SYLLABUS & CURRICULUM

of

B.Tech.

CHEMICAL ENGINEERING
(3rd to 8th semesters)

UNIVERSITY OF CALICUT

(2014 admission)
## SCHEME for Chemical Engineering (CH) Branch for 3rd to 8th Semesters

### 3rd Semester

<table>
<thead>
<tr>
<th>Code</th>
<th>Subject</th>
<th>Hours/ Week</th>
<th>Marks</th>
<th>Duration of End Semester examination</th>
<th>Credits</th>
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<tbody>
<tr>
<td>EN14 301</td>
<td>Engineering Mathematics III</td>
<td>L 3 T 1 P/D 0</td>
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<td>EN14 302</td>
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<tr>
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<td>Fluid and Particle Mechanics</td>
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<td>CH14 307(P)</td>
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<tr>
<td>CH14 308(P)</td>
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**Note:**
For EN 14 302 Computer Programming in C, the end semester examination will be held by the University as a theory paper.

### 4th Semester

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<tr>
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<tr>
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<td>CH14 404</td>
<td>Chemical Engineering Thermodynamics II</td>
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<td>CH14 405</td>
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<td>CH14 406</td>
<td>Process Heat Transfer</td>
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<td>Mass Transfer Operations I</td>
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<td>Petroleum Refinery Engineering &amp; Petrochemicals</td>
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<td>Process Dynamics &amp; Control</td>
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<td>Polymer Engineering And Technology</td>
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<td>CH14 607(P)</td>
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<td>CH14 608(P)</td>
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<td>CH14 701</td>
<td>Chemical Engineering Design &amp; Drawing I</td>
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**Elective I**

- CH14 704 (A) Numerical Analysis (Global)
- CH14 704 (B) Mathematical Methods In Chemical Engineering
- CH14 704 (C) Petrochemicals
- CH14 704 (D) Unconventional Separation Techniques
- CH14 704 (E) Electrochemical Engineering
- CH14 704 (F) Ceramic Technology
- CH 14 704 (G) Water Treatment Technology

**Elective II**

- CH14 705(A) Nanomaterial And Nanotechnology (Global)
- CH14 705(B) Process Modeling And Simulation
- CH14 705(C) Membrane Separation Techniques
- CH14 705(D) Food Technology
- CH14 705(E) Micro Electronics Processing
- CH14 705(F) Catalysis- Theory And Practice
- CH14 705 (G) Composite Materials
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<tr>
<th>Code</th>
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<th>Hours/ Week</th>
<th>Marks</th>
<th>Duration of End Semester Examination</th>
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<td>Optimization of Chemical Processes</td>
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<td>Viva Voce</td>
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**ELECTIVE III**

- CH14 804(A) Introduction To Chemical Engineering Computing
- CH14 804(B) Petroleum Exploration And Storage
- CH14 804(C) Industrial Pollution Control (Global)
- CH14 804(D) Computer Aided Design
- CH14 804(E) Fertilizer Technology
- CH14 804(F) Advances In Biochemical Engineering
- CH14 804(G) Essentials Of Management

**ELECTIVE IV**

- CH14 805(A) Solid Waste Management
- CH14 805(B) Project Engineering (Global)
- CH14 805(C) Nuclear Technology/Engineering
- CH14 805(D) Marketing Management
- CH14 805(E) Rubber Technology
- CH14 805(F) Surface Coatings
- CH14 805(G) Computational Fluid Dynamics
University of Calicut

THIRD SEMESTER

EN14 301: ENGINEERING MATHEMATICS III
(Common for all branches)

Teaching scheme
3 hours lecture and 1 hour tutorial per week

Credits: 4

Objective
➢ To provide a quick overview of the concepts and results in complex analysis that may be useful in engineering.
➢ To introduce the concepts of linear algebra and Fourier transform which results with wide area of application.

Module I: Functions of a Complex Variable (15 hours)
Functions of a Complex Variable – Limit – Continuity – Derivative of a Complex function – Analytic functions – Cauchy-Riemann Equations – Laplace equation – Harmonic Functions – Conformal Mapping – Examples: $e^z$, $\sin z$, $\cosh z$, $(z+1)/z$ – Mobius Transformation.

Module II: Functions of a Complex Variable (15 hours)

Module III: Linear Algebra (15 hours) – (Proofs not required)

Module IV: Fourier Transforms (15 hours)

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:

Module III:

Module IV:
References:

Internal Continuous Assessment *(Maximum Marks-50)*

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% - Attendance and Regularity in the class

University Examination Pattern

**PART A:** Analytical/problem solving SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 100*
EN14 302 COMPUTER PROGRAMMING IN C
(Common for all branches)

Teaching scheme
Credits: 4
2 hours lectures and 2 hours lab per week

Objectives
➢ To impart the basic concepts of computer and information technology
➢ To develop skill in problem solving concepts through learning C programming in practical approach.

Module I (15 hours)

Module II (15 hours)
Basic elements of C: Flow chart and algorithm – Development of algorithms for simple problems. Structure of C program – Operators and expressions – Procedure and order of evaluation – Input and Output functions, while, do-while and for statements, if, if-else, switch, break, continue, goto, and labels. Programming examples.

Module III (15 hours)

Module IV (15 hours)

Text Books

Reference Books
5. S. Kochan, Programming in C, CBS publishers & distributors

Internal Continuous Assessment (Maximum Marks-50)
50% - Lab Practical Tests
20% - Assignments
20% - Main Record
10% - Regularity in the class
University Examination Pattern

**PART A:** Analytical/problem solving SHORT questions  
8 x 5 marks = 40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions  
4 x 15 marks = 60 marks

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

*Maximum Total Marks: 100*

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**CH 14 303 ORGANIC CHEMISTRY**

**Teaching scheme**

3 hours lecture & 1 hour tutorial per week

**Credits:** 4

**Objectives**

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

**MODULE –I (15 hours)**


**MODULE –II (15 hours)**


**MODULE –III (15 hours)**

MODULE –IV (15 hours)

Text Book:
2. Bahl & Bahl, Advanced Organic Chemistry, S. Chand

References:
2. Sony, P.L., Organic Chemistry, S. Chand
3. Albert L. Lehninger; David L. Nelson; Michael M. Cox; David L. Nelson, Lehninger Principles of Biochemistry, W H Freeman & Co
4. Tewari, Mehrotra and Vishnoi- Advanced Organic Chemistry

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 304 CHEMICAL PROCESS PRINCIPLES

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

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, unit operations and unit processes, fundamental concepts, units and dimensions, conversion of units, 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 (16 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. 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.

Module 3 (14 hours)

Module 4 (14 hours)

Text books:
1. K.V.Narayanan & B.Lakshmikutty Stoichiometry and Process Calculations, Prentice Hall Of India

References:
1 David M Himmelblau, Basic principles and calculations in chemical engineering, Prentice Hall.
2 Richard M Felder & Ronald W. Rousseau Elementary Principles of Chemical Processes, Wiley India
4 Williams E T, Johnson R C, Stoichiometry for chemical engineers, McGraw Hill.
5 Rao D P, Murthy D V S, Stoichiometry for chemical engineers, McMillan

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8 x 5 marks = 40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks = 60 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 100*

**CH 14 305 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.
- To impart the understanding about various thermodynamic properties and its evaluation
- To familiarize the various equation of states and property models available
- To provide fundamentals of refrigeration and power cycles

**Module 1** (15 hours)
Fundamental concepts and definitions - closed, open and isolated system - intensive and extensive properties - path and state functions - reversible and irreversible process – phase rule for non-reacting systems, 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 for real gases – van der Waals equation, Redlich-Kwong equation, Virial equation - principle of corresponding states - critical and pseudo critical properties - Compressibility charts.

