiers - mechanical and non-mechanical, hydrocyclones, pneumatic classifiers - principles of mineral benefication methods - jiggings - willy table - heavy media separation - magnetic and high-tension separation - types of equipment - froth flotation, principles, additives, and flotation cell arrangements and types of equipment - batch and continuous thickening - kynch theory - design of continuous thickener

Module 3 (13 hours)
Filtration - theory of constant pressure and constant rate filtration - cake porosity and compressibility - filter aids - optimum filtration cycle - types of batch and continuous filters - washing of filter cakes - centrifugal methods of separation including centrifugal filtration - continuous centrifuge - gas cleaning methods - gravity settling - cyclone separation - electrostatic precipitation - scrubbing

Module 4 (13 hours)
Laws of communication - mechanism and efficiency of size reduction - principles of important size reduction equipment - types and selection of equipment for all ranges - closed circuit and open circuit grinding - free crushing and choke feeding - wet and dry grinding - mixing of granular solids and pastes - degree of mixing - type and selection of equipment - storage and conveying of solids - silos, bins and hoppers - different types of conveyors - selection of conveyors

References:
6. George Granger Brown, Unit Operations, Wiley

**Internal Continuous Assessment (Maximum Marks-30)**

- 60% - Tests (minimum 2)
- 30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
- 10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences)  
5 x 2 marks = 10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions  
4 x 5 marks = 20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions  
4 x 10 marks = 40 marks

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

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**CH09 407(P) ENVIRONMENTAL ENGINEERING LAB**

**Teaching scheme**

3 hours practical per week

**Credits:** 2

**Objectives**

- To provide experience on analysis of water, waste water and air.
- To acquaint the students with the measurement using sophisticated instruments.

1. Determination of hardness of water
2. Determination of dissolved oxygen in water
3. Determination of BOD of wastewater sample
4. Determination of COD of wastewater sample
5. Determination of total nitrogen and ammoniacal nitrogen
6. Determination of SS, TDS, and VSS of a wastewater sample
7. Analysis of oil & grease in wastewater sample
8. Determination of fluoride, silica, sodium, calcium, potassium, magnesium, sulphide, sulphate, phosphate, nitrate, iron and heavy metals
9. Flame photometer
10. Spectrophotometer
11. pH meter
12. Mercury Analyser
13. Atomic Absorption Spectrophotometer
14. Polarimeter
15. Sound level meter
16. Analysis of ambient air using high volume sampler
17. Stack analysis
18. Water analyser

**Internal Continuous Assessment (Maximum Marks-50)**

- 60% - Laboratory practical and record
- 30% - Tests/s
- 10% - Regularity in the class
**End Semester Examination** *(Maximum Marks-50)*
70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record

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**CH09 408(P) MATERIALS TECHNOLOGY AND ENGINEERING LAB**

**Teaching scheme**

*Credits: 2*

*3 hours practical per week*

**Objectives**

- To provide experience on preparation, testing, and analysis of materials.

1. Viscosity measurement using Ostwald viscometer and Brookefield viscometer
2. Melt flow index
3. Measurement of environmental crack resistance of plastic materials
4. Measurement of abrasion resistance
5. Fabrication of FRP laminates and/or products
6. Measurement of softening point of plastic materials
7. Measurement of hardness of materials
8. Determination of the effect of a filler on a non-Newtonian fluid
9. Injection moulding
10. Specific gravity measurement
11. Heat deflection temperature measurement
12. Measurement of impact strength of plastic materials
14. Measurement of resistance of materials
15. Study the fatigue behavior of materials using rotary fatigue testing machine
16. Measurement of the tensile properties of plastic materials
17. Preparation of phenol formaldehyde and urea formaldehyde
18. Preparation of PMMA, cupra-ammonium rayon and polystyrene

**Internal Continuous Assessment** *(Maximum Marks-50)*

60% - Laboratory practical and record
30% - Test/s
10% - Regularity in the class

**End Semester Examination** *(Maximum Marks-50)*

70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record
CH09 501 CHEMICAL REACTION ENGINEERING

Teaching scheme
3 hours lecture & 2 hour tutorial per week

Objectives
- To impart the basic concepts of chemical reaction engineering
- To develop understanding about reactor analysis and design

Module 1 (18 hours)

Module 2 (15 hours)

Module 3 (15 hours)

Module 4 (18 hours)

References:
1. Levenspiel O., Chemical Reaction Engineering, John Wiley
2. Fogler H.S., Elements of Chemical Reaction Engineering, Prentice Hall of India

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B: Analytical/Problem solving questions**

4 x 5 marks = 20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C: Descriptive/Analytical/Problem solving questions**

4 x 10 marks = 40 marks

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

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**CH09 502 PETROLEUM REFINERY ENGINEERING & PETROCHEMICALS**

**Teaching scheme**

3 hours lecture & 1 hour tutorial per week

**Credits:**

4

**Objectives**

- To impart the basic concepts of petroleum processing and manufacture of petrochemicals
- To develop understanding about refining and post refining operations

**MODULE 1** (13 Hour)


**MODULE 2** (13 Hour)


**MODULE 3** (13 Hour)


**MODULE 4** (13 Hour)

Production of Acetylene, Ethylene and Propylene by steam cracking of Naphtha. Production of Aromatics in Refinery. Manufacture of Caprolactum from Benzene. Production of Phenol and Acetone from Benzene and propylene. Manufacture of Poly ethylene, P.V.C, Poly propylene, Poly styrene, Mono ethylene glycol, Methanol and Formaldehyde

**References:**

2. Dr. Kochu Baby Manjooran S, Modern Petroleum Chemistry
3. Dr. Ram Prasad, Petroleum Refining Technology, Khanna Publishers
5. Gopala Rao M & Sitting M, Drydens Outline of Chemical Technology, Affiliated East West Press

**Internal Continuous Assessment (Maximum Marks-30)**
- **60% - Tests** (minimum 2)
- **30% - Assignments** (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
- **10% - Regularity in the class**

**University Examination Pattern**

PART A: Short answer questions (one/two sentences)  
5 x 2 marks = 10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions  
4 x 5 marks = 20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions  
4 x 10 marks = 40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

**CH09 503 PROCESS HEAT TRANSFER**

**Teaching scheme**

*Credits: 4*

**3 hours lecture & 1 hour tutorial per week**

**Objectives**
- To impart the basic concepts of heat transport
- To develop understanding about heat exchangers and evaporators

**Module 1 (11 hours)**

**Module 2 (15 hours)**
Forced convection heat transfer - factors influencing heat transfer coefficients - analogy between heat and momentum transfer - Reynolds, Prandtl and Colburn analogies - dimensional analysis - heat transfer to fluids in laminar and turbulent flow - empirical equations for heat transfer coefficient - natural convection and empirical correlations for different geometry - heat transfer to boiling liquids - regimes of boiling - mechanism of nucleate boiling - film condensation on vertical surfaces - Nusselt equation - dropwise condensation

**Module 3 (13 hours)**
Module 4 (13 hours)
Evaporation - equipment and classification - single effect and multiple effect evaporators -
methods of feeding - performance criteria and factors affecting evaporator performance -
calculation of heat transfer area - evaporator accessories - vapour recompression evaporators
- scale formation and its effect

References:
1. McCabe W.L., Smith J.C. & Harriott P., Unit Operations in Chemical Engineering,
   McGraw Hill
   Press

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions,
   quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not
more than two questions from any module.
PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from
each module and not more than two questions from any module.
PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70
heat and momentum transfer - application of empirical correlations to known geometry such as flat plates, wetted wall columns. Elementary treatment of theories of mass transfer: penetration and surface renewal theories - interphase mass transfer - equilibrium - diffusion between phases - two-film theory - local and overall k-type coefficients.

Module 2 (13 hours)
Gas absorption, absorption equipment, multistage absorption, tray towers, tray types and general features of tray designs (qualitative treatment), continuous contact equipment, venturi scrubbers, packed columns, packing materials and characteristics, general constructional details of packed columns, flooding and loading, choice between plate and packed columns. Solubility of gases in liquid, choice of solvent, material balance in countercurrent and concurrent absorption and stripping, L/G ratio, multistage operation, number of plates by graphical construction, Kremser equation, tray efficiency, design of packed columns, transfer unit and general graphical method, dilute solutions and simplified design methods.

Module 3 (13 hours)
Humidification and dehumidification, theory of wet-bulb temperature and adiabatic saturation temperature, Lewis relation, water cooling with air, types of cooling towers, enthalpy transfer unit, general design procedure, application of simplified methods of cooling tower design, spray chambers for air humidification, principles of gas dehumidification by countercurrent contact with water. Crystallization, principles of crystallization, purity, yield, energy requirements, super saturation, nucleation, rate of nucleation, growth of crystals, growth coefficients, crystallisation equipment, MSMPR crystallizer.

Module 4 (13 hours)
Drying, equilibrium moisture content, batch drying, rate of drying, cross-circulation drying, mechanism of moisture movement, continuous drying, parallel and countercurrent, material and enthalpy balances, rough estimate of size of rotary dryer based on heat-transfer units for drying at high temperature, industrial dryers for batch and continuous drying. Adsorption, types of adsorption, nature of adsorbents, adsorption isotherm for single gases, vapours and dilute liquid solutions, Freundlich isotherm, contact filtration of liquids, single stage and multistage operation, unsteady state fixed-bed adsorbers, adsorption wave, rate of adsorption and breakthrough curve.

References:
3. Seader J.D. & Henley E.J Separation Process Principles

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B: Analytical/Problem solving questions**  
4 x 5 marks = 20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C: Descriptive/Analytical/Problem solving questions**  
4 x 10 marks = 40 marks

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

**CH09 505 ENVIRONMENTAL ENGINEERING**

**Teaching scheme**
3 hours lecture & 1 hour tutorial per week

**Credits:** 4

**Objectives**
- To impart the basic concepts of environmental engineering
- To develop understanding about pollution and its treatment methodology.

**Module 1 (13 hours)**
Introduction to environmental engineering - environmental legislation and regulation - Water treatment - precipitation processes - alum treatment and lime soda softening - municipal water conditioning - ion exchange processes - boiler feed water treatment - desalting - sources and classification of wastewater - physical, chemical and biological characteristics of wastewater - types of water pollutants and their effects - water quality standards - wastewater sampling and analysis - determination of organic matter - dissolved oxygen - biochemical oxygen demand - chemical oxygen demand - wastewater microbiology

**Module 2 (13 hours)**

**Module 3 (13 hours)**
Module 4 (13hours)
Air pollution - sources and classification of air pollution - effects of air pollution - global effects of air pollution - global warming and ozone depletion - air pollution meteorology - atmospheric dispersion - air pollution from automobiles - sampling and analysis of air pollutants - air pollution control methods and equipment - settling chambers - cyclone separators - fabric filters - electrostatic precipitators - wet scrubbers - control of gaseous emission - absorption by liquid and adsorption by solids - noise pollution - effects of noise on people - noise control methods

References
2. Peavy H.S., Rose D.R.& Tchobanoglous G., Environmental Engineering, Mcgraw Hill
5. Rao C.S., Environmental Pollution Control Engineering, New age International Pub.
7. Babitt H.E., Sewage & Sewage Treatment, John Willey

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 506 PROCESS INSTRUMENTATION
Teaching scheme
2 hours lecture & 1 hour tutorial per week

Objectives
• To impart the basic concepts of instrumentation

Module 1 (10 hours)
Introduction-definition of instrumentation-concept of an instrument-functional elements and functions of an instrument –classification of instruments. Performance characteristics of an
instrument like static and dynamic type. Temperature measurement-electrical, non-electrical, contact and non-contact methods, thermometers of three types like liquid-filled, vapour-pressure and gas-filled type, bimetallic thermometers, resistance thermometers, thermocouple type-thermoelectric principles like Seebeck effect, Peltier effect & Thomson effect and the laws of thermoelectricity-thermocouple output measurement. Radiation methods-radiation and optical pyrometry. Thermistors-resistance characteristics and their application in temperature measurement.

**Module 2** (10 hours)
Pressure measurement- manometers of U-tube type, well type and inclined type. Prandtl and air type micromanometers. Barometer method for atmospheric pressure measurement. Low pressure measurement by kenetometer, McLeod gage, thermal conductivity gauge, Pressure measurement by bourdon tube, flat and corrugated diaphragms, and capsules. Measurement of pressure in corrosive fluids using liquid seal and diaphragm seal. Transducers of electrical and mechanical type. Density measurement using constant volume hydrometer and, air pressure balance method, gas density detector and gas specific gravity measuring system.

**Module 3** (10 hours)
Flow measurement using head type flowmeters based on differential pressure measurement-orifice meter, venturimeter, flow nozzle and pitot tube. Open channel meters like weirs, flumes. Electromagnetic flowmeters. Variable area meters like rotameter and cone and float type. Mechanical flowmeters of positive displacement type like rotating disk and turbine type & anemometers. Level measurement-direct type and indirect type. Differential pressure method for pressurized vessels. Solid level detectors.

**Module 4** (10 hours)
Moisture content and humidity definition, moisture content determination by thermal drying. Instruments for measuring humidity like hygrometer, psychrometer, dew point apparatus. pH measurement using calomel electrode. Composition analysis using spectroscopic methods like absorption, emission and mass spectrometers. Analysis of solids by X-ray diffraction. Gas analysis by thermal conductivity, polarography & chromatography.