**Module 2** (15 hours)

**Module 3** (15 hours)
Module 4 (15 hours)

Text Book:

References:
2. Kyle B.G., Chemical and Process Thermodynamics, Prentice-Hall of India
3. Y.V.C. Rao, Chemical Engineering Thermodynamics, Universities Press

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 306 FLUID AND PARTICLE MECHANICS

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
- To impart the basic concepts of fluid flow phenomena.
- To develop understanding about viscosity, pipe flow, open channel flow and fluid moving machineries
- To understand the equations of fluid flow and particle mechanics
- Encourage creative thinking and development of a deeper understanding and intuitive feel for fluid mechanics.
Module 1 (15 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-Pascal’s law-Hydrostatic equilibrium in gravity and centrifugal field-Barometric equation-Lapse rate-Principle of Manometer-Simple manometer and inclined tube manometer-Principles of continuous 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 (15 Hour)
Basic equations of fluid flow-Continuity, Bernoulli’s and Momentum equation-Toricelli equation. Kinetic energy and Momentum correction factors-Correction for fluid friction and pump work for Bernoulli’s 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. Churchill, Darcy and Fanning friction factor. Turbulent flow of incompressible fluids in pipes and conduits-Universal velocity distribution equation-Friction factor and Reynolds number relationship-Nikuradse and Karman equation-Blasius equation (derivation not required) Prandtl 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 (15 Hour)

Module 4 (15 Hour)

Text Books:
1. McCabe W.L. & Smith J.C., Unit Operations of Chemical Engg, McGraw Hill

References:
3. Foust, Wenzel, Clump, Maus & Anderson, Principles of Unit Operation
5. Rajput R.K., A textbook of Fluid Mechanics
**Internal Continuous Assessment (Maximum Marks-50)**

- **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 SHORT questions

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

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

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

**CH 14 307(P) CHEMICAL TECHNOLOGY AND ENVIRONMENTAL ENGINEERING LAB**

**Teaching scheme**

*3 hours practical per week*

**Credits: 2**

**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. Determination of sucrose content in sugar
6. Determination of available chlorine in bleaching powder
7. Determination of flash and fire point and viscosity of lubricating oil
8. Determination of hardness of water
9. Determination of dissolved oxygen in water
10. Determination of BOD of wastewater sample
11. Determination of COD of wastewater sample
12. Determination of total nitrogen and ammoniacal nitrogen
13. Determination of SS, TDS, and VSS of a wastewater sample
14. Analysis of oil & grease in wastewater sample
15. Study of analytical instruments: Spectrophotometer, pH meter, Gas Chromatograph, High Performance Liquid Chromatograph (HPLC), Total Organic Carbon Analyser (TOC) etc.

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

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

**End Semester Examination (Maximum Marks-100)**

- **70%** - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record
CH14 308(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 6 numbers)
2. Estimation of Glucose
3. Estimation of aromatic primary amine / phenol
4. Preparation of Aspirin
5. Preparation of Benzanilide
6. Preparation of m-dinitrobenzene
7. Preparation of Benzoic acid
8. Preparation of Glucosazone
9. Preparation of Acetanilide
10. Preparation of Salicylic Acid

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-100)

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

EN14 401A: Engineering Mathematics IV
(Common for ME, CE, PE, CH, BT, PT, AM, and AN)

Teaching scheme
3 hours lecture and 1 hour tutorial per week

Credits: 4

Objective

➢ To provide a comprehensive introduction to those models and methods most likely to be encountered and used by students in their careers in engineering.

➢ To provide an introduction to some important partial differential equations

Module I: Probability Distributions (15 hours)

Module II: Theory of Inference (15 hours)

Module III: Series Solutions of Differential Equations (15 hours)

Module IV: Partial Differential Equations (15 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, F1(x,q) = F2(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.

Text Books

Module I:
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

Module II:
Richard A Johnson, CB Gupta, Miller and Freund’s Probability and statistics for Engineers, 7e, Pearson Education- Sections: 6.1, 6.2, 6.3, 6.4, 7.2, 7.4, 7.5, 7.8, 8.1, 8.2, 8.3, 9.5

Module III:
Erwin Kreysig, Advanced Engineering Mathematics, 8e, John Wiley and Sons, Inc.- Sections: 4.1, 4.4, 4.5
Module IV:
Erwin Kreysig, Advanced Engineering Mathematics, 8e, John Wiley and Sons, Inc.
Sections: 11.2, 11.3, 9.8 Ex.3, 11.5

Reference:

Internal Continuous Assessment (Maximum Marks-50)
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% - Attendance and Regularity in the class

University Examination Pattern

**PART A:** Analytical/problem solving SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100
EN 14 402 ENVIRONMENTAL SCIENCE
(Common for all branches)

Teaching scheme
3 hours lecture and 1 hour tutorial per week

Credits: 4

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 I (15 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 landslides, soil erosion and desertification.

Module II (15 hours)

Module III (15 hours)
Environmental pollution Definition-Causes, effects and control measures of Air pollution- 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 IV (15 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:
1. Daniels & Krishnaswamy, Environmental studies, Wiley India pvt ltd, 2009

References:
2. S.P Misra, S.N Pandey, Essential Environmental studies, Ane books, Pvt Ltd, 2009

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8 x 5 marks = 40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks = 60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

Note: Field work can be Visit to a local area to document environmental assets - river/forest/grassland/mountain or Visit to local polluted site - urban/rural/industrial/agricultural etc. or Study of common plants, insects, birds etc. or Study of simple ecosystems - pond, river, hill slopes etc. or mini project work on renewable energy and other natural resources, management of wastes etc.
CH14 403 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 (15 hours)

Module 2 (15 hours)

Module 3 (15 hours)

Module 4 (15 hours)

Text Books:
1. B.R. Puri, L.R. Sharma, M.S. Pathania, Principles of Physical Chemistry, Vishal Publishing Company

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. K.Veera Reddy Symmetry and spectroscopy of molecules, New Age International (P) Ltd
Internal Continuous Assessment (Maximum Marks - 50)

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 SHORT questions 8 x 5 marks = 40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks = 60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 404 CHEMICAL ENGINEERING THERMODYNAMICS II

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
➢ To impart the detailed concepts of solution thermodynamics.
➢ To provide knowledge of phase and chemical reaction equilibrium.

Module 1 (15 hours)

Module 2 (15 hours)

Module 3 (15 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.

**Module 4 (15 hours)**

**Text Book:**

**References:**
2. Kyle B.G., Chemical and Process Thermodynamics, Prentice-Hall of India
3. Y.V.C. Rao, Chemical Engineering Thermodynamics, Universities Press

**Internal Continuous Assessment (Maximum Marks-50)**
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

**Maximum Total Marks: 100**

**CH 14 405 PARTICLE TECHNOLOGY**

**Teaching scheme**
3 hours lecture & 1hour 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 (15 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 - Techniques for particle size measurements - elutriation - microscopic counting - permeability and adsorption - screening - effectiveness and capacity of screens and factors affecting them - types of industrial screens

Module 2 (15 hours)
Principles of free and hindered settling - equal settling particles - classifiers - types of classifiers - mechanical and non-mechanical, pneumatic classifiers - principles of mineral benefication methods - jiggling - wilfley table - heavy media separation - magnetic and high-tension separation - froth flotation, principles, additives, and flotation cell arrangements - batch and continuous thickening - kynch theory - design of continuous thickener

Module 3 (15 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 (15 hours)
Laws of comminution - 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

Text Book:
2. Badger & Banchero, Introduction to Chemical Engineering, McGraw Hill

References:
2. Foust A.S. et al, Principles of Unit Operations, John Wiley
4. George Granger Brown, Unit Operations, Wiley

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.
PART B: Analytical/Problem solving DESCRIPTIVE questions  
4 x 15 marks = 60 marks

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

Maximum Total Marks: 100

CH 14 406 PROCESS HEAT TRANSFER

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives

- To understand the different heat exchange modes.
- To impart the basic knowledge of heat transfer processes depending on time.
- To develop understanding about heat exchangers and evaporators.

Module 1 (15 hours)
Modes of heat transfer - conduction and Fourier’s law - thermal conductivity of solids, liquids and gases - convection and film concept of heat transfer coefficient, Newton’s law of cooling - steady-state conduction through single resistance and composite resistances in series for plane wall, cylinder and sphere - critical and optimum thickness of insulation – Introduction to unsteady state heat conduction, Biot Number, Fourier Number.

Module 2 (15 hours)
Forced convection heat transfer - factors influencing heat transfer coefficients - analogy between heat and momentum transfer - Reynold’s analogy - dimensional analysis - heat transfer to fluids in laminar and turbulent flow - empirical equations for heat transfer coefficient for flow past plates and pipe flow in laminar and turbulent conditions - 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 (15 hours)
Radiation heat transfer - laws of radiation - radiation heat exchange between infinite plane gray bodies - view factor - radiation shields - radiation from flames and gases - combined radiation and convection - heat exchange equipments - classification and constructional details - double pipe, shell and tube single and multipass, crossflow and extended surface heat exchangers - condensers, shell and tube and contact type - logarithmic mean temperature difference and LMTD correction factors - overall heat transfer coefficient - fouling factors - heat exchanger effectiveness - NTU approach

Module 4 (15 hours)
Evaporation - equipment and classification - single effect and multiple effect evaporators – material and enthalpy balance, methods of feeding - performance criteria and factors affecting evaporator performance - calculation of heat transfer area - evaporator accessories - vapour recompression and thermal recompression evaporators - scale formation and its effect

Text Book:

References:

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

- 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 SHORT questions 8x 5 marks=40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

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

Maximum Total Marks: 100

*Note:* - Use of Heat and Mass Transfer data book, Steam Tables and attested copies of relevant charts are permitted for examination.

**CH14 407(P) FLUID & PARTICLE MECHANICS LAB**

**Teaching scheme**

Credit: 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. Free settling - (Stoke’s Law)
3. Packed bed - (pressure drop characteristics)
4. Fluidisation - (liquid-solid)
5. Centrifugal pump - (characteristic curves)
6. Rotary pump - (study of features)
7. Orifice plate and venturimeter - (hydraulic equation)
8. Orifices and mouthpieces - (flow coefficients)
9. Flow under varying head - (Equation of discharge)
10. Weirs and notches - (hydraulic equation)
11. Rotameter – (calibration)

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

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

End Semester Examination (*Maximum Marks-100*)
- 70% - Procedure, conducting experiment, results, tabulation, and inference
- 20% - Viva voce
- 10% - Fair record

**CH14 408(P) MATERIALS TECHNOLOGY AND ENGINEERING LAB**

*Teaching scheme*
3 hours practical per week

*Credits: 2*

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

1. Viscosity measurement using Ostwald viscometer.
2. Fabrication of FRP laminates and/or products
3. Determination of the effect of a filler on a non-Newtonian fluid
4. Injection moulding
5. Specific gravity measurement
6. Heat deflection temperature measurement
7. Measurement of impact strength of plastic materials
8. Measurement of shore – D hardness
9. Study the fatigue behaviour of materials using rotary fatigue testing machine
10. Preparation of phenol formaldehyde and urea formaldehyde
11. Preparation of PMMA, cupra-ammonium rayon and polystyrene.
12. Rheological studies using Rheometer and Brookefield viscometer.

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

**End Semester Examination (*Maximum Marks-100*)**
- 70% - Procedure, conducting experiment, results, tabulation, and inference
- 20% - Viva voce
- 10% - Fair record
FIFTH SEMESTER

CH09 501 CHEMICAL REACTION ENGINEERING

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

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

Module 1 (15 hours)

Module 2 (15 hours)

Module 3 (15 hours)

Module 4 (15 hours)

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

References:
5. Ronald W. Missen, “Introduction to Chemical reaction Engineering and Kinetics”, John Wiley & Sons, Inc. publication
Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8 x 5 marks = 40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks = 60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 502 MASS TRANSFER OPERATIONS I

Teaching scheme
3 hours lecture and 1 hour tutorial per week

Credits: 4

Objectives
➢ To impart the basic concepts of mass transport
➢ To develop understanding about gas absorption, humidification, crystallization, adsorption and drying.

Module 1 (15 hours)
Molecular diffusion - mass fluxes $J_A$ and $N_A$ - fick’s law - diffusivity and estimation - steady state diffusion of A through stagnant B and equimolar counter diffusion in binary gases, liquids and multicomponent gas mixtures. Mass transfer coefficients - film theory - f-type and k-type coefficients - dimensionless groups and dimensional analysis - analogy between mass, 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 (15 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, multisatge 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 (15 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 (15 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.

Text Book:
2. Binay K Dutta , Principles of Mass Transfer and Separation Processes, PHI publishers

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

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

Note: - Use of Heat and Mass Transfer data book, Steam Tables and attested copies of psychrometric charts are permitted for examination.
CH 14 503 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
- To understand the storage and transportation of Petroleum products

Module 1 (15 Hour)

Module 2 (15 Hour)

Module 3 (15 Hour)

Module 4 (15 Hour)

Text Books:
2. I D Mall, Petrochemical Process technology, Macmillan

References:
1. Dr.Kochu Baby Manjooran S, Modern Petroleum Chemistry
2. Dr.Ram Prasad, Petroleum Refining Technology, Khanna Publishers

Internal Continuous Assessment (Maximum Marks-50)
60% - Tests (minimum 2)
University of Calicut

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 SHORT questions  8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions  4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 100*

**CH 14 504 ENERGY ENGINEERING**

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

**Credits:** 4

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

**Module 1** (15 hours)
Energy, units of energy, general classification of energy, Indian and world energy resources and consumption, energy crisis, thermal, hydel and nuclear power plants, merits and demerits of the above power plants, brief description of wind, ocean wave, tidal, ocean thermal, geothermal, magneto hydrodynamics energy conversion, hydrogen energy. Solar energy –flat plate collectors, focusing collectors, solar water heating, solar distillation, solar thermal power generation, solar photovoltaic power generation, industrial application of solar energy.

**Module 2** (15 hours)
Biomass energy resources, thermo chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, bioethanol, biobutanol, biohydrogen, biodiesel production.
Fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, energy storage routes like thermal energy storage, chemical energy storage, mechanical energy storage, and electrical energy storage.

**Module 3** (15 hours)

**Module 4** (15 hours)
Energy conservation in chemical process plants, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, energy conservation in petroleum, fertilizer, pulp
and paper, and steel industries. Pinch technology, recycling for energy saving, electrical energy conservation in chemical process plants. Climate change and clean development mechanism, future clean energy options.

References:
7. Venkataswarlu D., Chemical Technology, I, S. Chand

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 505 ENVIROMENTAL 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 (15hours)
Module 2 (15 hours)

Module 3 (15 hours)

Module 4 (15 hours)
Air pollution - sources and classification of air pollution - effects of air pollution - global effects of air pollution - global warming and ozone layer 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.

Text Book:
2. Rao C.S., Environmental Pollution Control Engineering, New age International Pub.