**References:**
1. Jain R.K., Mechanical and Industrial Measurements, Khanna
2. Eckman D.P., Industrial Instrumentation, Wiley Eastern

**Internal Continuous Assessment (Maximum Marks-30)**
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*
CH09 507(P) FLUID & PARTICLE MECHANICS LAB

Teaching scheme

Credits: 2
3 hours practical per week

Objectives

- To provide experience on various basic fluid and particle mechanics experiments

1. Losses in pipe fittings, expansion and contractions
2. Determination of equivalent lengths of piping layouts
3. Free settling - (Stoke’s Law)
4. Packed bed - (pressure drop characteristics)
5. Fluidisation - (liquid-solid)
6. Centrifugal pump - (characteristic curves)
7. Rotary pump - (study of features)
8. Orifice plate and venturimeter - (hydraulic equation)
9. Orifices and mouthpieces - (flow coefficients)
10. Flow under varying head - (Equation of discharge)
11. Weirs and notches - (hydraulic equation)
12. Rotameter – (calibration)

Internal Continuous Assessment (Maximum Marks-50)
60% - Laboratory practical and record
30% - Test/s
10% - Regularity in the class

End Semester Examination (Maximum Marks-50)
70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record

CH09 508(P) PARTICLE TECHNOLOGY LAB

Teaching scheme

Credits: 2
3 hours practical per week

Objectives

- To provide experience on analysis of size and size reduction.
- To acquaint the students with the separations based on size.

1. Ball mill - verification of the laws of crushing
2. Ball mill - determination of the critical speed
3. Sieve analysis - determination of particle size - size distribution, mean diameter, specific surface area and number of particles per unit mass
4. Determination of the effectiveness of the screen
5. Pipette analysis
6. Beaker decantation
7. Sedimentation
8. Leaf filter- specific cake resistance and compressibility factor
9. Plate & frame filter press
10. Froth floatation
11. Elutriator
12. Mineral jig
13. Super centrifuge
14. Wilfley table
15. Continuous thickener
16. Rotary drum filter
17. Jaw crusher and hammer mill
18. Cyclone separator
19. Study of equipments

**Internal Continuous Assessment (Maximum Marks-50)**
60% - Laboratory practical and record
30% - Test/s
10% - Regularity in the class

**End Semester Examination (Maximum Marks-50)**
70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record
SIXTH SEMESTER

CH09 601 CHEMICAL PROCESS INDUSTRIES

Teaching scheme
3 hours lecture & 2 hour tutorial per week

Credits: 5

Objectives
- To impart the basic concepts of chemical technology
- To develop understanding about unit process and unit operations in various industries.

Module 1 (16 hours)

Module 2 (16 hours)

Module 3 (16 hours)

Module 4 (16 hours)
General study of food processing, food byproducts, leather, gelatin, adhesives, vegetable oils, animal fats and oils, waxes, sugar, starches and related products, industrial alcohol by fermentation, absolute alcohol, beers, wines and liquors. Pharmaceuticals, biotechnology.

References:
2. Gopal Rao M. & Sittig M. (Eds.), Dryden’s Outlines of Chemical Technology, Affiliated East West Press

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.
PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C: Descriptive/Analytical/Problem solving questions**

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

**CH09 602 PROCESS DYNAMICS & CONTROL**

**Teaching scheme**  
3 hours lecture & 1 hour tutorial per week

**Objectives**

- To impart the basic concepts of controls for chemical processes

**Module 1** (13 hours)
Introduction to process dynamics and control - definition of terms - Laplace transform - transform of simple functions - derivatives and integral - properties of Laplace transforms - final value theorem - initial value theorem - transition of transforms and functions - examples - inversion by partial fraction - solution of differential equations - qualitative nature of solutions - linear open loop systems - first order systems - mercury thermometer, liquid level and mixing processes - response of these to different types of forcing functions - systems in series - interacting and non-interacting types and generalization of results

**Module 2** (13 hours)
Linear open loop systems - second order systems - mercury thermometer in a well and manometer - impulse and step response of under damped, critically damped and over damped system, their derivation - closed loop system - servo and regulator problems - block diagram development - block diagram reduction - controllers - types, basic principles and transfer functions - the flapper nozzle assembly - pneumatic & electronic controllers - PID, PI and PD (derivation excluded) - supervisory control and data acquisition (SCADA) - distributed control system (DCS)

**Module 3** (13 hours)
Transient response of simple control systems - step response and offset - introduction to stability of linear systems - Routh-Hurwitz criterion for stability - root locus technique - plotting the root locus diagram - transportation lag and its effect on root locus diagram

**Module 4** (13 hours)
Introduction to frequency response - substitution rule - Bode diagram for first order systems - first order systems in series - second order systems - Bode stability criterion, gain margin and phase margin - controller tuning - Ziegler-Nichols method - reaction curve method - comparison of closed loop responses for different controller settings. Basic principles of advanced control systems: Cascade control, ratio control and Fuzzy logic.

**References:**
4. Ceaglske N.H., Automatic Process Control for Chemical Engineers  
5. Eckman D.P., Principles of Industrial Process Control  
6. Tsai T.H., Lane J.W. & Lom C.S., Modern Control Techniques for the Processing Industries, Marwel Dekker  
7. Albert C.L. & Coggen D.A., Fundamentals of Industrial Control, ISA
**Internal Continuous Assessment** *(Maximum Marks=30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A: Short answer questions (one/two sentences)**  
$5 \times 2 \text{ marks}=10 \text{ marks}$  
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B: Analytical/Problem solving questions**  
$4 \times 5 \text{ marks}=20 \text{ marks}$  
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C: Descriptive/Analytical/Problem solving questions**  
$4 \times 10 \text{ marks}=40 \text{ marks}$  
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

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**CH09 603  MASS TRANSFER OPERATIONS II**

**Teaching scheme**  
Credits: 4
3 hours lecture & 1 hour tutorial per week

**Objectives**

- To impart the basic concepts of mass transfer in distillation, extraction, leaching and membrane operations
- To develop understanding about design and analysis of distillation, extraction, leaching and membrane operation units.

**Module 1** (13 hours)
Distillation - boiling-point diagram and equilibrium curves - application of Raoult’s law - relative volatility - flash distillation - differential distillation - steam distillation - fractionation - plate columns for distillation - condensers - reboilers - principles of rectification - material and energy balance - reflux ratio and its importance - Ponchon-Savarit method - enthalpy-composition diagrams - difference points and L/G ratio - number of plates - feed plate location - minimum reflux conditions

**Module 2** (13 hours)
Design of fractionation columns by McCabe-Thiele method - basic assumptions - number of plates - feed quality and feed line - feed plate location - total reflux - minimum reflux - optimum reflux - cold reflux - open steam - intermediate streams - rectification of partially miscible mixtures - comparison of McCabe-Thiele and Ponchon-Savarit methods - plate efficiency - relation between Murphree and overall efficiency - rectification in packed columns - height of packed towers - azeotropic and extractive distillation (qualitative treatment only)

**Module 3** (13 hours)
Extraction - applications - ternary equilibria on triangular coordinate system - mixer rule - distribution curve - selectivity - choice of solvent - single-stage and multistage operations - calculations for immiscible systems and partially miscible systems - extraction with reflux - construction and working of mixer - settler cascades, sieve-tray columns, and baffle towers for extraction - continuous contact extraction - design for insoluble liquids - simplification for
dilute solutions - packed columns versus spray columns for extraction - construction and working of agitated towers, pulse columns and centrifugal extractors

**Module 4 (13 hours)**

**References:**
3. Seader J.D.& Henley E.J Separation Process Principles Wiley India
5. Foust A.S. et al, Principles of Unit Operations, John Wiley

**Internal Continuous Assessment (Maximum Marks-30)**
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences) 5 x 2 marks = 10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions 4 x 5 marks = 20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions 4 x 10 marks = 40 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

**CH09 604 ECONOMICS AND MANAGEMENT OF CHEMICAL INDUSTRIES**

**Teaching scheme**
3 hours lecture & 1 hour tutorial per week

**Credits:** 4

**Objectives**
- To impart the basic concepts of economics and management

**Module 1 (13 hours)**
Equivalence and cost comparison - time value of money and equivalence - equations used in economic analysis - compound interest and continuous interest as una cost - Hoskold’s formula - capitalized cost - cost comparison with equal and unequal duration of service life - depreciation and taxes - nature of depreciation - methods of determining depreciation - straight line - sinking fund - declining balances - double declining balance - sum of years digits and units of production methods - present worth after taxes - cost comparison after taxes
Module 2 (13 hours)
Cost estimation - equipments for process plants - cost indices - construction cost indices - material cost indices - labour cost indices - William’s sixteenth factor - location index - types of cost estimates - order of magnitude estimate - study estimate - preliminary estimate - definitive estimate - detailed estimate - techniques of cost estimates - conference techniques - comparison techniques graphic relationship - tabular relationship - unit rate techniques - lang factor method - hand factor method - Chilton method - miller method - Peter’s and Timmerhaus ratio factor method - check list of items for capital cost estimates, product cost estimates, direct production cost, administration expenses - check list of items for total product cost estimates - elements of complete costs - start up costs

Module 3 (13 hours)
Profitability analysis - mathematical methods for profitability evaluation - payout time - payout time with interest - return on average investment - DCF rate of return - net present value - net present value index - incremental analysis - break even analysis - variable cost and fixed cost - economic production chart for 100% capacity and dumping - non-linear economic production chart

Module 4 (13 hours)
Inflation - cost comparison under inflation - una burden - allowance for inflation - displacement vs replacement - one year more of existent - more than one year of the existent - principles of accounting - accounting definition - trial balance - balance sheet - profit and loss accounts - financial ratios related to balance sheet and profit and loss account - financial institutions - feasibility analysis report of a venture - canons of ethics of engineers

References:
5. Tyler, Chemical Engineering Cost Estimation
6. Aries & Newton, Chemical Engineering & Cost Estimation
7. Happel, Chemical Process Economics, Marcel Decker

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70
CH09 605 ENERGY ENGINEERING

Teaching scheme

2 hours lecture & 1 hour tutorial per week

Credits: 3

Objectives

- To impart the basic concepts of energy engineering
- To develop understanding about energy harnessing methodology for sustainable development.

Module 1 (10 hours)

Energy, units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, electrical energy from conventional energy resources, internal combustion engines, steam turbines, gas turbines, hydroturbines (thermodynamic cycles not included), nuclear reactors, thermal, hydel and nuclear power plants (process outlines only), efficiency, merits and demerits of the above power plants, combined cycle power plants, fluidized bed combustion, small hydropower.

Module 2 (10 hours)

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooing, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar photovoltaic systems, solar cells, solar photovoltaic power generation, solar energy application in India, energy plantations, wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

Module 3 (10 hours)

Biomass energy resources, thermochemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydro dynamics, open cycle and closed cycle systems, magneto hydro dynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage, electrical storage.

Module 4 (10 hours)

Energy conservation in chemical process plants, energy audit energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation in petroleum, fertilizer and steel industry, cogeneration, pinch technology, recycling for energy saving, electrical energy conservation in chemical process plants, environmental aspects of energy use.

References:

5. Venkataswarlu D., Chemical Technology, I, S. Chand

**Internal Continuous Assessment (Maximum Marks-30)**
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

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**ELECTIVE I**

**CH09 L01  HIGH POLYMER ENGINEERING**

**Teaching scheme**

3 hours lecture and 1 hour tutorial per week

**Credits:** 4

**Objectives**

- To impart the basic concepts of polymer technology
- To develop understanding about polymer as an engineering material

**No Pre-requisites**

**Module 1** (12 hours)

**Module 2** (16 hours)
**Module 3** (12 hours)

**Module 4** (12 hours)

**References:**
2. Gowariker V.R., Polymer Science, New Age.

**Internal Continuous Assessment** *(Maximum Marks-30)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

**CH09 L02 WATER TREATMENT TECHNOLOGY**

**Teaching scheme**
3 hours lecture and 1 hour tutorial per week

**Credits:** 4

**Objectives**
- To impart the basic concepts of water treatment technology
**No Pre-requisites**

**Module 1** (13 hours)
Water resources- Rainfall and runoff, ground water and surface waters. Quantity of water- Domestic water needs, Industrial demand, Institutional demand and Fire fighting demand. Quality of water- Impurities in water and their importance, water borne diseases. Water Analysis-Physical, Chemical and Biological analysis.

**Module 2** (13 hours)
Treatment technologies-Coagulation, flocculation and sedimentation. Usual coagulants, the jar test, flash mixers, flocculators, clarifiers and clariflocculators. Filtration- classification of filters, slow sand filters, rapid sand filters and pressure sand filters. Disinfection of water- chlorination, ozonation and ultra-violet rays.

**Module 3** (13 hours)

**Module 4** (13 hours)
Water quality standards for drinking water, mineral water, boiler feed water and swimming pools. Water recycling and reuse, rain water harvesting. Water pollution control and water management.

**References:**
1. Mark J. Hammer & Mark J. Hammer Jr., Water and Wastewater Technology, Prentice Hall of India. Ltd.
3. Areadio P Sincen & Gregoria A Sincen, Environmental Engineering A Design Approach, Prentice Hall of India Ltd.
4. Ragwala, Water supply and sanitary Engineering, Charator Publishing House, Anand, India

**Internal Continuous Assessment** *(Maximum Marks-30)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences)  
5 x 2 marks = 10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions  
4 x 5 marks = 20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions  
4 x 10 marks = 40 marks

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*
CH09 L03 ESSENTIALS OF MANAGEMENT

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Objectives
• To impart the basic concepts of management

No Pre-requisites

Module 1 (13 hours)
Definitions of management - evolution of management thought - classical theories of management - human relations approach - quantitative school - systems approach - contingency approach - functions or process of management - managerial roles - levels of management - management skills - areas of management

Module 2 (13 hours)
Planning - costs of planning - strategic planning - operational planning - the basic steps in planning - management by objective (MBO) - decision making - steps in decision making process - decision making styles - quantitative decision making aids - decision trees

Module 3 (13 hours)
Organizing - job design - organizational relationships - delegation - decentralization - organizational culture - time management - leadership - managerial grid - theory X and theory Y - behavioural approach to leadership - path-goal model of leadership - motivational techniques - communication - formal channels of communication - barrier to effective communication

Module 4 (13 hours)
Controlling - the basic control process - financial control methods - budgetory control methods - types of auditing - introduction to total quality management (TQM) - quality - costs of quality - the deming philosophy - designing for quality - conformance to design - quality certification - introduction to business process reengineering (BPR) - management information systems (MIS)

References:
2. Stoner J.A.F., Management, Prentice Hall of India

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C: Descriptive/Analytical/Problem solving questions**

4 x 10 marks = 40 marks

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

**CH09 L04 NUMERICAL ANALYSIS**

**Teaching scheme**

3 hours lecture & 1 hour tutorial per week

**Objectives**

- To impart the basic concepts of numerical analysis
- To develop understanding about numerical solutions for engineering problems.