References:
7. Babbitt H.E., Sewage & Sewage Treatment, John Willey

Internal Continuous Assessment (Maximum Marks 50)
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 SHORT questions 8x 5 marks = 40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks = 60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 506 PROCESS INSTRUMENTATION

Teaching scheme
2 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
➢ To impart the basic concepts of instrumentation

Module 1 (15 hours)

Module 2 (15 hours)

Module 3 (15 hours)

Module 4 (15 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

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

References:
1. K. Krishnaswamy, Industrial Instrumentation, New Age International
2. Doebelin, Measurment System, Tata McGraw-Hill Education
4. Al Sutko, Jerry D. Faulk, Industrial Instrumentation, Delmar

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH14 507(P) HEAT TRANSFER OPERATIONS LAB

Teaching scheme
3 hours practical per week

Credits: 2

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

Laboratory experiments and study of equipment based on the course CH14 503 PROCESS HEAT TRANSFER such as
1. Thickness of insulation
2. Radiation constant and emissivity of solids
3. Thermal conductivity of materials
4. Stefan-Boltzman constant
5. Heat transfer in double-pipe exchanger - parallel and counter current flow
6. Heat transfer in shell and tube exchanger
7. Condensation on vertical and horizontal surfaces
8. Heat transfer by natural convection
9. Heat transfer by forced convection
10. Heat transfer in agitated vessels
11. Emissivity measurement apparatus
12. 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-100)
70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record

CH14 508(P) PARTICLE TECHNOLOGY LAB

Teaching scheme
3 hours practical per week

Credits: 2

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

1. Sieve analysis - Determination of particle size distribution, mean diameters, specific surface area and number of particles per unit mass
2. Determination of the effectiveness of the given screen
3. Pipette analysis - Determination of particle size distribution, specific surface area and mean diameters
4. Beaker decantation – Determination of particle size distribution, specific surface area and mean diameters
5. Sedimentation – Determination of area of a thickener
6. Ball mill - Verification of the laws of crushing
7. Ball mill - Determination of the critical speed
8. Leaf filter- Determination of specific cake resistance and compressibility factor
9. Cyclone separator – Determination of collection efficiency
10. Studies on Plate & frame filter press, Mineral jig, Wilfley table and Cyclone Separator
11. Studies on Continuous thickener, Rotary drum filter, Jaw crusher and Hammer Mill.

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

CH14 601 CHEMICAL PROCESS INDUSTRIES

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

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

Module 1 (15 hours)

Module 2 (15 hours)

Module 3 (15 hours)

Module 4 (15 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.

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

References:
1. Kirk-Othmer Encyclopedia of Chemical Technology, John Wiley and Sons
2. Ullmann’s Encyclopedia of Industrial Chemistry, John Wiley and Sons

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
Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 602  PROCESS DYNAMICS AND CONTROL

Teaching scheme
3 hours lecture & 1hour tutorial per week

Credits: 4

Objectives
➢ To teach the fundamental concepts of control systems and mathematical modelling
➢ To impart the basics of industrial control systems
➢ To provide the basics of stability analysis and controller design
➢ To render fundamental concepts on advanced control strategies

Module 1 (15 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 systems to different types of forcing functions. First order systems in series - interacting and non-interacting types and generalization of results.

Module 2 (15 hours)

Module 3 (15 hours)
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. Introduction to frequency response - substitution rule - Bode diagram for first order systems - first order systems in series - higher order systems.
Module 4 (15 hours)
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. Control valves – construction and characteristics. Introduction to advanced control systems: Cascade control, feed forward control and ratio control. Basics of supervisory control and data acquisition (SCADA) and distributed control system (DCS).

Text Book:
2. Stephanopoulos G., Chemical Process Control, An Introduction to Theory & Practice, Prentice Hall

References:
3. Bequette B. W., Process Control Modeling, Design and Simulation
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
8. Ceaglske N.H., Automatic Process Control for Chemical Engineers

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 603  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 (15 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 (15 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 (15 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 (15 hours)

Text Book:
2. Binay K Dutta, Principles of Mass Transfer and Separation Processes - PHI publishers

References:
2. Seader J.D. & Henley E.J Separation Process Principles Wiley India
5. Geankoplis C.J., Transport Processes and Unit Operations, Prentice Hall India

Internal Continuous Assessment (Maximum Marks-50)
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 of Calicut

University Examination Pattern

**PART A:** Analytical/problem solving SHORT questions 8 x 5 marks = 40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks = 60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

**Note:** Use of Heat and Mass Transfer data book, Steam Tables and attested copies of relevant charts are permitted for examination.

**CH14 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 of chemical process industries.

**Module 1 (15 hours)**
Equivalence and cost comparison - time value of money and equivalence - equations used in economic analysis - compound interest and continuous interest - unacost - 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 (15 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 (15 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 (15 hours)
Inflation - cost comparison under inflation - unburden - 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 – feasibility analysis report of a venture - canons of ethics of engineers

Text Book:

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

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 605 MATERIAL SCIENCE & ENGINEERING

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

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

Module 1 (15 hours)
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
stressed 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 (15 hours)

Module 3 (15 hours)

Module 4 (15 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.

Text Book:
2. Van Vlack, Elements of Material Science and Engineering, Pearson Education India

References:
1. Hajra Choudhary, Material Science & Processes
2. R. B.Gupta, Material science and engineering, Satya Prakashan, New Delhi
3. Chilton & Perry, Chemical Engineers Handbook
4. Nanocomposite science and technology, Pulikel M. Ajayan, Wiley-VCH 2005

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions  8 x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions  4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100
CH14 606  POLYMER ENGINEERING AND TECHNOLOGY

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
➢ To understand the techniques of Polymer processing

Module 1 (15 hours)

Module 2 (15 hours)

Module 3 (15 hours)

Module 4 (15 hours)

Text books:
2.  Gowariker V.R.,Polymer Science, New Age.

References:
1.  Shah V.H., Handbook of Plastic Testing Technology

Internal Continuous Assessment (Maximum Marks-50)
60% - Tests (minimum 2)
Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.

Regularity in the class

University Examination Pattern

**PART A:** Analytical/problem solving SHORT questions  8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions  4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 607 (P) MASS TRANSFER OPERATIONS LAB

Teaching scheme  
3 hours practical per week

Credits: 2

Objectives

➢ To provide experience analysis of mass transfer operations.

The experiments based on the courses CH14-504 MASS TRANSFER OPERATIONS I and CH14-604 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. Packed absorption columns
13. Height equivalent of theoretical plate
14. Experiments on liquid-liquid extraction
15. 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-100)
70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record
University of Calicut

CH14 608 (P) MINI PROJECT

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-100)
50% - Design and development
30% - Final result and Demonstration
20% - Report

SEVENTH SEMESTER

CH14 701 CHEMICAL ENGINEERING DESIGN& DRAWING I

Teaching scheme

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

Credits: 4

Objectives

➢ To develop basic understanding about engineering drawings, pressure vessel design, storage tank design and thermal design of heat exchangers

Module 1 (30 hrs)
Introduction to chemical engineering drawing – P&ID of heat exchangers, distillation columns and stirred tank jacketed reactors with at least one control loop. Introduction to pressure vessels: stress variation. Mechanical design of pressure vessels and jacketed vessels. tall columns, column supports- skirt, bracket- saddle as per IS codes. Mechanical design of non standard flange.
Module 2  
(30 hrs)

Text Book:

References:
4. IS Codes.
8. Rase & Barrow, Project Engineering of Process Plants, John Wiley
11. I.S.A. code (P&ID)

Internal Continuous Assessment (Maximum Marks-50)
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 - Problem solving questions with drawing  1 x 50 marks=50 marks
2 question of 50 marks from first module with choice to answer one.

Part B - Problem solving questions with drawing  1 x 50 marks=50 marks
2 question of 50 marks from second module with choice to answer one.

Maximum Total Marks: 100

Note:- Use of Perry’s Chemical Engineers Handbook, IS Codes, Steam Tables and attested copies of relevant charts, data tables and empirical correlations are permitted for examination.
CH14 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 (15 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 (15 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

Module 3 (15 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

Module 4 (15 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)

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

Text Book:

References:
University of Calicut


**Internal Continuous Assessment (Maximum Marks-50)**
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 100*

**Note:- Use of attested copies of relevant charts, data tables and empirical correlations are permitted for examination.**

**CH 14 703 BIOCHEMICAL ENGINEERING**

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

**Credits: 4**

**Objectives**
- To impart the basic concepts of biochemical engineering
- To develop understanding about biochemistry and bioprocesses

**Module 1 (15 hours)**

**Module 2 (15 hours)**

**Module 3 (15 hours)**
Introduction to enzymes . Classification, kinetics of enzyme catalyzed reactions, Han Levespiel kinetics model, factors affecting Enzyme Substrate complex formation, derivation of Michaelis Menten equation for single substrate, determination of Michaelis Menten parameters, enzyme
inhibition- types, Effect of Conditions on Enzyme reaction rate, immobilization of enzymes, methods, immobilized enzyme kinetics, applications of immobilized enzymes.