**No Pre-requisites**

**Module 1: Errors in numerical calculations (13 hours)**
Sources of errors, significant digits and numerical instability - numerical solution of polynomial and transcendental equations - bisection method - method of false position - Newton-Raphson method - fixed-point iteration - rate of convergence of these methods - iteration based on second degree equation - the Muller’s method - Chebyshev method - Graeffe’s root squaring method for polynomial equations - Bairstow’s method for quadratic factors in the case of polynomial equations

**Module 2: Solutions of system of linear algebraic equations (13 hours)**
Direct methods - gauss and gauss - Jordan methods - Crout’s reduction method - error analysis - iterative methods - Jacobi’s iteration - Gauss-seidel iteration - the relaxation method - convergence analysis - solution of system of nonlinear equations by Newton-Raphson method - power method for the determination of Eigen values - convergence of power method

**Module 3: Polynomial interpolation (13 hours)**
Lagrange’s interpolation polynomial - divided differences Newton’s divided difference interpolation polynomial - error of interpolation - finite difference operators - Gregory – Newton forward and backward interpolations - Stirling’s interpolation formula - interpolation with a cubic spline - numerical differentiation - differential formulas in the case of equally spaced points - numerical integration - trapezoidal and Simpson’s rules - gaussian integration - errors of integration formulas

**Module 4: Numerical solution of ordinary differential equations (13 hours)**
The Taylor series method - Euler and modified Euler methods - Runge–Kutta methods (2nd order and 4th order only) - multistep methods - Milne’s predictor - corrector formulas - Adam-Bashforth & Adam-Moulton formulas - solution of boundary value problems in ordinary differential equations - finite difference methods for solving two dimensional Laplace’s equation for a rectangular region - finite difference method of solving heat equation and wave equation with given initial and boundary conditions

**References:**
1. Froberg C.E., Introduction to Numerical Analysis, Addison Wesley
2. Gerald C.F., Applied Numerical Analysis, Addison Wesley
3. Hildebrand F.B., Introduction to Numerical Analysis, T.M.H.

**Internal Continuous Assessment (Maximum Marks-30)**
- **60%** - Tests (minimum 2)
- **30%** - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
- **10%** - Regularity in the class

**University Examination Pattern**
- **PART A:** Short answer questions (one/two sentences)  
  5 x 2 marks = 10 marks
  All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.
- **PART B:** Analytical/Problem solving questions  
  4 x 5 marks = 20 marks
  Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.
- **PART C:** Descriptive/Analytical/Problem solving questions  
  4 x 10 marks = 40 marks
  Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

**CH09 L05  COMPUTATIONAL FLUID DYNAMICS**

**Teaching scheme**  
3 hours lecture and 1 hour practicals per week

**Credits:** 4

**Objectives**
- To impart the basic concepts of computational fluid dynamics

**No Pre-requisites**

**Module 1** (10 hours)
Introduction of the governing equations of fluid mechanics - Conservation equations for mass, momentum, energy and chemical species - Derivation of the governing equations - turbulence closure and mass transfer models — Dimensionless form – simplified equations-

**Module 2** (10 hours)

**Module 3** (14 hours)
Introduction of finite difference method - Discretisation – linearisation of the governing equations – linear wave equation, Burgers equation, convection-diffusion equation, First and second order numerical methods such as upwind, Lax-Frederichs, Lax_Wendroff, MacCormack, etc. Examples and applications of fluid flow, heat transfer, non Newtonian flow – Implicit and explicit schemes – Stability and CFL condition – Two dimensional problem – Finite difference method for the momentum equations, boundary conditions for the velocity – The equations for the pressure, boundary conditions for pressure.

**Module 4** (18 hours)
The numerical procedure for solving Navier-Stokes equation – Mixed variational form – Galerkin and FE approximations – the algebraic problem – stability, the LBB condition- mass conservation.
Computer lab practical class) Computer programs for solving Navier-Stokes equations – Practical exposure to different CFD packages for solving Navier-Stokes equation, Euler equation, etc.

References:

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)  
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) 5 x 2 marks = 10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks = 20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks = 40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 607(P) HEAT TRANSFER OPERATIONS LAB

Teaching scheme Credits: 2
3 hours practical per week

Objectives
- To provide experience on testing, and analysis of heat transfer in various approaches.

Laboratory experiments and study of equipment based on the course CH09 503 PROCESS HEAT TRANSFER such as
1. Thickness of insulation
2. Radiation constant and emissivity of solids
3. Thermal conductivity of materials
4. Transient conduction
5. Stefan-Boltzman constant
6. Heat transfer in double-pipe exchanger - parallel and counter current flow
7. Heat transfer in shell and tube exchanger
8. Condensation on vertical and horizontal surfaces
9. Heat transfer by natural and forced convection
10. Heat exchange in jacketed kettles
11. Heat transfer in agitated vessels
12. Open pan evaporation
13. Single and multiple effect evaporation

**Internal Continuous Assessment (Maximum Marks-50)**
60% - Laboratory practical and record
30% - Test/s
10% - Regularity in the class

**End Semester Examination (Maximum Marks-50)**
70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record

**CH09 608(P) MINI PROJECT / PROCESS DESIGN SOFTWARE LAB**

**Teaching scheme**
3 hours practical per week

**Credits:** 2

**Objectives**
- To provide experience on chemical engineering research.
- For enabling the students to gain experience in organisation and implementation of a small project and thus acquire the necessary confidence to carry out main project in the final year.

**MINI PROJECT:** The student jointly or individually is required to prepare a project report based on experimental or theoretical work, literature review, computer application to chemical engineering problems or any other work such as fabrication or setting up of an experimental set-up, preparation of feasibility report etc. under the supervision of a guide - the project report is to be submitted by the end of the semester and the work will be assessed based on the report and the presentation of the work. The assessment of all the mini projects should be done by a committee consisting of three or four faculty members - the students will present their project work before the committee - the relative grading and group average marks for the various projects will be fixed by the committee - the guides will award the marks for the individual students in the project maintaining the group average - each group will submit the project report to the department through the guide - the head of the department will certify the copies and keep one copy in the departmental library.

**Internal Continuous Assessment (50 marks)**
40% - Design and development
30% - Final result and Demonstration
20% - Report
10% - Regularity in the class

**End Semester Examination (Maximum Marks-50)**
20% - Demonstration of mini project
50% - Practical test connected with mini project
20% - Viva voce
10% - Fair record

**Objectives**
- To provide experience on chemical engineering research.
- For enabling the students to gain experience in software
PROCESS DESIGN SOFTWARE LAB: Use of Aspen plus, chemcad, Matlab, Hysis, CFD

Internal Continuous Assessment (Maximum Marks-50)
60%-Laboratory practical and record
30%- Test/s
10%- Regularity in the class

End Semester Examination (Maximum Marks-50)
70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record
SEVENTH SEMESTER

CH09 701 CHEMICAL ENGINEERING DESIGN& DRAWING I

Teaching scheme

Credits: 5

2 hours lecture, 1hour tutorial & 2 hours drawing per week

Objectives

- To impart the basic concepts of chemical engineering drawing, mechanical design and process design of evaporators
- To develop understanding about P&ID, I&C drawing, pressure vessel design, storage tank design and heat exchangers

Module 1 (18 hrs)

Introduction to chemical engineering drawing – P&ID symbols and drawings – I&C drawing of heat exchangers, distillation columns and stirred tank jacketed reactors.
Introduction to pressure vessels: stress variation. Mechanical design of pressure vessels and jacketed vessels.

Module 2 (24 hrs)

Mechanical design of process equipment: tall columns, column supports & accessories, etc.
Mechanical design of non standard flange. Design of storage tanks for Volatile and Non-volatile liquids.

Module 3 (24 hrs)

Process design and detailed drawing of shell & tube heat exchangers and double pipe heat exchanger for single phase streams. Process design of condensers: Tubular horizontal & Tubular vertical for condensation of single vapours.

References:

6. IS Codes.
8. Bhatt N.D., Machine Drawing, Charator Book Stall

Internal Continuous Assessment (Maximum Marks-30)

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, drawings, etc.
10% - Regularity in the class
University Examination Pattern

Part A - Analytical/Problem solving questions with drawing  
marks  
2 question of 20 marks from first module with choice to answer one.  
marks  
Part B - Analytical/Problem solving questions  
marks  
2 question of 25 marks from second module with choice to answer one.  
marks  
Part C - Analytical/Problem solving questions with drawing  
marks  
2 question of 25 marks from third module with choice to answer one.  

Maximum Total Marks: 70

CH09 702 TRANSPORT PHENOMENA

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
- To impart the basic concepts of transport phenomena
- To develop understanding about momentum transport, heat transport and mass transport

Module 1 (10 hours)
Prediction of transport coefficients - viscosity, thermal conductivity, diffusivity - effect of temperature, pressure and composition on transport coefficients - kinetic theories of viscosity, thermal conductivity and diffusivity of gases - relationship among viscosity, thermal conductivity and diffusivity in gases - prediction of transport coefficients of liquids

Module 2 (14 hours)
Shell momentum balance - boundary conditions - application of shell balance to simple flow systems - falling film - flow through tube - flow through annulus - flow of immiscible liquids in layers - creeping flow around solid sphere - general transport equations for momentum - derivation of continuity equation and equation of motion in rectangular coordinates - Navier-Stoke’s equation and Euler equation - transport equations in curvilinear coordinates (no derivation) - application of transport equations to steady flow problems - flow through tube - tangential annular flow - rotating liquid - cone and plate viscometer

Module 3 (14 hours)
Shell energy balance - boundary conditions - application of shell balance to heat conduction problems - conduction with electric, nuclear and viscous heat sources - fixed bed flow reactor - cooling fin - heat transfer by forced and free convection - equations of energy in rectangular coordinates - energy equations in curvilinear coordinates (no derivation) - application to steady-state heat transfer problems - tangential flow in annulus with viscous heat generation - flow of nonisothermal film - transpiration cooling - free convection from vertical plate

Module 4 (14 hours)
Shell mass balance - boundary conditions - diffusion through stagnant gas - diffusion with heterogeneous and homogeneous chemical reaction - diffusion into falling film - diffusion and chemical reaction in porous catalyst - equation of continuity for binary mixtures in rectangular coordinates - equation of continuity in curvilinear coordinates and multicomponent equations of change (no derivation) - application to combined heat and mass transfer, thermal diffusion and pressure diffusion

Note: For the University examinations, students are permitted to take tables of equations of continuity, motion and energy inside the examination hall.
References:

**Internal Continuous Assessment (Maximum Marks-30)**
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A: Short answer questions (one/two sentences)**  
5 x 2 marks=10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B: Analytical/Problem solving questions**  
4 x 5 marks=20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C: Descriptive/Analytical/Problem solving questions**  
4 x 10 marks=40 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

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**CH09 703 SAFETY ENGINEERING IN PROCESS PLANTS**

**Teaching scheme**

Credits: 3

2 hours lecture & 1 hour tutorial per week

**Objectives**
- To impart the basic concepts of industrial safety.
- To develop understanding about safety practices in industries and emergency procedures.

**Module 1 (10 hours)**
Introduction to safety: Concept and importance of industrial safety. Fundamental safety tenets. Safety in the site selection and lay out. Location and design parameters for chimney, flares, rupture discs, location of boiler houses, storage of hazardous chemicals etc. Safety in operations and processes. Work permit system. Confined space safety practices.

**Module 2 (10 hours)**

**Module 3 (10 hours)**
System Safety Analysis: Systems approach to safety utilizing techniques such as plant Inspections, safety Audits, Job- safety Analysis, Hazard Survey and analysis, HAZOP, Fault tree analysis, failure mode and effect analysis, Event tree analysis etc. Case studies on these techniques applied in process industries.

**Module 4 (10 hours)**

References:
12. Safety in Chemical Process Industries: 0. P. Kharbanda

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 704 BIOCHEMICAL ENGINEERING
Teaching scheme

2 hours lecture & 1hour tutorial per week
Credits: 3

Objectives
- To impart the basic concepts of biochemical engineering
- To develop understanding about biochemistry and bioprocesses
Module 1 (10 hours)

Module 2 (10 hours)
Sterilization - Media and air, methods. Stoichiometry of Growth and Product Formation, Fermentation Energy-Balance, Mixing in Fermenters, Role of Shear in Stirred Fermenters, Role of Diffusion in Bioprocessing, Oxygen Uptake in Cell Cultures. Oxygen Transfer in Fermenters, Cell Disruption

Module 3 (10 hours)

Module 4 (10 hours)

References:
2. M.L.Shuler and F.Kargi, Bioprocess Engineering, Prentice-Hall of India
3. Pauline Doran, Bioprocess Engineering Principles, Elsevier

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) 5 x 2 marks = 10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks = 20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks = 40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70
CH09 Lxx ELECTIVE II
Teaching scheme
Credits: 4
3 hours lecture & 1 hour tutorial per week
Any one from Ch09 L06 to CH09 L025 or Global Electives listed at last with maximum one global elective for one semester

CH09 Lxx ELECTIVE III
Teaching scheme
Credits: 4
3 hours lecture & 1 hour tutorial per week
Any one from Ch09 L06 to CH09 L025 or Global Electives listed at last with maximum one global elective for one semester

CH09 707(P) MASS TRANSFER OPERATIONS LAB
Teaching scheme
Credits: 2
3 hours practical per week
OBJECTIVES
• To provide experience analysis of mass transfer operations.

The experiments based on the courses CH09-504 MASS TRANSFER OPERATIONS I and CH09-604 MASS TRANSFER OPERATIONS II such as
1. Determination of diffusivity
2. Determination of mass transfer coefficient in surface evaporation
3. Simple distillation
4. Steam distillation
5. Simple leaching
6. Cross-current leaching
7. Counter current leaching
8. Ternary liquid equilibrium
9. Adsorption isotherm
10. Atmospheric batch drying
11. Wetted wall columns
12. Fractionation columns
13. Packed absorption columns
14. Height equivalent of theoretical plate
15. Experiments on liquid-liquid extraction
16. Continuous drying

Internal Continuous Assessment (Maximum Marks-50)
60% - Laboratory practical and record
30% - Test/s
10% - Regularity in the class

End Semester Examination (Maximum Marks-50)
70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record
CH09 708(P) PROCESS CONTROL AND REACTION ENGINEERING LAB

Teaching scheme

Credits: 2
3 hours practical per week

Objectives

- To provide experience on analysis of process control and reaction engineering.

1. Calibration of thermocouple
2. Dynamics of thermocouple
3. Dynamics of thermometer
4. Dynamics of thermometer with thermo well
5. Dynamics of liquid level system - single tank
6. Dynamics of liquid level system - non-interacting tanks in series
7. Dynamics of liquid level system - interacting tanks in series
8. Control of level process systems
9. Dynamics of mixing process
10. Dynamics of manometer
11. Control of temperature process system
12. Comparative study of P, PI and PID controllers for temperature process system
13. Study of Electro-pneumatic converter
14. Control valve characteristics
15. Determination of activation energy
16. Kinetics of hydrolysis of methyl acetate
17. Kinetics of hydrolysis of ethyl acetate
18. Performance study of plug flow reactor
19. Performance study of CSTR
20. RTD studies

Internal Continuous Assessment (Maximum Marks-50)

60%-Laboratory practical and record
30%- Test/s
10%- Regularity in the class

End Semester Examination (Maximum Marks-50)

70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record

CH09 708(P) PROJECT

Teaching scheme

Credits: 1
1 hours per week

Objectives:

- To judge the capacity of the students in converting the theoretical knowledge into practical systems/investigative analysis.

Project work is for duration of two semesters and is expected to be completed in the eighth semester. Each student group consisting of not more than five members is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. The objective of the project is to test the ability of the student to coordinate the entire knowledge of chemical engineering and to judge his/her originality and capacity in the design of a plant/process/system - the students are required to prepare a project report on a complete process showing the selection of alternatives, preparation of flow-sheet, material
and energy balances, detailed design calculations of the major items of equipment including mechanical design and drawing, capital cost and product cost estimation and profitability, break even analysis, selection of plant location and lay-out - the project has to be completed in the VII and VIII semester - the progress of the work in the VII semester will be assessed and evaluated based on the preliminary report submitted towards the end of the semester and a presentation before a project evaluation committee consisting of three or four faculty members - the complete project report is not expected at the end of the seventh semester - however a three-four page typed report based on the work done should be submitted by the students to the assessing committee - the project guides will award the marks for the individual students in a project group maintaining the group average assigned by the project evaluation committee.

Each project group should submit project synopsis within three weeks from start of seventh semester. Project evaluation committee shall study the feasibility of each project work before giving consent. Literature survey is to be completed in the seventh semester.

Students should execute the project work using the facilities of the institute. However, external projects can be taken up in reputed industries, if that work solves a technical problem of the external firm. Prior sanction should be obtained from the head of department before taking up external project work and there must be an internal guide for such projects.

Each student has to submit an interim report of the project at the end of the 7th semester. Members of the group will present the project details and progress of the project before the committee at the end of the 7th semester.

50% of the marks is to be awarded by the guide and 50% by the evaluation committee.

**Internal Continuous Assessment**

- 20% - Technical relevance of the project
- 40% - Literature survey and data collection
- 20% - Progress of the project and presentation
- 10% - Report
- 10% - Regularity in the class
EIGHTH SEMESTER

CH09 801 CHEMICAL ENGINEERING DESIGN & DRAWING II

Teaching scheme
2 hours lecture, 1 hour tutorial & 2 hours drawing per week

Credits: 5

Objectives
- To impart the basic concepts of process design of evaporators, distillation, absorption and stripping columns, extraction columns, dryers and cooling towers.

Module 1 (20 hrs)

Module 2 (23 hrs)

Module 3 (22 hrs)
Process design and drawing of: tray and packed Extraction columns; Rotary Dryers and tray dryers.

References:
6. IS Codes.

Internal Continuous Assessment (Maximum Marks-30)
- 60% - Tests (minimum 2)
- 30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
- 10% - Regularity in the class

University Examination Pattern
Part A - Analytical/Problem solving questions with drawing 1 x 20 marks = 20 marks
- 2 question of 20 marks from first module with choice to answer one.
Part B - Analytical/Problem solving questions with drawing 1 x 25 marks = 25 marks
2 question of 25 marks from second module with choice to answer one.

Part C - Analytical/Problem solving questions with drawing 1 x 25 marks = 25 marks
2 question of 25 marks from third module with choice to answer one.

Maximum Total Marks: 70

CH09 802 OPTIMISATION OF CHEMICAL PROCESSES
Teaching scheme
Credits: 3
2 hours lecture & 1 hour tutorial per week

Objectives
- To impart the basic concepts of optimization

Module 1 (10 hours)
Nature and organisation of optimisation problems - scope and hierarchy of optimisation - typical applications of optimisation - essential features of optimisation problems - objective function - investment costs and operating costs in objective function - optimising profitability - constraints - internal and external constraints - formulation of optimisation problems - typical examples - nature of functions and their representation - continuous functions - discrete functions - unimodal functions - convex and concave functions - necessary and sufficient conditions for optimum of unconstrained functions

Module 2 (10 hours)

Module 3 (10 hours)
Linear programming - basic concepts in linear programming - graphical interpretation - simplex method - apparent difficulties in the simplex method - two-phase simplex method - nonlinear programming with constraints - equality constraints - method of direct substitution - lagrange multiplier method - use of lagrange multipliers for inequality constraints - kuhn-tucker conditions

Module 4 (10 hours)
Zoutendijk’s method - Rosen’s gradient projection method - some typical applications (numerical solution not expected) - optimising recovery of waste heat - optimisation of evaporator design - optimum diameter for pipe for transportation of fluid - optimisation of liquid - liquid extraction process - optimal design and operation of staged distillation columns - optimum residence time for isothermal batch reactor - linear programming to optimise reactor operations

Reference books:
Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
PART A: Short answer questions (one/two sentences) 5 x 2 marks = 10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.
PART B: Analytical/Problem solving questions 4 x 5 marks = 20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.
PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks = 40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 Lxx ELECTIVE IV
Teaching scheme Credits: 4
3 hours lecture & 1 hour tutorial per week
Any one from Ch09 L06 to CH09 L025 or Global Electives listed at last with maximum one global elective for one semester

CH09 Lxx ELECTIVE V
Teaching scheme Credits: 4
3 hours lecture & 1 hour tutorial per week
Any one from Ch09 L06 to CH09 L025 or Global Electives listed at last with maximum one global elective for one semester

CH09 805(P) SEMINAR
Teaching scheme Credits: 3
3 hours per week
Objective:
• To assess the ability of the student to study and present a seminar on a topic of current relevance in chemical engineering or allied areas.

It enables the students to gain knowledge in any of the technically relevant current topics and acquire the confidence in presenting the topic. The student will undertake a detailed study on the chosen topic under the supervision of a faculty member, by referring papers published in reputed journals and conferences. Each student has to submit a seminar report, based on these papers; the report must not be reproduction of any original paper.
The student shall give at least one seminar for about thirty minutes during the seventh semester before a committee consisting of three or four staff members of the department. The committee assesses the presentation of the seminars and award the marks to the students.
Each student should be asked to submit at least two copies of a write up of his seminar talk – one copy should be returned to the student after duly certifying it by the chairman of the assessing committee and the other kept in the departmental library.

Internal Continuous Assessment
20% - Relevance of the topic and literature survey
50% - Presentation and discussion
20% - Report
10% - Regularity in the class and Participation in the seminar

**CH09 806(P) PROJECT**

**Teaching scheme**
11 hours per week

This project work is the continuation of the project initiated in seventh semester. The performance of the students in the project work shall be assessed on a continuous basis by the project evaluation committee through progress seminars and demonstrations conducted during the semester. Each project group should maintain a log book of activities of the project. It should have entries related to the work done, problems faced, solution evolved etc. Extension and completion of the project work assigned in VII semester - the project report is to be submitted towards the end of the semester. In addition, the student has to make a presentation of his work and appear for a viva-voce before the project evaluation committee constituted for assessing the work. The assessment committee as constituted in the seventh semester, will assess the various projects, fix the relative grading and group average marks - the guides will award the marks for the individual students in a project maintaining the group average - each group will submit the copies of the completed project report signed by the guide to the department - the head of the department will certify the copies and return them to the students - one copy will be kept in the departmental library.

There shall be at least an Interim Evaluation and a final evaluation of the project in the 8th semester. Each project group has to submit an interim report in the prescribed format for the interim evaluation. Each project group should complete the project work in the 8th semester. Each student is expected to prepare a report in the prescribed format, based on the project work. Members of the group will present the relevance, design, implementation, and results of the project before the project evaluation committee comprising of the guide, and three/four faculty members specialised in chemical engineering.

50% of the marks is to be awarded by the guide and 50% by the evaluation committee.

**Internal Continuous Assessment**

40% - Design and development/Simulation and analysis
30% - Presentation & demonstration of results
20% - Report
10% - Regularity in the class

**CH09 807(P) VIVA-VOCE**

**Credits:** 4

**Objective**

- To examine the knowledge acquired by the student during the B.Tech. course, through an oral examination

The students shall prepare for the oral examination based on the theory and laboratory subjects studied in the B.Tech. Course, mini project, seminar, and project. There is only university examination for viva-voce. University will appoint two external examiners and an internal examiner for viva-voce. These examiners shall be senior faculty members having minimum five years teaching experience at engineering degree level. For final viva-voce, candidates should produce certified reports of mini project, seminar, and project (two interim reports and main report). If he/she has
undergone industrial training/industrial visit/educational tour or presented a paper in any conference, the certified report/technical paper shall also be brought for the viva-voce.

**Assessment in Viva-voce**

- **40%** - Subjects
- **30%** - Project and Mini Project
- **20%** - Seminar
- **10%** - Industrial training/industrial visit/educational tour or Paper presented at National-level

Maximum marks: 100

**ELECTIVES**

**CH09 L06  ADVANCES IN BIOCHEMICAL ENGINEERING**

**Teaching scheme**

3 hours lecture and 1 hour tutorial per week

**Objectives**

- To impart the detailed concepts of biochemical engineering

**No Pre-requisites**

**Module 1** (13 hours)

Definition and introduction of biochemical engineering. Microbiology – general idea on structure of cells (prokaryotes and eukaryotes) and cell theory. Classification of microorganisms (protist kingdom) and their morphological characteristics eg. bacteria, blue-green algae, actinomycetes, fungi (mold, yeasts), protozoa (primitive animals) and algae (primitive plants). Biochemistry - study of structure, properties and functions of important cell chemicals like lipids (fatty acids, fats, vitamins, steroids, phospholipids) and carbohydrates, proteins and nucleic acids. Molecular genetics - concept and definition - process of gene expression, DNA replication and mutation, recombinant DNA technology, prospects of genetic engineering.

**Module 2** (13 hours)


**Module 3** (13 hours)


**Module 4** (13 hours)

Design and analysis of biological reactors – Ideal reactors and non-ideal reactors, sterilization reactors, multiphase reactors - packed type, bubble column, fluidized bed, fixed bed (general

References:
3. ‘Biochemical Engineering’ by A.Aiba, E.Humphrey and N.R.Milli
5. ‘Biochemical Engineering’ by J.M.Lee
6. ‘Biochemical Engineering’ by H.W.Blanch and D.S.Clark

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.
PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.
PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 L07 COMPUTER AIDED DESIGN
Teaching scheme
3 hours lecture & 1 hour tutorial per week
Credits: 4

Objectives
• To impart the basic concepts of computer aided design

No Pre-requisites

Module 1 (13 hours)
Introduction to computer aided design - use of computers for physical property evaluation - thermodynamic properties of gases and binary mixtures - methods of calculating vapour-liquid equilibrium data for ideal and non-ideal mixture - bubble point and dew point - flash calculations

Module 2 (13 hours)
Design of pressure vessels - vessels under internal pressure - heads and closures - compensation requirements for openings and flanges - vessels under external pressure - tall vessels - development of CAD modules for design of pressure vessels

Module 3 (13 hours)
Module 4 (13 hours)
Computer aided design of packed bed absorbers and strippers - computer aided mechanical design of bubble - cap distillation column

Reference books:

Internal Work Assessment
60% - Test papers (minimum 2)
30% - Assignments / Term project/any other mode decided by the teacher.
10% - Other measures like Regularity and Participation in Class.