**Module 4** (15 hours)

Text Books:
2. M.L.Shuler and F. Kargi, Bioprocess Engineering, Prentice-Hall of India

References:
1. Pauline Doran, Bioprocess Engineering Principles, Elsevier
2. Georges N Cohen, Microbial Biochemistry, Springer

**Internal Continuous Assessment** *(Maximum Marks-50)*
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 **SHORT questions**  
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving **DESCRIPTIVE questions**  
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 100*
ELECTIVE I

Teaching scheme

3 hours lecture & 1 hour tutorial per week

Credits: 4

3 hours lecture & 1 hour tutorial per week

Any one from CH 14 704(A) to CH 14 704(G) or Global Electives listed at least with maximum one global elective for one semester

1 CH 14 704 (A) NUMERICAL ANALYSIS (GLOBAL)
2 CH14 704 (B) MATHEMATICAL METHODS IN CHEMICAL ENGINEERING
3 CH 14 704 (C) PETROCHEMICALS
4 CH 14 704 (D) UNCONVENTIONAL SEPARATION TECHNIQUES
5 CH 14 704 (E) ELECTROCHEMICAL ENGINEERING
6 CH 14 704 (F) CERAMIC TECHNOLOGY
7 CH 14 704 (G) WATER TREATMENT TECHNOLOGY

CH 14 704(A) NUMERICAL ANALYSIS

Teaching scheme

3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives

➢ To impart the basic concepts of numerical analysis
➢ To develop the skill to choose appropriate method for the numerical solution of chemical engineering problems.

No Pre-requisites

Module 1: Errors in numerical calculations (15 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 - 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 (15 hours)
Direct methods - Gauss elimination and Gauss - Jordan methods – Factorisation (LU decomposition) method - 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

Module 3: Polynomial interpolation (15 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 (15 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. Introductory methods of Numerical Analysis, S.S. Sastry, PHI
2. Froberg C.E., Introduction to Numerical Analysis, Addison Wesley
5. Hildebrand F.B., Introduction to Numerical Analysis, T.M.H.

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 704 (B) MATHEMATICAL METHODS IN CHEMICAL ENGINEERING

Teaching scheme
3 hours lecture & 1hour tutorial per week

Credits: 4

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

No Pre-requisites

Module 1 (15 hours)
Module 2 (15 hours)
Mathematical formulation of the physical problems - application of the law of conservation of mass, salt accumulation in stirred tank, 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. Applications to Chemical Engineering systems – Linear algebraic Equations- First order system of homogeneous and non-homogeneous ODE

Module 3 (15 hours)

Module 4 (15 hours)
Functions- Error function, Gamma function, Beta function, Bessel function and its properties. Green functions – ODE and PDE, Finite differences (preliminary analysis). Treatment of Experimental Results, theoretical properties, contour plots, propagation of errors, curve fitting.

References:

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100
CH 14 704 (C) PETROCHEMICALS

Teaching scheme

3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives

➢ To introduce the student to the world of petrochemicals, processes used to manufacture them and their wide range of application.

No Pre-requisites

Module 1 (15 hours)

Petrochemical Industries & their feed stocks: Brief History and Survey of Petrochemical Industries in India. Different feed stocks used for Petrochemical Industries and their sources. Feed stocks used by Petrochemical Industries in India and their sources. Impurities in feed stocks and processes for their removal.


Module 2 (15 hours)

Major Petrochemical products and their applications. First, Second and Third generation petrochemical products. Production of Ethylene, Propylene, and Butadiene by Naphtha/Gas cracking.

Petrochemicals based on Ethylene, Propylene and Butadiene: Like VCM, VAM, Ethylene Oxide, Ethylene Glycol, Ethanol Amines from Ethylene. Acrylonitrile, Isopropanol, Propylene oxide, Glycerine, Acrylic acid, Acrolein from Propylene. Production of Butadiene.

Module 3 (15 hours)

Formaldehyde, Ethylene dichrolide, Ethanol, Ethanolamines-mono and di, Acetic acid, isopropanol, acetone, Phenol, Production of SBR, PBR and Butyl rubber. Production of ABS plastics. Polytetrafluoroethylene, polycarbonate, Purified teraphthalicacid (PTA), Ethylene Glycol, Production of Polyamide (Nylon 6 and Nylon 6,6) , Polyester and Acrylic fibres. Production of Phenol Formaldehyde resins.

Module 4 (15 hours)


Reference books:

2. Petrochemical processes: Chauvel, Gulf Publishing
4. Advanced Petrochemicals: Dr. G. N. Sarkar, Khanna Publishers

Internal Continuous Assessment (Maximum Marks-50)

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 SHORT questions  8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions  4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 100*

**CH 704 (D) UNCONVENTIONAL SEPARATION TECHNIQUES**

**Teaching scheme**

*3 hours lecture & 1hour tutorial per week*

**Credits:** 4

**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 (15 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 (15 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 (15 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 - adductive crystallization and zone melting - ultra and zonal centrifugation

**Module 4 (15 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-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 704 (E) ELECTROCHEMICAL ENGINEERING

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Objectives
➢ To impart the basic concepts of electrochemical engineering

Module 1 (15 hours)
BASIC ELECTROCHEMICAL CONCEPTS:
Introduction and thermodynamic in terms of electrochemical potential-phase equilibrium, chemical and electrochemical potentials, cells with solution of uniform concentration, transport processes in junction regions, cells with a single electrolyte of varying concentration. The electric potential-the electrostatic potential, intermolecular forces, outer and inner potential, potentials of reference electrode, the electric potential in thermodynamics. Activity coefficients-ionic distributions in dilute solutions, electrical contribution to the free energy, measurement of activity coefficients.

Module 2 (15 hours)
REFERENCE ELECTRODE AND ELECTRICAL DOUBLE LAYER
Reference electrode-criteria of reference electrodes, hydrogen electrode, the calomel electrode and other mercury and mercurous salt electrodes, silver-silver halide electrodes. Potentials of cells with junction- the Nernst equation, types of liquid junctions, cells with liquid junction, potentials across membranes. Structure of the electric double layer, qualitative description of
double layers, the Gibbs adsorption isotherm, the Lippmann equation, the diffused part of the double layer. Electrode kinetics, electro-kinetic phenomena, Electro capillary phenomena.

**Module 3** (15 hours)

**INFINITELY DILUTE SOLUTIONS AND THERMAL BALANCE**


**Module 4** (15 hours)

**TRANSPORT PROPERTIES**

Transport properties- single and multicomponent solutions. Fluid mechanics-stress in a Newtonian fluid, magnitude of electrical forces. Transport in dilutes solutions, simplification for convective transport, the Graetz problem, two-dimensional diffusion layer in laminar forced convection, axisymmetric diffusion layers in forced convection.

**References:**


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

- 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 SHORT questions 8x 5 marks=40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

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

*Maximum Total Marks: 100*

**CH 14 704 (F) CERAMIC TECHNOLOGY**

**Teaching scheme**

3 hours lecture & 1hour tutorial per week

**Credits:** 4

**Objectives**

➢ To impart the basic concepts of ceramics technology

**No Pre-requisites**
Module 1 (15 hours)
Synthesis and fabrication of advanced and future materials with emphasis on ceramic, semi-conducting and superconducting materials with superior structural, optical and electrical properties. Comparison of properties of such advanced materials, with conventional materials such as metals and polymers.