Total Marks = 30

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 L08 SOFTWARE ENGINEERING
Teaching scheme
3 hours lecture and 1 hour practical per week

Objectives
- To impart the basic concepts of software engineering

No Pre-requisites

Module 1 (13 hours)

Module 2 (13 hours)

Module 3 (13 hours)

Module 4 (13 hours)

References:
1. Ian Sommerville, Software Engineering, Pearson Education Asia

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class
University Examination Pattern

**PART A:** Short answer questions (one/two sentences)  
5 x 2 marks = 10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions  
4 x 5 marks = 20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions  
4 x 10 marks = 40 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 L09  UNCONVENTIONAL SEPARATION TECHNIQUES

**Teaching scheme**

Credits: 4

3 hours lecture & 1 hour tutorial per week

**Objectives**

- To impart the basic concepts of unconventional separation techniques
- To develop understanding about membrane processes, chromatography, super critical fluid extraction, etc

**No Pre-requisites**

**Module 1** (13 hours)
Membrane separation processes - fundamentals, mechanism and equilibrium relationships - types and structure of membranes - membrane permeation of liquids and gases - effects of concentration, pressure and temperature - dialysis - mechanism - basic idea on dialyser design - industrial application - reverse osmosis - definitions and theory - design considerations - applications - evaporation - ultra filtration

**Module 2** (13 hours)
Diffusional separation processes - gaseous diffusion - mechanism - process description - design considerations - basic principles of thermal diffusion and pressure diffusion - fundamentals of mass diffusion - desalting by freezing - molecular sieves - super critical extraction - SCE solvents - phase behaviour - industrial applications

**Module 3** (13 hours)
Chromatographic and allied fixed bed separation processes - theory and principle of operation - concentration profile and effluent curves - major applications - foam and bubble fractionation processes - foam-column theory - limiting equations - foam drainage and overflow - additive crystallization and zone melting - ultra and zonal centrifugation

**Module 4** (13 hours)
Separation by action in a field - theory of electrical separation - electrophoresis - electrophoretic mobility - modes of operation - membrane electrophoresis - continuous flow electrophoresis - electro dialysis - ion-selective membranes - design aspects - operating parameters - applications

**References:**

1. Shoen K.M. (Ed.), New Chemical Engineering Separation Techniques, Inter Science
2. Loeb S., Industrial Membrane Separation Processes
7. Seader J.D.& Henley E.J Separation Process Principles

**Internal Continuous Assessment (Maximum Marks-30)**
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

*PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks*
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

*PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks*
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

*PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks*
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

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**CH09 L10  MICRO ELECTRONICS PROCESSING**

**Teaching scheme**
3 hours lecture and 1 hour tutorial per week

**Objectives**
- To impart the basic concepts of microelectronics processing

**No Pre-requisites**

**Module 1 (12 hours)**
Integrated circuits –Semiconductors and charge carriers –basic relationships and conductivity – basic units of integrated circuits- broad view of microelectronics processing. Silicon refining and other raw materials – metallurgical grade and electronic grade silicon – metal organic compounds.

**Module 2 (12 Hours)**
Bulk crystal growth: crystal structures and defects – crystal growth and impurity distribution – oxygen precipitation. Chemical rate processes in the fabrication of ICs: growth processes of films of crystalline structure – heterogeneous reactions and deposition kinetics.

**Module 3 (14 Hours)**
Chemical vapour deposition reactors – regimes of fluid flow – intrinsic kinetics and transport effects – reactor design – isothermal, nonisothermal and molecular flow reactors. Incorporation and transportation of dopants – dopant incorporation – radiation damage and annealing – dopant redistribution and auto doping

**Module 4 (14 Hours)**
Lithography – illumination and pattern transfer – resists and resist development – yield and ultimate limits. Physical and physico chemical rate processes: evaporation and physical
vapour deposition – plasma – physical sputtering – plasma deposition and gas-solid reaction – plasma etching – physical vapour deposition apparatuses – plasma reactors

References:
2. Dennis W. Hess, Klavs F. Jensen, Microelectronics processing: chemical engineering aspects, American Chemical Society, 1989
3. Roy A. Colclaser, Microelectronics: processing and device design, Wiley

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 L11 FOOD TECHNOLOGY
Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
• To impart the basic concepts of food processing

No Pre-requisites

Module 1 (13 hours)
Introduction - general aspects of food industry - world food needs and Indian situation - constituents of food - quality and nutritive aspects - food additives - standards - deteriorative factors and their control - preliminary processing methods - conversion and preservation operations

Module 2 (13 hours)
Preservation by heat and cold - dehydration - concentration - frying - irradiation - micro wave heating - sterilization and pasteurisation - fermentation and pickling - packing methods

Module 3 (13 hours)
Production and utilization of food products - cereal grains - pulses - vegetables - spices - fats and oils - bakery, confectionery and chocolate products

Module 4 (13 hours)
Soft and alcoholic beverages - dairy products, meat, poultry and fish products - treatment and disposal of food processing wastes

Reference books:
3. Wasten E.L., Elements of Food Engineering, Van Nostrand-Reinhold
4. Ronsivalli L.J., Elementary Food Science, Van Nostrand-Reinhold
7. Goldberg I., Biotechnology & Food Ingredients, Van Nostrand-Reinhold

**Internal Continuous Assessment (Maximum Marks-30)**

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences) 5 x 2 marks=10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions 4 x 5 marks=20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

**CH09 L12 PROCESS MODELING AND SIMULATION**

**Teaching scheme**

3 hours lecture & 1 hour tutorial per week

**Objectives**

- To impart the basic concepts of simulation and modeling of chemical processes

**No Pre-requisites**

**Module 1** (13 hours)

Basic modelling principles - uses of mathematical modelling - classification of modelling techniques - fundamental laws - energy equations - continuity equation - equations of motion - transport equations - equations of state - equilibrium states and chemical kinetics - examples

**Module 2** (13 hours)

Mathematical models for chemical engineering systems - continuous flow tanks - enclosed vessel - mixing vessel - mixing with reaction - reversible reaction - steam jacketed vessel - boiling of single component liquid - open and closed vessel - continuous boiling - multicomponent boiling system - batch distillation

**Module 3** (13 hours)

Gas flow system - hydraulic transients between two reservoirs - reaction kinetics - general modelling scheme - liquid phase CSTR - batch reactor - ideal binary distillation column - distributed systems - jacketed tubular reactor - laminar flow in a pipe - counter current heat exchanger
Module 4 (13 hours)
Digital simulation - numerical integration - Euler and fourth order Runge Kutta methods - simulation of gravity flow tank - CSTR in series - non isothermal CSTR - binary distillation column - batch reactor

Reference books:
3. John Ingham et.al., Chemical Engineering Dynamics- Modeling with PC Simulation, VCH Publishers

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
PART A: Short answer questions (one/two sentences) 5 x 2 marks = 10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks = 20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks = 40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 L13 MARKETING MANAGEMENT
Teaching scheme
3 hours lecture & 1 hour tutorial per week

Objectives
- To impart the basic concepts of marketing
- To develop understanding about market analysis and sales promotion

No Pre-requisites

Module 1 (13 hours)
Critical role of management in organization and society - global economy - concept of marketing - company orientation towards marketplace - customer, values and satisfaction - corporate strategic planning - business strategic planning - marketing information systems - marketing intelligence systems - marketing research systems - analysing marketing environment - demographic - economic - natural - technological - political - cultural - consumer market and buyer behaviour - major factors influencing buyer behaviour - buying decision process - business market and business buying - analysing industries and competitors
Module 2 (13 hours)
Measuring and forecasting market demand - estimating current demand and future demand - market segments and selecting target market - differentiating and positioning market offer - developing, testing and launching new products

Module 3 (13 hours)
Product life cycle - introduction stage - growth stage - maturity stage - decline stage - designing marketing strategies for market leaders - challengers - followers - strategies for global market place - managing product lines, brands and packaging - pricing strategies and programs - marketing channels, retailing, wholesaling and physical distribution systems

Module 4 (13 hours)
Direct marketing, sales promotion and public relations programs - managing the sales force - organizing and implementing marketing programs - evaluating and controlling marketing programs

Reference books:
2. Candiff & Still, Basic Marketing, Prentice Hall of India

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) 5 x 2 marks = 10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks = 20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks = 40 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 L14 PETROLEUM EXPLORATION AND STORAGE

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
• To impart the basic concepts of petroleum drilling and exploration

No Pre-requisites

Module 1 (13 Hours)
Petroleum geology and its scope, Origin of petroleum (emphasis on both techniques and geochemistry), oil and gas traps. Physical and chemical characteristics of crude oil, source rock and maturation. Migration of oil-mechanism pattern and barriers, Reservoir rocks and cap rocks, Entrapment of oil-types and mechanism. Reservoir Rock Properties: Porosity, permeability, Effective and relative permeability, wettability, capillary pressure
characteristics. Application of remote sensing in petroleum resource development, Basin and exploration strategies. The model approach to exploration strategy, Basin mapping methods, Depositional systems such as marine, non-marine, coastal, shelf, carbonate evaporates, Basin evolution, Sedimentation and plate techtonics, Basin evaluation, factors governing hydrocarbon potential.

**Module 2 (13 Hours)**

Instruments used, principles and working, magnetometers, Seismograms, Radiation counters and gravimeters. Effective strategies for integrated geophysical exploration from a system view point. Interpretation of electrical, electromagnetic, magneto telluric, gravity and seismic data. Types of hydrocarbon groups present in petroleum & their structures, sulfur, nitrogen, oxygen and metal –organic compound in petroleum. Estimation of reservoir is and determination criteria for commercial exploration. Methods for offshore and onshore petroleum recovery methods primary, secondary, and tertiary.

**Module 3 (13 Hours)**

Methods of petroleum prospecting and exploration such as geophysical, seismic, etc. drilling equipments such as rigs, platforms etc and techniques for offshore and onshore operation. Surface operation for separation of oil and gas, well head operation including separation of oil from associated gas. Separation of natural gas from casing head gas. Transportation of crude oil and gas. Flow of fluids through porous media: Darcy’s law, single and multiphase flow. Reservoir flow through porous media, drive mechanism, Introduction to enhanced oil recovery methods. Petroleum Exploitation – Well testing and completion, Production potential and well performances. Material balance, Artificial lift, Improved recovery methods.

**Module 4 (13 Hours)**

Drilling: Introduction to on-shore and offshore drilling operations, drilling accessories rig components, drilling fluid circulation system. Types of wells – Exploration, appraisalal and development, deviated hole, horizontal and multilateral wells. Well design and casing policy. Types and structure of drilling rigs and Rig components. Drilling tubulars and bits, Offshore rigs-for shallow and deep waters, Borehole profile and environment. Drilling methods, predrill operations in onland and offshore environments, planning and execution of drilling operations. Types of drilling fluids, properties and functions, Fluid influx studies and identification by Gas chromatography, Drilling fluid circulation loop. Types of oil well cements, slurry designing and cementation. Production: Production equipment, Introduction to work over and well stimulation method. Two phase oil and gas separation equipment, Types, their description, vessel internal sizing. Theory of separation., Three phase oil- Gas and water separators- type of separators their description, various control and vessel internals. LACT Units. Storage and handling of Petroleum fluids: Different types of tanks for storage of oil and LPG

**References:**

5. Cole F W, Reservoir Engineering manual
8. D. S. Parasnis, Principles of Applied Geophysics, Chapman
9. R. K. Jain, Engineering Metrology
**Internal Continuous Assessment (Maximum Marks-30)**

- **60% - Tests (minimum 2)**
- **30% - Assignments (minimum 2)** such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
- **10% - Regularity in the class**

**University Examination Pattern**

**PART A: Short answer questions (one/two sentences)**  
5 x 2 marks = 10 marks  
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B: Analytical/Problem solving questions**  
4 x 5 marks = 20 marks  
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C: Descriptive/Analytical/Problem solving questions**  
4 x 10 marks = 40 marks  
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

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**CH09 L15  COMPOSITE MATERIALS**

**Teaching scheme**

- **Credits:** 4
- 3 hours lecture & 1 hour tutorial per week

**Objectives**

- To impart the basic concepts of composite materials

**No Pre-requisites**

**MODULE 1 (13 hours)**


**MODULE 2 (13 hours)**


**MODULE 3 (13 hours)**

Theory of reinforcement –basic criterion to be adopted in the selection of matrix and reinforcement-mechanics of composite materials-micromechanics and macro mechanics-mechanism of load transfer-minimum and critical fibre content-critical fibre length-law of mixture rule-unidirectional and fibrous composites-effects of fibre orientation on stiffness
and strength-bidirectional and random fibre composites-concepts of unit cell-stress analysis of unit cells-toughness of fibrous composites, microscopic stress-strain curves.

**MODULE 4** (13 hours)

**References**
5. Composite Materials – K.K.Chawla

**Internal Continuous Assessment (Maximum Marks-30)**
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A: Short answer questions (one/two sentences)**
5 x 2 marks=10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B: Analytical/Problem solving questions**
4 x 5 marks=20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C: Descriptive/Analytical/Problem solving questions**
4 x 10 marks=40 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

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**CH09 L16 CATALYSIS- THEORY AND PRACTICE**

**Teaching scheme**
3 hours lecture & 1hour tutorial per week

**Credits: 4**

**Objectives**
- To impart the basic concepts of catalysis
- To develop understanding about catalyst selection for various unit processes

**No Pre-requisites**

**Module 1** (13 hours)

**Module 2 (13 hours)**

**Module 3 (13 hours)**

**Module 4 (13 hours)**
Phenomena of Fluidization, liquid like behavior of fluidized beds, advantages and disadvantages of fluidized beds, different types of fluidized beds and applications of fluidization technique in process industries. Heat and Mass Transfer in Fluidized Beds: Variables affecting heat transfer rate, heat transfer at the wall of containing vessel, heat transfer to immersed tubes. Models proposed by (i) Wicke- Fetting, (ii) Mickley and Fair Banks and (iii) Levenspiel and Walton. Heat transfer in fixed and fluidized beds. Definition and evaluation of mass transfer coefficient.

**References:**
2. Fogler H.S., Elements of Chemical Reaction Engineering, Prentice Hall of India
3. Levenspiel O., Chemical Reaction Engineering, John Wiley
7. Diazo Kunii, and Octave Levenspiel, Fluidization Engineering, Butterworth-Heinemann
8. Max Leva, Fluidization, McGraw-Hill

**Internal Continuous Assessment (Maximum Marks-30)**
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A: Short answer questions (one/two sentences)**
5 x 2 marks = 10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B: Analytical/Problem solving questions**
4 x 5 marks = 20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C: Descriptive/Analytical/Problem solving questions**  
4 x 10 marks = 40 marks

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

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**CH09 L17 SURFACE COATINGS**

**Teaching scheme**

3 hours lecture & 1 hour tutorial per week

**Objectives**

- To impart the basic concepts of surface coating
- To develop understanding about coatings and its constituents.

**No Pre-requisites**

**Module 1** (13 hours)

Film formation - Film forming compositions - properties - types of polymerization in film forming compounds - drying oils - composition - manufacturing procedure.

**Module 2** (13 hours)

Resins - types - natural resins and its extraction - alkyd resin - manufacturing - compositions - properties - various synthetic resins - chemical constitution - manufacturing procedures - diluents - thinners - plasticizers - driers - additives - anti settling agents in surface coating

**Module 3** (13 hours)

Pigments - properties - types - white pigments - properties - manufacturing procedures - red pigments, green, blue and black pigments - properties and manufacturing procedure

**Module 4** (13 hours)

Formulation of exterior coating – interior, decorative, industrial, special purpose, marine, bituminous and powder coatings – manufacture of various paints

**References:**


**Internal Continuous Assessment (Maximum Marks-30)**

- 60% - Tests (minimum 2)
- 30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
- 10% - Regularity in the class

**University Examination Pattern**

**PART A: Short answer questions (one/two sentences)**  
5 x 2 marks = 10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

Analytical/Problem solving questions  
4 x 5 marks = 20 marks
PART B:
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 L18 CERAMIC TECHNOLOGY

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Objectives
- To impart the basic concepts of ceramics technology

No Pre-requisites

Module 1 (13 hours)
Synthesis and fabrication of advanced and future materials with emphasis on ceramic, semi-conducting and super-conducting materials with superior structural, optical and electrical properties. Comparison of properties of such advanced materials, with conventional materials such as metal and polymers.

Module 2 (13 hours)
Techniques for preparation of ultra-pure, ultra fine powders; of oxides, nitrides, carbides, etc., with very well defined characteristics and superior properties.

Module 3 (13 hours)
Processing techniques: such as Sintering, hot pressing, hot isostatic pressing, tape-casting, sol-gel processing for the formation of monolithic ceramics composites (Ceramic, Ceramic Metal, as well as metal matrix). SiO2, Glasses from above powders. Synthesis and processing of mixed ceramic oxides with high temperature super conducting properties.

Module 4 (13 hours)
Processing techniques based on reaction methods: such as chemical vapour deposition (CVD), vapour phase epitaxy, plasma-enhanced chemical vapour deposition (PECVD), Chemical vapour infiltration (CVI), self-propagating high temperature synthesis (SHS) for the preparation of monolithic ceramics, composites, coating, thin films, whiskers and fibres and semi conducting materials such as SI and gallium arsenide.

References:

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class
University Examination Pattern

**PART A:** Short answer questions (one/two sentences) \(5 \times 2 \text{ marks} = 10 \text{ marks}\)

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions \(4 \times 5 \text{ marks} = 20 \text{ marks}\)

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions \(4 \times 10 \text{ marks} = 40 \text{ marks}\)

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

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**CH09 L19 RUBBER TECHNOLOGY**

**Teaching scheme**

*3 hours lecture & 1 hour tutorial per week*

**Credits:** 4

**Objectives**

- To impart the basic concepts of rubber processing and testing
- To develop understanding about rubber products and its constituents.

**No Pre-requisites**

**Module 1 (13 hours)**

Introduction: Definition and fundamental characteristics of latex; Comparison between latex and polymer solutions; Comparison between product manufacture from latex and solid rubbers; Handling of latex; Important latex products including their classification. Natural rubber latex: Important aspects of rubber cultivation; Tapping and collection of latex, Composition and properties of fresh latex; Preservation of latex; Methods of concentration of latex; Details of latex centrifuging and creaming; Specifications and quality control of concentrated latex; Storage of latex; Choice of latex type. Synthetic rubber latices: Basic principles of emulsion, polymerization; Comparison of synthetic and natural rubber latices; Agglomeration and concentration of synthetic latices: SBR, NBR, CR, Vinyl Acetate and Vinyl Pyridine latices; Characterisation of synthetic latices; Salient features of compounding; Applications of synthetic latices. Prevulcanised latex: Principles of prevulcanisation: Methods of Prevulcanisation; Properties of prevulcanised latex; Advantages of prevulcanisation; Use of prevulcanised latex in different products.

**Module 2 (13 hours)**

Latex compounding ingredients: Vulcanising agents; accelerators; Antioxidants; Fillers and pigments; Surface active agents including wetting agents, dispersing agents, stabilizers, emulsifiers, foam promoters etc.; Viscosity modifiers and protective colloids; miscellaneous ingredients including mineral oils, tackifiers, antifoaming agents etc. Preparation of compounding ingredients: General principles; Preparation of solutions; Preparation of dispersions; Equipment for preparing dispersions such as ball and pebble mills, colloid mills, ultrasonic mills etc.; Preparation of emulsions; Representation of latex formulations. Latex dipping: Outline of the dipping process; Design of latex compounds for dipping; Different dipping processes such as straight, wet-coagulant, dry-coagulant, heat sensitized dipping and electrodeposition; Production of articles by dipping including details of formers, dipping tanks, sequence of operations and after-treatments; Defects in dipped goods. Latex gloves: Introduction to the glove industry; Different types of latex gloves; Details of production of examination, surgical and household gloves; Machinery used for automatic production of...
gloves; Protein removal from NR latex gloves; After-treatments for gloves; Manufacture of gloves from NBR latex; Testing and quality control of gloves; Defects and remedies; Packing.

**Module 3** (13 hours)
Latex condoms: Introduction to the condom industry; Different types of latex condoms; Details of production of condoms; Machinery for condom manufacture; Protein removal by leaching; After-treatments; Testing and quality control; defects and remedies; Packing. Miscellaneous dipped goods: Foley catheters; Urinary condoms; Balloons; Industrial gloves; Electricians gloves; Football bladders; Feeding bottle nipples and soothers, Latex foam: Introduction to latex foam manufacture; Dunlop and Talalay Processes; Details of the Dunlop process; Compounding; Batchwise and continuous foaming; Machinery; Details of processes including frothing, refining, foam stabilization, moulding and gelling; Vulcanization, washing, dewatering and drying; Testing and quality control; Defects and remedies; Foam backing of carpets.

**Module 4** (13 hours)
Fibre foam: Introduction to fibre foam products; Predominance of coir foam; Different processes in coir foam production such as curling of coir fibre, latex compounding, spreading of fibre and spraying of latex compound, drying and vulcanisation, pressing, finishing; Quality control; Defects and remedies, Fibres other than coir. Latex thread: Introduction to elastic thread manufacture; Types of elastic thread; Latex thread by extrusion; Compounding of latex; Maturation of latex; Manual and automatic production; Machinery and equipment; Different stages in production; Extrusion, Coagulation, Washing, Drying and vulcanization, Band formation, Dusting, Spooling, Testing and quality control; Defects and remedies. Latex adhesives: Introduction to latex based adhesives; General principles of formulation such as choice of polymer, adhesion promoters, plasticizers, curatives, fillers, thickeners etc; Paper and leather adhesives based on NR, SBR and PVA; Rubber-textile bonding adhesives; Evaluation of adhesives; Latex treatment of tyre chords. Miscellaneous latex applications: Moulded and cast latex products; Latex based surface coatings; Latex in paper; latex-cement compositions; Latex modified bitumen; Soil stabilization and seepage control with latex; Flowers and other ornamental products from latex.

**References:**
1. Morton, Maurice Morton, Rubber Technology
2. James E. Mark, Burak Erman, Frederick Roland Eirich. Science and technology of rubber
3. Claude M. Blow, Rubber technology and manufacture
4. Alexander S. Craig, Rubber Technology: A Basic Course
5. Maurice Morton, Introduction to rubber technology

**Internal Continuous Assessment** (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences) \( 5 \times 2 \text{ marks} = 10 \text{ marks} \)
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions \( 4 \times 5 \text{ marks} = 20 \text{ marks} \)
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C: Descriptive/Analytical/Problem solving questions**  
4 x 10 marks = 40 marks

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*

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**CH09 L20  MATHEMATICAL METHODS IN CHEMICAL ENGINEERING**

**Teaching scheme**  
3 hours lecture & 1 hour tutorial per week

**Credits:** 4

**Objectives**
- To impart the basic concepts of mathematical methods in chemical engineering

**No Pre-requisites**

**Module 1** (13 hours)
Mathematical formulation of the physical problems - application of the law of conservation of mass, salt accumulation in stirred tank, starting equilibrium still, solvent extraction in two stages, diffusion with chemical reaction, application of the law of conservation of energy, radial heat transfer through cylindrical conductors, heating a closed kettle, flow of heat from a fin.

**Module 2** (13 hours)
Analytical (explicit) solution of ordinary differential equations encountered in chemical engineering problems - first order differential equations, method of separation of variables, equations solved by integration factors, certain examples involving mass and energy balances and reaction kinetics, second order differential equations, non-linear equations, linear equations, simultaneous diffusions and chemical reaction in a tubular reactor, continuous hydrolysis of tallow in a spray column. Formulation of partial differential equations, unsteady state heat conduction in one dimension, mass transfer with axial symmetry, continuity equations, boundary conditions, function specified, derivative specified and mixed conditions, iterative solution of algebraic equations - Jacobi’s method, Gauss- Siedal method and successive order – relaxation (S.O.R) method.

**Module 3** (13 hours)
The difference operator, properties of the difference operator, difference tables and other difference operators, linear finite difference equations, the complimentary solution of the particular solution, simultaneous linear differential equations, non-linear finite difference equations, analytical solution. Solution of the following type of problems by finite difference method - calculation of the number of plates required for absorption column, calculation of the number of theoretical plates required for distillation column, number of steps required for a counter-current extraction and leaching operations.

**Module 4** (13 hours)

Least square methods, design of experiments: factorial, fractional factorial methods.
References:
  3. S. Pushpavanam, Mathematical Methods in Chemical Engineering, PHI

**Internal Continuous Assessment (Maximum Marks-30)**

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

**University Examination Pattern**

*PART A: Short answer questions (one/two sentences)*

5 x 2 marks = 10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

*PART B: Analytical/Problem solving questions*

4 x 5 marks = 20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

*PART C: Descriptive/Analytical/Problem solving questions*

4 x 10 marks = 40 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

**CH09 L21 SOLID WASTE MANAGEMENT**

**Teaching scheme**

3 hours lecture & 1 hour tutorial per week

**Credits**: 4

**Objectives**

- To impart the basic concepts of solid waste management
- To develop understanding about recovery, reuse and disposal of solid waste.

**No Pre-requisites**

**Module 1** (12 hours)


**Module 2** (11 hours)

Collection of solid waste, On-site storage methods-containers, their type, size and location, Collection systems-Vehicles, Types of collection system –HCS,SCS, Determination of vehicle and labor requirements, Collection routing, route balancing and transfer stations, Transfer methods Processing methods.

**Module 3** (9 hours)

Recovery and reuse of materials and energy, Disposal methods such as sanitary landfill – methods, leachate in landfills – control of leachate movement, Gas movement – control, Design and operation of landfills, Landfarming, Deep well injection, etc.
Module 4 (13 hours)

References:
1. Environmental Engineering - Howard S.Peavy, Donald R.Rowe, George Tchobanoglous
2. Environmental Engineering - Gerard Kiely
4. Handbook of Solid Waste Management and Waste Minimization Technologies, Nicholas P. Cheremisinoff
5. Handbook of Solid Waste Management, Frank Kreith, George Tchobanoglous

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 L22  NUCLEAR ENGINEERING

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
- To impart the basic concepts of nuclear fusion and fission as energy source
- To develop understanding about feed processing and fuel recovery for nuclear reactors

No Pre-requisites

Module 1 (13 Hours)
Nuclear fission and fusion, types and classification of nuclear reactors, nuclear fuels, other reactor materials, fuel processing flow sheet, chemical processes for nuclear power industries, separation of reactor products, nuclides, radioactivity, decay chains, neutron reactions, fission
process, growth and decay of fission products in a reactor with neutron burnout and continuous processing. Make up of reactor, reactor fuel process flow sheet, irradiation schemes, neutron balance, feed requirements and fuel burn up for completely mixed fuels with no recycle.

**Module 2 (13 Hours)**

**Module 3 (13 Hours)**

**Module 4 (13 Hours)**

References:
1. Vanson benedict and Thomas H Pigford “Nuclear chemical Engineering ”Mcgraw hill

**Internal Continuous Assessment (Maximum Marks-30)**
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences)  \(5 \times 2 \text{ marks}=10 \text{ marks}\)
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions  \(4 \times 5 \text{ marks}=20 \text{ marks}\)
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions  \(4 \times 10 \text{ marks}=40 \text{ marks}\)
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

CH09 L23  NANOMATERIAL AND NANOTECHNOLOGY

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Objectives
- To impart the basic concepts of nanotechnology
- To develop understanding about application of nanomaterials.

No Pre-requisites

Module 1 (13 Hours)
Introduction to nanotechnology, nanoscale, electromagnetic spectrum, top down and bottom up approach, particle size, chemistry and physics of nanomaterials, electronic phenomenon in nanostructures, optical absorption in solids, quantum effects.