Module 2 (15 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 (15 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 (15 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: Analytical/problem solving SHORT questions  8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions  4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100
CH14 704 (G) 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 (15hours)
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 (15hours)
Treatment technologies-Coagulation, floculation and sedimentation. Usual coagulants, the jar test, flash mixers, floculators, clarifiers and clarifloculators. 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 (15hours)

Module 4 (15hours)

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-50)
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 of Calicut

University Examination Pattern

**PART A:** Analytical/problem solving SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 100*

**CH14 705( ) ELECTIVE II**

**Teaching scheme**
3 hours lecture & 1 hour tutorial per week
Any one from CH14 705(A) to CH14 705(F) or Global Electives listed at last with maximum one global elective for one semester

1 CH 14 705(A) NANOMATERIAL AND NANOTECHNOLOGY (GLOBAL)
2 CH 14 705(B) PROCESS MODELING AND SIMULATION
3 CH 14 705(C) MEMBRANE SEPARATION TECHNIQUES
4 CH 14 705(D) FOOD TECHNOLOGY
5 CH 14 705(E) MICRO ELECTRONICS PROCESSING
6 CH 14 705(F) CATALYSIS- THEORY AND PRACTICE
7 CH14 705 (G) COMPOSITE MATERIALS

**CH14 705(A) 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** (15 Hours)
Introduction to nanotechnology, definition, history, electromagnetic spectrum. Methods of synthesis of nanomaterials fabrication—“Top-down” vs. “bottom-up” approaches, particle size, chemistry and physics of nanomaterials, electronic phenomenon in nanostructures, optical absorption in solids, quantum effects.

**Module 2** (15 Hours)
Nanomaterials, preparation of nanomaterials like gold, silver, different types of nano-oxides, Al₂O₃, TiO₂, ZnO etc. Sol-gel methods, chemical vapour deposition, ball milling etc. Carbon nanotubes – single walled and multiwalled CNT, preparation properties and applications like field emission displays. Different types of characterization techniques like SEM, AFM, TEM & STM.
Module 3 (15 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 (15 Hours)
Nanomanipulation, Micro and nanofabrication techniques, Photolithography, E-beam, FIB etc. Nanolithography, self lithography, 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, Woodhead publishing 2005
5. Micro and Nanofabrication, Zheng Cui, Springer 2005

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100
CH 14 705(B)  PROCESS MODELING AND SIMULATION

Teaching scheme
Credits: 4
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 (15 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 (15 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 (15 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 (15 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-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.
PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks = 60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 705(C) MEMBRANE SEPARATION TECHNIQUES

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
- To impart the basic concepts of membrane technology
- To understand the major steps in membrane separation and purification process
- To develop the knowledge of industrial application of membrane process

Module 1 (15 hours)
Overview of membrane separation process- Basic principle of membrane separation, Historical development of membranes, Classification of membrane process, Advantages of membrane process, Disadvantages, Major areas of application, Future prospects.
Membrane types, materials, preparation- Types of synthetic membranes, Membrane modules, Typical flow patterns, Membrane materials, Pore characteristics, General methods of membrane manufacture.

Module 2 (15 hours)
Reverse Osmosis- Concept of Osmosis, Phenomenon of Reverse Osmosis- Pressure requirement, High pressure and Low pressure RO, advantages of Reverse osmosis, Membrane materials and modules, Selection criteria of RO membrane. Design and operating parameters, Concentration polarization. Osmotic Pinch effect.
Nanofiltration- Principle of nanofiltration, Nanofiltration membranes, Transport mechanism in NF membranes, Parameters affecting the performance of NF membranes, Process limitation, Industrial applications.

Module 3 (15 hours)
Ultrafiltration- Basic principles, Ultrafiltration membranes, Factors affecting performance of UF, Flux equation for UF, Fouling and flux decline, Applications.
Microfiltration- Basic principles, Microfiltration membranes, Mechanism of transport, Flow characteristics, Fouling in MF membranes, Applications.
Dialysis- Principles, Dialysis membranes, Mass transfer in dialysis, Applications- Hemodialysis, Diffusion dialysis- advantages, application.

Module 4 (15 hours)
Gas separation- Basic principle, membranes for gas separation, Fundamental mechanism of gas transport, Factors affecting gas permeation, Applications.
Pervaporation- basic principles, Membrane characteristics, Mass transfer in pervaporation, Factors affecting pervaporation, Concentration polarization, Advantages, applications.

Reference:
3. E.J Hoffman, Membrane Separation Technology, Gulf Publishers
CH 14 705(D) FOOD TECHNOLOGY

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
➢ To impart the basic concepts of food processing.
➢ To understand the unit operations in food engineering.
➢ To impart the concepts of food laws and legislation.

No Pre-requisites

Module 1 (15 hours)
Introduction - general aspects of food industry - constituents of food - quality and nutritive aspects - food additives- Scope- permitted food additives, General principles for the use of food additives - Concept and significance of Food Legislation, Indian Food Laws and Legislation, Prevention of Food Adulteration (PFA), International Standardization and Organization (ISO), Codex Food standards, deteriorative factors and their control

Module 2 (15 hours)
Food conversion operations- Mechanical Cleaning, Grading, Sorting, Size reduction, Mixing, emulsification, Kneading, Blending, Homogenization, Size Separation, filtration, membrane separation, centrifugation, Extraction, Leaching, Crystallization, Preservation of foods by high temperature: Basic concepts in thermal destruction of microorganisms, kinetics, thermal death time, thermal process time, Heat resistance in micro-organisms. Cooking, blanching, pasteurization and sterilization of foods – Food preservation by Evaporation-equipments used, drying-equipments, kinetics, drying rate curve, Food preservation at low temperatures-refrigeration, freezing methods, thawing, irradiation-microwave heating, kinetics, Fermentation and pickling.
Module 3 (15 hours)

Module 4 (15 hours)
Technology of dairy products- milk processing operations, types of milk and their characteristics, milk products and their manufacture, Beverage industry- carbonated non-alcoholic beverages, stimulating beverages, alcoholic beverages, manufacturing of beverages, meat and meat products- types of meat, preservation, poultry processing, Sea foods-storage and processing, treatment and disposal of food processing wastes.

Reference books:
3. Waston 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
8. Zacharias B. Maroulis, George D. Saravacos, Food Process Design, Marcel Dekker-USA
9. B.Sivasankar, Food Processing and Preservation, Prentice Hall of India

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8 x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100
CH 14 705(E) MICRO ELECTRONICS PROCESSING

Teaching scheme
3 hours lecture and 1 hour tutorial per week

Credits: 4

Objectives
➢ To impart the basic concepts of microelectronics processing

No Pre-requisites

Module 1 (15 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 (15 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 (15 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 (15 Hours)

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-50)
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 SHORT questions 8 x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 705(F) 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 (15 hours)

Module 2 (15 hours)

Module 3 (15 hours)

Module 4 (15 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 Kunit, and Octave Levenspiel, Fluidization Engineering, Butterworth-Heinemann
8. Max Leva, Fluidization, McGraw-Hill

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

- **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 SHORT questions*  
8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** *Analytical/Problem solving DESCRIPTIVE questions*  
4x 15 marks=60 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 100*

**CH 14 705 (G) COMPOSITE MATERIALS**

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

**Objectives**
- **To impart the basic concepts of composite materials**

**No Pre-requisites**

**Module 1 (15 hours)**

**Module 2 (15 hours)**

**Module 3 (15 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** (15 hours)
Testing of composites materials and products for quality control- Brief outlines of testing of glass fibre, testing of resins-testing of products. General design considerations-design values-factor of safety-working stress approach – service ability design-warning of danger-design process-shape design & se4lection of materials and processing methods-application of composite of materials in various fields-chemical industries- electrical and electronic industries- aerospace, marine, and transport applications- application in buildings.