Module 2 (13 Hours)
Nanomaterials, preparation of nanomaterials like gold, silver, different types of nano-oxides, \(\text{Al}_2\text{O}_3\), \(\text{TiO}_2\), \(\text{ZnO}\) etc. Sol-gel methods, chemical vapour deposition, ball milling etc. Carbon nanotubes, preparation properties and applications like field emission displays. Different types of characterization techniques like SEM, AFM, TEM & STM.

Module 3 (13 Hours)
Nanocomposites, nanofillers, high performance materials, polymer nanocomposites, nanoclays, nanowires, nanotubes, nanoclusters etc. Smart materials, self assembly of materials, safety issues with nanoscale powders.

Module 4 (13 Hours)
Nanomanipulation, Micro and nanofabrication techniques, Photolithography, E-beam, FIB etc. Nanolithography., softlithography, photoresist materials. Introduction to MEMS, NEMS and nanoelectronics. Introduction to bionanotechnology and nanomedicines.

References:
1. Nanocomposite science and technology, Pulikel M. Ajayan, Wiley-VCH 2005
2. Nanolithography and patterning techniques in microelectronics, David G. Bucknall, Wood head publishing 2005
5. Micro and Nanofabrication, Zheng Cui, Springer 2005

**Internal Continuous Assessment (Maximum Marks-30)**

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences) 5 x 2 marks=10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions 4 x 5 marks=20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks

Two questions from each module with choice to answer one question.

Maximum Total Marks: 70

**CH09 L24 INDUSTRIAL POLLUTION CONTROL**

**Teaching scheme**

Credits: 4
3 hours lecture & 1 hour tutorial per week

**Objectives**

- To impart the basic concepts of industrial pollution control
- To develop understanding about water, air, light pollution control

**No Pre-requisites**

**Module 1 (13hours)**
Classification of industrial wastewater - types of pollutants and their effects - monitoring and analysis methods - water pollution laws and standards - industrial wastewater treatment - processes and equipment

**Module 2 (13hours)**
Water pollution control in industries - pulp and paper, textile processing, tannery wastes, dairy wastes, canneries wastes, brewery, distillery, meet packing, food processing wastes, pharmaceutical wastes, chlor-alkali industries, fertilizer industry, petrochemical industry, rubber processing industry, starch industries, metal industries, nuclear power plant wastes, thermal power plant wastes.

**Module 3 (13hours)**
Air pollution control in industries: source and classification of industrial air pollutants - monitoring equipment and method of analysis - damages to health, vegetation and materials - air pollution laws and standards - treatment method in specific industries - thermal power
plants - cement - fertilizers - petroleum refineries - iron and steel - chlor-alkali - pulp and paper

**Module 4 (13 hours)**


**References:**
5. Rao C.S., Environmental Pollution Control Engineering, New Age Int. Pub.
7. Babbbitt H.E, Sewage & Sewage Treatment, John Wiley
8. Abbasi S.A, & Ramasami E, Biotechnical Methods of Pollution Control, Universities Press(India) Ltd.

**Internal Continuous Assessment (Maximum Marks-30)**
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

**University Examination Pattern**

**PART A:** Short answer questions (one/two sentences) \[5 \times 2 \text{ marks} = 10 \text{ marks}\]
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions \[4 \times 5 \text{ marks} = 20 \text{ marks}\]
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions \[4 \times 10 \text{ marks} = 40 \text{ marks}\]
Two questions from each module with choice to answer one question.

**Maximum Total Marks:** 70

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**CH09 L25 PROJECT ENGINEERING**

**Teaching scheme**

3 hours lecture & 1 hour tutorial per week

**Credits:** 4

**Objectives**

- To impart the basic concepts of project management

**No Pre-requisites**

**Module 1 (13 hours)**

Scope of project engineering - the role of project engineer - R & D - TEFR - plant location and site selection - preliminary data for construction projects - process engineering - flow diagrams - plot plans - engineering design and drafting
Module 2 (13 hours)
Planning and scheduling of projects - bar chart and network techniques - procurement operations - office procedures - contracts and contractors - project financing - statutory sanctions

Module 3 (13 hours)
Details of engineering design and equipment selection I - design calculations excluded - vessels - heat exchangers - process pumps - compressors and vacuum pumps - motors and turbines - other process equipment

Module 4 (13 hours)
Details of engineering design and equipment selection II - design calculations excluded - piping design - thermal insulation and buildings - safety in plant design - plant constructions, start up and commissioning

References:
1. Rase & Barrow, Project Engineering of Process Plants, John Wiley
2. Peter S. Max & Timmerhaus, Plant design and economics for chemical engineers.
7. Frederick B. Plummer, Project Engineering, BH

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern
PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 70
**GLOBAL ELECTIVES**

PE09 L23  TOTAL QUALITY MANAGEMENT
PE09 L24  INDUSTRIAL PSYCHOLOGY
PE09 L25  ENTREPRENEURSHIP
BT09 L23  BIO-NANOTECHNOLOGY
BT09 L24  BIO-ETHICS AND INTELLECTUAL PROPERTY RIGHTS
BT09 L25  BIOMATERIALS
BM09 L23  OPERATION RESEARCH
EC09 L23  DATA STRUCTURES AND ALGORITHMS
CE09 L23  EXPERIMENTAL STRESS ANALYSIS
CE09 L25  FINITE ELEMENT METHODS
EE09 L22  SOFT COMPUTING TECHNIQUES
CS09 L24  COMPUTER BASED NUMERICAL METHODS
IC09 L24  NON-LINEAR DYNAMICS AND CHAOS
IT09 L24  MANAGEMENT INFORMATION SYSTEMS
PT09 L24  DIGITAL PHOTOGRAPHY

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**PE09 L23: TOTAL QUALITY MANAGEMENT**

**Teaching scheme**

3 hours lecture and 1 hour tutorial per week

**Credits:** 4

**Objectives**

- *To impart knowledge on the concept of quality tools for analysing quality statistical tools in quality acceptance sampling life tests*

**Module I (14 hours)**

Definition of quality—internal and external customers—vision statement—mission statements—objectives—goals—targets—evolution of TQM—Defining TQM—stages in TQM implementation—TQM models

**Module II (14 hours)**

SWOT analysis—strategic planning—customer focus—quality function deployment—customer satisfaction measurement—seven new management tools—Deming wheel—zero defect concept—benchmarking—six sigma concepts—failure mode and effect analysis—poke yoke
Module III (13 hours)
Five S for quality assurance-quality circle philosophy-failure rate analysis-mean failure rate-
mean time to failure (MTTF)-Mean time between failure (MTBF)-hazard models-system reliability-availability- maintenance

Module IV (13 hours)
Quality and cost-characteristics of quality cost-micro analysis of quality cost-measurement of
14000 certification-QS 9000 auditing-Quality auditing-quality awards

Text Books
1. L Suganthi, Anand A Samuel, Total Quality Management, PHI

Reference Books

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions,
quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.
PE09 L24: INDUSTRIAL PSYCHOLOGY

Teaching scheme
3 hours lecture and 1 hour tutorial per week

Credits: 4

Objectives
- To give awareness on the Human and Industrial Psychology

Module I (14 hours)

Module II (14 hours)
Organizational behaviour- definition –development- fundamental concept- nature of people- nature of organization – an organizational behaviour system- models- autocratic model- hybrid model- understanding a social-system social culture- managing communication- downward, upward and other forms of communication

Module III (13 hours)
Motivation- motivation driver- human needs- behavior modification- goal setting- expectancy model- comparison models- interpreting motivational models- leadership- path goal model- style – contingency approach

Module IV (13 hours)
Special topics in industrial psychology- managing group in organization- group and inter group dynamics- managing change and organizational development- nature planned change- resistance- characteristic of OD-OD process

Text Books
1. Davis K. & Newstrom J.W., Human Behaviour at work, Mcgraw Hill International

Reference Books
2. Luthans, Organizational Behaviour, McGraw Hill, International
3. Morgan C.t.,King R.A.,John Rweisz &John Schoples, Introduction to Psychology,

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class
University Examination Pattern

**PART A:** Short answer questions (one/two sentences)  
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions  
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions  
Two questions from each module with choice to answer one question.
PE09 L25: ENTREPRENEURSHIP

Teaching scheme
3 hours lecture and 1 hour tutorial per week

Credits: 4

Objectives
• To give an idea on entrepreneurial perspectives

Module I (14 hours)
Entrepreneurial perspectives- understanding of entrepreneurship process- entrepreneurial decision process- entrepreneurship and economic development- characteristics of entrepreneur- entrepreneurial competencies- managerial functions for enterprise.

Module II (14 hours)
Process of business opportunity identification and evaluation- industrial policy- environment- market survey and market assessment- project report preparation- study of feasibility and viability of a project- assessment of risk in the industry

Module III (13 hours)
Process and strategies for starting venture- stages of small business growth- entrepreneurship in international environment- entrepreneurship- achievement motivation- time management creativity and innovation structure of the enterprise- planning, implementation and growth

Module IV (13 hours)
Technology acquisition for small units- formalities to be completed for setting up a small scale unit- forms of organizations for small scale units- financing of project and working capital- venture capital and other equity assistance available- break even analysis and economic ratios technology transfer and business incubation

Text Books
5. Dr. Patel V.G., Seven Business Crisis, Tata McGraw hill
7. Rao C.R., Finance for small scale Industries

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class
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<th>University Examination Pattern</th>
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<tr>
<td><strong>PART A:</strong> Short answer questions (one/two sentences)</td>
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<tr>
<td>All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.</td>
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| **PART B:** Analytical/Problem solving questions | 4 x 5 marks=20 marks |
| Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module. |

| **PART C:** Descriptive/Analytical/Problem solving questions | 4 x 10 marks=40 marks |
| Two questions from each module with choice to answer one question. |
BT 09 L23       BIONANOTECHNOLOGY

Teaching Scheme :
3-hours lecture and 1 hour tutorial per week
Credits : 4

Objectives
• To impart basic ideas on nanoparticles
• To impart knowledge on the use of nanotechnology in biotechnology

Prerequisite : No prerequisite

Module – I

Module – II
Quantum Dots, Gold Nanoparticles, Lipoparticles, Assembly of Nanoparticles into Micelles, Biomedical Applications of Self-Assembly of Nanoparticles, Paramagnetic and Superparamagnetic Nanoparticles, Fluorescent Nanoparticles.

Module – III
Bacterial Structure Relevant to Nanobiotechnology, Cubosomes, Dendrimers, DNA-Nanoparticle Conjugates, DNA Octahedron, Fullerences, Nanoshells, Carbon Nanotubes, Nanopores, Nanostructured Silicon.

Module – IV
Molecular Motors, Nanoparticles for Molecular Diagnostics, Nano biosensors, Nanopharmaceuticals, Nanoparticle – Based Drug Delivery, Nanostructures for Tissue Engineering/Regenerative Medicine, Ethical Safety, and Regulatory issues of Nanomedicine.

References
2. Nanomaterials and Nanosystems for Biomedical Applications: M. Reza Mozafari.
3. The Handbook of Nanomedicine, Kewal K. Jain
4. Bio Nanotechnology, Elisabeth S. Pappazoglou, Aravind Parthasarathy
5. Biomedical Nanostructures, Kenneth E. Goonsalves, Craig R. Halberstadt, Cate T. Laurecin, Lakshmi S. Nair.

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class
**University Examination Pattern**

| PART A: Short answer questions (one/two sentences) | 5 x 2 marks = 10 marks |
| All questions are compulsory. There should be at least one question from each module and not more than two questions from any module. |

| PART B: Analytical/Problem solving questions | 4 x 5 marks = 20 marks |
| Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module. |

| PART C: Descriptive/Analytical/Problem solving questions | 4 x 10 marks = 40 marks |
| Two questions from each module with choice to answer one question. |
BT 09 L24  BIOTECHNICS & INTELLECTUAL PROPERTY RIGHTS

Teaching Scheme:
3 hours lecture and 1 hour tutorial per week Credits : 4

Objectives:
- To impart knowledge on bioethics and intellectual property rights
- To study the various ethical issues in biotechnology

Prerequisite : No prerequisite

Module – I

Module – II
Intellectual Property Rights – Development and need for IPR in knowledge based industries. Various types of intellectual Property Rights with examples (Trademarks, copyrights, Industrial Designs, Patents, Geographical Indicators etc) – Objectives of the patent system – Basic Principles and General Requirements of Patents (Novelty, Utility Non obviousness. Etc) and tenets of patent law – Product and process Patents

Module – III


Module – IV

Text Books
### Internal Continuous Assessment *(Maximum Marks-30)*

- 60% - Tests (minimum 2)
- 30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
- 10% - Regularity in the class

### University Examination Pattern

**PART A:** Short answer questions (one/two sentences)  
5 x 2 marks = 10 marks  
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions  
4 x 5 marks = 20 marks  
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions  
4 x 10 marks = 40 marks  
Two questions from each module with choice to answer one question.
BT 09 L25      BIO MATERIALS

Teaching Scheme:
3 hours lecture and 1 hour tutorial per week

- To study the structure and characteristics of biomaterials of synthetic and natural origin
- To give an idea on the effective uses of these biomaterials

Prerequisite: No prerequisite

Module I

Module II

Module III

Module IV

Textbooks/References
4. R.M. Johnson, R.M. Mwaikambo, Tucker: Biopolymers. Rapra technology
**Internal Continuous Assessment** *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

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**University Examination Pattern**

**PART A:** *Short answer questions (one/two sentences)* 
5 x 2 marks = 10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** *Analytical/Problem solving questions* 
4 x 5 marks = 20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** *Descriptive/Analytical/Problem solving questions* 
4 x 10 marks = 40 marks

Two questions from each module with choice to answer one question.
BM09 L23: OPERATION RESEARCH

Teaching scheme
3 hours lecture and 1 hour tutorial per week

Credits: 4

Objectives
Objective of this introductory course on operations research is to give the students the essential tools of operations research. This will enable them to model and make scientifically based decisions in economic and production environments

Module 1 (13 hours)
Introduction to operation research: OR model, solving the OR model, simulation models, art of modeling, phases of OR study.
Linear programming: Formulation (Identification of decision variables, constructing objective functions and constraints, assumption), Graphical LP solution,

Module II (14 hours)
Simplex Method: Standard LP form, basic solution,, the M-method, the two-phase method, degeneracy, alternative optimal solution, unbounded solution, infeasible solution.
Sensitivity analysis and dual problem: Definition of the dual problem, the relationship between the optimal primal and dual solution, economic interpretation of duality, the dual Simplex method, primal-dual computations, sensitivity analysis

Module III (13 hours)
Transportation Model: Definition of the transportation model, determination of a starting solution, the transportation algorithm, definition of the assignment problem, the Hungarian method.
Network models: Network definition, minimal spanning tree algorithm, shortest route problem, shortest route algorithm, maximal flow model, enumeration of cuts, maximal flow algorithm, CPM, PERT

Module IV (14 hours)
Queuing systems: Elements of a queuing model, role of exponential distribution, birth and death models, steady state measures of performance, single server models
Game theory: Formulation of two person zero sum games, solution of simple games, mixed strategy games(using graphical method and Lp), saddle point condition.