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

**Internal Continuous Assessment** *(Maximum Marks-50)*
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 **SHORT questions** 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving **DESCRIPTIVE questions** 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 100*

**CH 14 706 (P) PROCESS SIMULATION LAB**

**Objectives**
- To develop the skill to model and simulate the unit operation and process using commercial simulators.

1. Introduction to process simulation
2. Equations of state: solution of problems using M.S.Excel, Matlab and Aspen Plus
3. Phase equilibrium: solution of problems using M.S.Excel, Matlab and Aspen Plus
8. Transport Processes in One Dimension: solution of problems using M.S.Excel, Matlab and Aspen Plus
10. Process simulation of typical chemical plants using Aspen Hysys

References:
1. Introduction to Chemical Engineering Computing by Bruce A. Finlayson, Wiley International.

Internal Continuous Assessment (Maximum Marks - 50)
40% - Simulation of experiments and record
50% - Test/s
10% - Regularity in the class

End Semester Examination (Maximum Marks - 100)
10% - Analysis of the problem
20% - Process Simulation Scheme
40% - Simulation and Result Analysis
20% - Viva voce
10% - Fair record

CH 14 707 (P) PROCESS CONTROL AND REACTION ENGINEERING LAB

Teaching scheme
3 hours practical per week

Credits: 2

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. Control of temperature process system
11. Control valve characteristics
12. Determination of activation energy
13. Kinetics of hydrolysis of methyl acetate
14 Kinetics of hydrolysis of ethyl acetate
15 Performance study of plug flow reactor
16 Performance study of CSTR
17 Simulation using MATLAB/SIMULINK or SCILAB/SCICOS
   (a) Step response of first order system and determination of time constant.
   (b) Study of the effect of time constant on speed of response.
   (c) Step response of second order systems by varying damping coefficients.
   (d) Stability analysis
   (e) Solution of differential equations

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

End Semester Examination (Maximum Marks-100)
70% - Procedure, conducting experiment, results, tabulation, and inference
20% - Viva voce
10% - Fair record

**CH 14 708 (P) PROJECT**

**Teaching scheme**

**Credits:** 4

4 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. One chapter on plant simulation using any process simulation packages and comparison of the results with conventional calculation is to be prepared. 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 external 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

CH14 801 CHEMICAL ENGINEERING DESIGN & DRAWING II

Teaching scheme

Credits: 4
2 hours lecture, 1 hour tutorial & 1 hour drawing per week

Objectives

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

Module 1

(30 hrs)


Module 2

(30 hrs)

Process design of steady state isothermal binary component distillation columns. Detailed drawing of distillation column and its accessories. Process design of steady state isothermal absorption and stripping column-detailed drawing. Process design and drawing of sieve tray single solvent extraction columns

Text Book:


References:

5. IS Codes.
8. Rase & Barrow, Project Engineering of Process Plants, John 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 - Problem solving questions with drawing 1 x 50 marks=50 marks
2 question of 50 marks from first module with choice to answer one.
Part B - Problem solving questions with drawing 1 x 50 marks=50 marks
2 question of 50 marks from second module with choice to answer one.

Maximum Total Marks: 100
Note: Use of Perry’s Chemical Engineers Handbook, IS Codes, Steam Tables and attested copies of relevant charts, data tables and empirical correlations are permitted for examination.

CH 14 802 OPTIMISATION OF CHEMICAL PROCESSES

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
➢ To impart the basic concepts of optimization

Module 1 (15 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 (15 hours)

Module 3 (15 hours)
Linear programming - basic concepts in linear programming - graphical interpretation - 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 (15 hours)
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

Text Books

Reference books:

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8 x 5 marks = 40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks = 60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 803 SAFETY ENGINEERING IN PROCESS PLANTS

Teaching scheme

3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives

➢ To impart the basic concepts of industrial safety.
➢ To develop understanding about safety practices in industries and emergency procedures.
➢ To understand about chemical hazards and risks.

Module 1 (15 hours)

Module 2 (15 hours)

Module 3 (15 hours)

Module 4 (15 hours)
Text books:

References:

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH14 804 ELECTIVE III

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Any one from CH 14 804A to CH 14 804G or Global Electives listed at last with maximum one global elective for one semester
ELECTIVE III

1. CH 14 804(A) INTRODUCTION TO CHEMICAL ENGINEERING COMPUTING
2. CH 14 804(B) PETROLEUM EXPLORATION AND STORAGE
3. CH 14 804(C) INDUSTRIAL POLLUTION CONTROL  (GLOBAL)
4. CH 14 804(D) COMPUTER AIDED DESIGN
5. CH 14 804(E) FERTILIZER TECHNOLOGY
6. CH 14 804(F) ADVANCES IN BIOCHEMICAL ENGINEERING
7. CH 14 804 (G) ESSENTIALS OF MANAGEMENT

CH 14 804(A) INTRODUCTION TO CHEMICAL ENGINEERING COMPUTING

Teaching scheme

2 hours lecture & 1 hour tutorial per week

Credits: 3

Objectives

➢ To impart concepts of modelling and simulation of chemical engineering problems.

Module 1 (15 hours)


Vapor–Liquid Equilibrium, Flash and Phase Separation, Isothermal Flash – Development of Equations, Example using Excel, MATLAB and Aspen Plus, Non-ideal Liquids – Test of Thermodynamic Model


Module 2 (15 hours)

Mass Balances with Recycle Streams, Mathematical Formulation, Example without Recycle, Example with Recycle; Comparison of Sequential and Simultaneous Solution Methods, Example of Process Simulation using Excel for Simple Mass Balances, Example of Process Simulation With Excel Including Chemical Reaction Equilibrium, Example of Process Simulation with Excel Including Phase Equilibrium


Module 3 (15 hours)

Module 4 (15 hours)

Reference book

University Examination Pattern
PART A: Analytical/problem solving SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 804(B) PETROLEUM EXPLORATION AND STORAGE

Teaching scheme
2 hours lecture & 1 hour tutorial per week

Credits: 3

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

No Pre-requisites
University of Calicut

Module 1 (15 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. Reservoir rocks and cap rocks, Entrapment of oil-types and mechanism. Reservoir Rock Properties: Porosity, permeability, effective and relative permeability, Wettability, capillary pressure characteristics.

Module 2 (15 Hours)
Instruments used, principles and working, magnetometers, Seismograms, Radiation counter sand gravimeters. Effective strategies for integrated geophysical exploration from a system view point. Interpretation of electrical, electromagnetic, magneto telluric, gravity and seismic data.

Module 3 (15 Hours)

Module 4 (15 Hours)
Drilling: Introduction to on-shore and offshore drilling operations, drilling accessories rig components, drilling fluid circulation system. Types of wells. Exploration, appraisal and development, deviated hole, horizontal and multilateral wells. Well design and casing policy. Types and structure of drilling rigs and Rig components. Drilling tubular and bits, offshore rigs-for shallow and deep waters, borehole profile and environment. Drilling methods, pre drill operations in on land 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.

References:
5. Cole F W, Reservoir Engineering manual
7. Mc Cray and Cole, Oil Well Drilling Technology, Oklahoma Press
8. D. S. Parasnis, Principles of Applied Geophysics, Chaman
9. R. K. Jain, Engineering Metrology

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions
4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 100*
CH 14 804(C) 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 (15 hours)
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 (15 hours)
Water pollution control in industries - pulp and paper, textile processing, tannery wastes, dairy wastes, cannery wastes, brewery, distillery, meat 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 (15 hours)

Module 4 (15 hours)

References:
5. Rao C.S., Environmental Pollution Control Engineering, New Age Int. Pub.
7. Babbitt 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-50)
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 SHORT questions  
8x 5 marks = 40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions  
4 x 15 marks = 60 marks 
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 100*

**CH14 804(D) 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** (15 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** (15 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** (15 hours)
Computer aided design of heat exchanger systems - double pipe and shell and tube heat exchanger design - computer aided design of evaporators - design of single effect evaporator and multiple effect evaporator systems

**Module 4** (15 hours)
Computer aided design of packed bed absorbers and strippers - computer aided mechanical design of tray 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-50)
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 - Problem solving questions with drawing 1 x 50 marks=50 marks
2 question of 50 marks from first module with choice to answer one.
Part B - Problem solving questions with drawing 1 x 50 marks=50 marks
2 question of 50 marks from second module with choice to answer one.