Text Books

Reference Book
Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

**PART A:**  Short answer questions (one/two sentences)  
5 x 2 marks=10 marks  
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:**  Analytical/Problem solving questions  
4 x 5 marks=20 marks  
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:**  Descriptive/Analytical/Problem solving questions  
4 x 10 marks=40 marks  
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*
EC09 L023: DATA STRUCTURE & ALGORITHMS

Teaching scheme
3 hours lecture and 1 hour tutorial per week

Credits: 4

Objectives
- To give ideas of basic data structures
- To impart knowledge about algorithm specification

Module I (14 hours)

Module II (14 hours)
Linked Lists - Linked stacks and queues - Doubly linked lists - Polynomial representation using linked lists, Strings – Data representation – Pattern matching.

Module III (15 hours)

Module IV (11 hours)

Text Books
1. Classic Data Structures: Samanta, PHI
2. Data Structures and program design in C: Robert Kruse, Pearson Education Asia
3. An introduction to Data Structures with applications: Trembley & Sorenson, McGraw Hill

Reference Books
2. Data Structures using C & C++: Langsam, Augenstein & Tanenbaum
4. Algorithms + Data Structures & Programs: N.Wirth, PHI
5. Data structures in Java: Thomas Standish, Pearson Education Asia
**Internal Continuous Assessment** *(Maximum Marks-30)*

- 60% - Tests (minimum 2)
- 30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
- 10% - Regularity in the class

One of the assignments shall be simulation using any of the tools

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**University Examination Pattern**

**PART A:**  Short answer questions (one/two sentences)  
5 x 2 marks=10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:**  Analytical/Problem solving questions  
4 x 5 marks=20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:**  Descriptive/Analytical/Problem solving questions  
4 x 10 marks=40 marks

Two questions from each module with choice to answer one question.

*Maximum Total Marks: 70*
CE09 L23 EXPERIMENTAL STRESS ANALYSIS*

Teaching scheme
3 hours lecture and 1 hour tutorial per week

Credits: 4

Objective
To make students aware of various measurement techniques and experimental planning and procedures adopted in laboratory

Module I (14 hours)
Strain gauges - definition of gauge length - sensitivity and range - characteristics of an ideal strain gauge - different types of mechanical strain gauges, optical strain gauge - acoustic strain gauge - pneumatic strain gauge - merits and demerits - electrical strain gauges - inductance, capacitance and piezo electric gauges - bonded and unbonded resistance gauges and their application in stress analysis - fixing techniques and measurement of strains - rosettes - determination of principal stress - construction of stress, strain circles - analytical solution

Module II (13 hours)
Photo elasticity - basics of optics, stress optic law - plane and circularly polarized light and their use in photos elasticity - polariscopes - diffusion type - lens type polariscopes - isoclinics and isochromatics

Module III (14 hours)
Model materials - calibration methods for finding material fringe values - model fringe values - examples of beam flexure and diametrically loaded circular plates.


Computer based data acquisition systems.

Module IV (13 hours)
Model analysis - direct and indirect models - laws of structural similitude - choice of scales - limitation of model studies - buckingham pi-theorem - dimensional analysis - model materials - Begg’s deformater and its use - simple design of direct and indirect models

Text Books
1. Dally, J. W. and Raliley W.F., Experimental Stress Analysis, McGraw Hill.
2. Srinath L.S., Experimental Stress Analysis, Tata McGraw Hill
3. Roy, T.K., Experimental Analysis of stress and strain
Reference Books
1. Dove and Adams, Experimental Stress Analysis and Motion measurement, Prentice Hall

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.
CE09 L25 FINITE ELEMENT METHODS*

Teaching scheme
3 hours lecture and 1 hour tutorial per week

Credits: 4

Objective:
To make the background, basic concepts and basic formulation of finite element method clear to the students

Module I (14 hours)


Module II (13 hours)
Continuous systems: Practical Examples –mathematical models- differential formulation – limitations – Variational formulation – Total potential energy - principle of stationary potential energy - problems having many d.o.f - potential energy of an elastic body - the Rayleigh-Ritz method - piecewise polynomial field - finite element form of Rayleigh-Ritz method - finite element formulations derived from a functional - interpolation - shape functions for \( C^0 \) and \( C^1 \) elements - Lagrangian interpolation functions for two and three dimensional elements

Module III (13 hours)
Displacement based elements for structural mechanics: formulas for element stiffness matrix and load vector - overview of element stiffness matrices - consistent element nodal vector - equilibrium and compatibility in the solution - convergence requirements - patch test - stress calculation - other formulation methods

Straight sided triangles and tetrahedral: natural coordinates for lines - triangles and tetrahedral - interpolation fields for plane triangles - linear and quadratic triangle - quadratic tetrahedron

Module IV (14 hours)

Coordinate transformation: transformation of vectors - transformation of stress, strain and material properties - transformation of stiffness matrices - transformation of flexibility to stiffness - inclined support - joining dissimilar elements to one another- rigid links - rigid elements
Text books:
1. Bathe K.J., Finite Element Procedures in Engineering Analysis, Prentice Hall of India
2. Cook R.D., Malkus D.S. & Plesha M.F., Concepts & Applications of Finite Element Analysis, John Wiley

Reference books:
1. Desai C.S., Elementary Finite Element Method, Prentice Hall of India

Internal Continuous Assessment (Maximum Marks-30)
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.
EE09 L 22 SOFT COMPUTING TECHNIQUES

Teaching scheme
3 hours lecture and 1 hour tutorial per week

Credits: 4

Objectives
- To acquaint the students with the important soft computing methodologies:
  neural networks, fuzzy logic, genetic algorithms and genetic programming

Module I (12 Hours)

Module II (14 Hours)

Module III (14 Hours)

Module IV (14 Hours)
Text Books

Reference Books
6. John Yen, Reza Lengari, *Fuzzy Logic- Intelligence, Control and Information*, Pearson Education

Internal Continuous Assessment *(Maximum Marks-30)*
60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

Note: One of the assignments may be simulation of systems using any technical software

University Examination Pattern

PART A: Short answer questions (one/two sentences) 5 x 2 marks=10 marks
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

PART B: Analytical/Problem solving questions 4 x 5 marks=20 marks
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

PART C: Descriptive/Analytical/Problem solving questions 4 x 10 marks=40 marks
Two questions from each module with choice to answer one question.
CS09 L24 : COMPUTER BASED NUMERICAL METHODS

Teaching scheme
3 hours lecture and 1 hour tutorial per week

Credits: 4

Objectives

- To impart the basic concepts of mathematical modelling of problems in science and engineering and to know procedures for solving different kinds of problems.
- To understand the various numerical techniques which provide solutions to non linear equations, partial differential equations etc that describe the mathematical models of problems.

Module I (13 hours)

Module II (13 hours)

Module III (13 hours)

Module IV (13 hours)
Statistical Computations - frequency Chart - method of least square curve fitting procedures - fitting a straight line - curve fitting by sum of exponential - data fitting with cubic splines - approximation of functions. Regression Analysis - linear and nonlinear regression - multiple regression - statistical quality control methods.
### Text Books

### Reference Books

### Internal Continuous Assessment *(Maximum Marks-30)*
- **60%** - Tests (minimum 2)
- **30%** - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
- **10%** - Regularity in the class

### University Examination Pattern

**PART A:** *Short answer questions (one/two sentences)*
5 x 2 marks = 10 marks
- All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** *Analytical/Problem solving questions*
4 x 5 marks = 20 marks
- Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** *Descriptive/Analytical/Problem solving questions*
4 x 10 marks = 40 marks
- Two questions from each module with choice to answer one question.
IC09 L24 NONLINEAR DYNAMICS AND CHAOS

Teaching scheme

3 hours lecture and 1 hour tutorial per week

Credits: 4

Objectives:
To enable the students to get an exposure to non linear dynamics and chaos.

Prerequisites: Familiarity with nonlinear control systems is desirable.

Module I (14 hours)
Introduction to Dynamical systems: Discrete time systems- Continuous time systems- Autonomous and non-autonomous systems phase space and flows- Attracting sets- Concepts of stability.

Equilibrium solutions: Fixed points and stability of continuous- Time systems- Classification and stability of equilibrium solutions- Fixed points of maps and their stability- Local and global bifurcation of continuous system- Static and dynamic bifurcation- Bifurcation of maps.

Module II (13 hours)
Periodic solutions: Periodic solutions of continuous- Time dynamical systems- Autonomous and non-autonomous systems- Limit cycle- Floquet theory- Poincare’ maps- Bifurcation- Symmetry breaking- Cyclic fold- Period doubling- Transcritical and Hopf bifurcation.

Quasiperiodic solutions: Poincare’ maps- Circle map- Construction of quasiperiodic solutions.

Module III (14 hours)
Chaotic solutions of maps: Dynamic of logistic equations- Bifurcation diagram of one dimensional maps- Feigenbaum number- Henon map.

Chaotic solutions of continuous systems: Duffing’s equation- Rossler equations- Period doubling and intermittency mechanisms.

Experimental methods in chaotic vibrations: Experimental system to measure the Poincare’ map of chaotic physical system.

Module IV (13 hours)
Fractals and dynamical systems: Fractal dimension- Capacity dimension- Correlation dimension and Information dimension- Fractal dimension of strange attractors.

Tools to identify and analyze motions: Time history- Space and pseudostate space- Embedding dimension and time delay- Fourier Spectra, Poincare’ section and maps- Iyapunov exponents.
Text Books


References


Internal Continuous Assessment *(Maximum Marks=30)*

60% - Tests (minimum 2)
30% - Assignments (minimum 2) such as homework, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
10% - Regularity in the class

University Examination Pattern

**PART A:** Short answer questions (one/two sentences) 5 x 2 marks = 10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions 4 x 5 marks = 20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions 4 x 10 marks = 40 marks

Two questions from each module with choice to answer one question.
IT09 L24: MANAGEMENT INFORMATION SYSTEMS

Teaching scheme
3 hours lecture and 1 hour tutorial per week

Credits: 4

Objectives
- This course will introduce the methods and the influence of the information systems in management milieu and use MIS as an effective tool in management and decision making.

Module - I: (12 hours)
Information systems - functions of management - levels of management - framework for information systems - systems approach - systems concepts - systems and their environment - effects of system approach in information systems design - using systems approach in problem solving - strategic uses of information technology

Module - II: (10 hours)
An overview of computer hardware and software components - file and database management systems - introduction to network components - topologies and types - remote access - the reasons for managers to implement networks - distributed systems - the internet and office communications

Module - III: (14 hours)
Application of information systems to functional - tactical and strategic areas of management, decision support systems and expert systems

Module - IV: (16 hours)
Information systems planning - critical success factor - business system planning - ends/means analysis - organizing the information systems plan - systems analysis and design - alternative application development approaches - organization of data processing - security and ethical issues of information systems

Text Books

Reference Books
2. Sadagopan S, Management Information Systems, Prentice Hall of India
Internal Continuous Assessment *(Maximum Marks-30)*

60% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

10% - Regularity in the class

University Examination Pattern

**PART A:** Short answer questions (one/two sentences)  
5 x 2 marks=10 marks

All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions  
4 x 5 marks=20 marks

Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions  
4 x 10 marks=40 marks

Two questions from each module with choice to answer one question.
PT09 L24 DIGITAL PHOTOGRAPHY

Teaching scheme
3Hours lecture and 1 Hr tutorial per week

Credit: 4

Objectives: To impart the basic concepts of photography & camera controls.
Gives an understanding of photographic processing methods & Digital Imaging.

Module I (13hours)

Module II (13hours)

Module III (13hours)

Module IV (13hours)

Text Book:

Reference Books:
2. George H Wallace, Chuck Gloman Digital Photography Solutions,
## Internal Continuous Assessment (Maximum Marks-30)

- **60%** - Tests (minimum 2)
- **30%** - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
- **10%** - Regularity in the class

## University Examination Pattern

**PART A:** Short answer questions (one/two sentences)  
5 x 2 marks = 10 marks  
All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

**PART B:** Analytical/Problem solving questions  
4 x 5 marks = 20 marks  
Candidates have to answer four questions out of six. There should be at least one question from each module and not more than two questions from any module.

**PART C:** Descriptive/Analytical/Problem solving questions  
4 x 10 marks = 40 marks  
Two questions from each module with choice to answer one question.