Maximum Total Marks: 100

CH 14 804(E) FERTILIZER TECHNOLOGY

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
➢ To impart the basic concepts of Fertilizer Technology

Module 1: (15 hours)
OVERVIEW
Role of organic manures and chemical fertiliser, types of chemical fertiliser, growth of fertiliser in India; their location; energy consumption in various fertiliser processes; materials of various fertiliser processes; materials of consumption in fertiliser industry.

Module 2: (15 hours)
NITROGENOUS FERTILISERS
Feed stock for production of ammonia-natural gas, associated gas, coke-oven gas, naphtha, fuel oil, petroleum heavy stock, coal, electricity etc; processes for gasification and methods of production of ammonia and nitric acid; nitrogenous fertiliser-ammonium sulphate, nitrate, urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling.

Module 3: (15 hours)
PHOSPHATIC FERTILISERS:
Raw materials; phosphate rock, sulphur; pyrites etc., processes for the production of sulphuric and phosphoric acids; phosphates fertilisers - ground rock phosphate; bone meal-single superphosphate, triple superphosphate, thermal phosphates and their methods of production, characteristics and specifications.

Module 4: (15 hours)
POTASSIC FERTILISERS:
Methods of production of potassium chloride, potassium schoenite, their characteristics and specifications.
COMPLEX AND NPK FERTILISERS:
Methods of production of ammonium phosphate, sulphate diammonium phosphate, nitrophosphates, urea, ammonium phosphate, mono-ammonium phosphate and various grades of
NPK fertilisers produced in the country.

MISCELLANEOUS FERTILISERS:
Mixed fertilisers and granulated mixtures; biofertilisers, nutrients, secondary nutrients and micro nutrients; fluid fertilisers, controlled release fertilisers, controlled release fertilisers.

POLLUTION FROM FERTILISER INDUSTRY:
Solid, liquid and gaseous pollution standards laid down for them.

References:

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH14 804(F) 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 (15hours)
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 (15 hours)

Module 3 (15 hours)

Module 4 (15 hours)

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-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.
PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH14 804 (G) ESSENTIALS OF MANAGEMENT

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

Objectives
➢ To impart the basic concepts of management

No Pre-requisites

Module 1 (15 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 (15 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 (15 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 (15 hours)
Controlling - the basic control process - financial control methods - budgetary 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-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

**Maximum Total Marks:** 100

CH14 805 ( ) ELECTIVE V

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

**Credits:** 4

Any one from CH 14 805A to CH 14 805G or Global Electives listed at last with maximum one global elective for one semester

**ELECTIVE V**

1. CH 14 805(A) SOLID WASTE MANAGEMENT
2. CH 14 805(B) PROJECT ENGINEERING (GLOBAL)
3. CH 14 805(C) NUCLEAR TECHNOLOGY/ENGINEERING
4. CH 14 805(D) MARKETING MANAGEMENT
5. CH 14 805(E) RUBBER TECHNOLOGY
   CH 14 805(F) SURFACE COATINGS
6. 7 CH14 805 (G) COMPUTATIONAL FLUID DYNAMICS

CH 14 805(A) 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** (15 hours)

**Module 2** (15 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, Toxic waste management, Plastics waste management.

**Module 3** (15 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., Treatment of leachates.

**Module 4** (15 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 Tchobanogulous

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

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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 100*

**CH 14 805(B) PROJECT ENGINEERING**

**Teaching scheme**

*3 hours lecture & 1 hour tutorial per week*

**Credits:** 4

**Objectives**

- To impart the basic concepts of project management
To understand the major steps in plant design
To develop the knowledge of engineering design and equipment selection

No Pre-requisites

Module 1 (15 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 (15 hours)
Planning and scheduling of projects - bar chart and network techniques - procurement operations - office procedures - contracts and contractors - project financing - statutory sanctions

Module 3 (15 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 (15 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

Text books:
1. Rase & Barrow, Project Engineering of Process Plants, John Wiley

References:
5. Frederick B. Plummer, Project Engineering, BH
VV Mahajani S M Mokashi, Chemical Project Economics, Macmillan

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8 x 5 marks = 40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks = 60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100
CH 14 805(C) NUCLEAR TECHNOLOGY/ENGINEERING

Teaching scheme
3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives
➢ To impart the basic concepts Nuclear technology

Module 1 (15 hours)

Module 2 (15 hours)
Nuclear Reactors: Introduction, General Components of Nuclear Reactor, General Problems of Reactor Operation, Different Types of Reactors, Pressurised Water Reactors (PWR), Boiling Water Reactors (BWR), Heavy Water-cooled and Moderated CANDU (Canadian Deuterium Uranium) Type Reactors, Gas-cooled Reactors, Breeder Reactors

Module 3 (15 hours)

Module 4 (15 hours)

Reference:

Internal Continuous Assessment (Maximum Marks-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 805(D) MARKETING MANAGEMENT

Teaching scheme

3 hours lecture & 1 hour tutorial per week

Credits: 4

Objectives

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

No Pre-requisites

Module 1 (15 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 (15 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 (15 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 (15 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-50)

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 SHORT questions 8x 5 marks = 40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks = 60 marks
Two questions from each module with choice to answer one question.

*Maximum Total Marks: 100*

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**CH 14 805(E) 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** (15 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** (15 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
Module 3 (15 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 (15 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-50)
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 SHORT questions 8x 5 marks=40 marks
Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

PART B: Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

\[ \text{Maximum Total Marks: 100} \]

**CH 14 805(F) SURFACE COATINGS**

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

**Credits:** 4

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

**No Pre-requisites**

**Module 1** (15 hours)
Film formation - Film forming compositions - properties - types of polymerization in film forming compounds - drying oils - composition - manufacturing procedure.

**Module 2** (15 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** (15 hours)
Pigments - properties - types - white pigments - properties - manufacturing procedures - red pigments, green, blue and black pigments - properties and manufacturing procedure

**Module 4** (15 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-50)**
- 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 SHORT questions  
8x 5 marks = 40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.
PART B: Analytical/Problem solving DESCRIPTIVE questions  4 x 15 marks=60 marks
Two questions from each module with choice to answer one question.

Maximum Total Marks: 100

CH 14 805 (G) COMPUTATIONAL FLUID DYNAMICS

Teaching scheme
3 hours lecture and 1 hour practical per week

Credits: 4

Objectives
➢ To impart the basic concepts of computational fluid dynamics
➢ To develop the understanding of the techniques for solving the fluid mechanics problems on computers.

No Pre-requisites

Module 1 (15 hours)
Introduction of the governing equations of fluid mechanics - Conservation equations for mass, momentum, energy and chemical species- Derivation of the governing equations – Different Boundary conditions- turbulence closure and mass transfer models — Dimensionless form – simplified equations.

Module 2 (15 hours)

Module 3 (15 hours)
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 (15 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-50)**

- 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 SHORT questions 8x 5 marks=40 marks

Candidates have to answer EIGHT questions out of TEN. There shall be minimum of TWO and maximum of THREE questions from each module with total TEN questions.

**PART B:** Analytical/Problem solving DESCRIPTIVE questions 4 x 15 marks=60 marks

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

Maximum Total Marks: 100

**CH14 806(P) SEMINAR**

**Teaching scheme**

3 hours per week

**Credits:** 3

**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
CH 14 807 (P) PROJECT

Teaching scheme
7 hours per week

Credits: 4

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. One chapter on plant simulation using any process simulation packages and comparison of the results with conventional calculation is to be prepared. 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 external 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
CH14 808(P) VIVA-VOCE

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