## Department of Chemical Engineering
### Bachelor of Technology in Chemical Engineering

### Basic Science Core (BSC)

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<th>Code</th>
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<tr>
<td>MA110</td>
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<td>PH110</td>
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<td>CY305</td>
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### Engineering Science Core (ESC)

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<tr>
<td>EE110</td>
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<td>ME110</td>
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<td>EC110</td>
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<td>AM110</td>
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<tr>
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<td>Principles of Management</td>
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### Programme Core (PC)

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<td>CH202</td>
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<td>Simultaneous Heat &amp; Mass Transfer</td>
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<td>CH355</td>
<td>Chemical Process Industries</td>
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<tr>
<td>CH402</td>
<td>Process Design of Chemical Equiments</td>
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<td>CH403</td>
<td>C.R.E. &amp; Process Control Lab</td>
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### Programme Specific Electives (PSE)

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<tbody>
<tr>
<td>CH211</td>
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<td>CH261</td>
<td>Energy Technology</td>
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<td>Petroleum Engineering</td>
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<td>CH312</td>
<td>Biochemical Engineering</td>
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<td>CH361</td>
<td>Process Modeling &amp; Simulation</td>
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<td>CH362</td>
<td>Separation Processes</td>
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<td>Fertilizer Technology</td>
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<td>CH364</td>
<td>Risk and Safety Management in Process Industries</td>
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<td>CH365</td>
<td>Introduction to Molecular Simulations</td>
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<td>CH366</td>
<td>Electrochemical Engg.</td>
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<td>CH367</td>
<td>Energy Conservation &amp; Management in process Industries</td>
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<td>Fuel Cell Engineering</td>
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### Mandatory Learning Courses (MLC)

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<tr>
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<td>HU111</td>
<td>Professional Ethics and Human Value</td>
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<td>CH440</td>
<td>Practical Training</td>
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<tr>
<td>CH 448</td>
<td>Seminar</td>
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### Open Electives (OE)

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<td>CH465</td>
<td>Air Pollution Control and Design of Equipments</td>
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### Suggested Plan of Study:

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### Degree Requirements:

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<th>Category of Courses</th>
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<tbody>
<tr>
<td>Foundation Courses</td>
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<tr>
<td>Basic Science Core (BSC)</td>
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<tr>
<td>Engineering Science Core (ESC)</td>
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<tr>
<td>Humanities and Social Sciences Core (HSC)</td>
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<td>Programme Core (PC)</td>
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<td>Project (MP)</td>
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<td>Mandatory Learning Courses (MLC)</td>
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<td><strong>Total</strong></td>
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Department of Chemical Engineering

CH200 Process Calculations  


CH201 Momentum Transfer  

Coulson and Richardson, Chemical Engineering Volume I ELBS, Pargamon 3rd Edition. 1977

CH202 Particulate Technology  

Richardson J.F and Coulson J.M, Chemical Engineering (SI Units) Vol 2; 1978.

CH203 Transport Phenomena  
Shell balances for momentum, energy and mass transfer. Introduction to general transport equations for momentum, energy and mass transfer in cartesian - cylindrical and spherical coordinates - simple solutions in one dimension. Simplification of general equations with time and spatial coordinates for momentum, energy, mass transport, boundary layer concepts of momentum energy and mass transport. Macroscopic balances for isothermal systems, nonisothermal systems and multi component systems.

Beek W.J. and Mutzall K.M.K., - Transport Phenomena, John Willey and Sons Ltd., 1975.

CH211 Process Instrumentation  

Instrumental Methods of Analysis, Willard, Merru, Dean and Settle, C.B.S. publication, New Delhi.
1986 (Chapters 17, 18, 19, 30 & 31).


CH250 Chemical Engg. Thermodynamics I
(2-1-0) 3


CH251 Heat Transfer
(3-1-0) 4


CH252 Mass Transfer – I
(3-1-0) 4


CH253 Chemical Reaction Engineering – I
(2-1-0) 3


CH254 Fluid & Fluid Particle Systems Lab
(0-0-3) 2
Experiments based on Momentum Transfer and Particulate Technology.

CH261 Energy Technology
(3-0-0) 3


CH 300 Chemical Engg. Thermodynamics II (2-1-0) 3
Statistical Thermodynamics.

CH301 Chemical Reaction Engineering – II (3-1-0) 4

CH302 Mass Transfer – II (3-1-0) 4
Badger and Banchero - Introduction to Chemical Engineering.

CH303 Heat Transfer Operations Lab. (0-0-3) 2
Experiments based on Heat Transfer course.

CH311 Petroleum Engineering (3-0-0)3

CH312 Biochemical Engineering (3-0-0) 3

CH351 Process Dynamics & Control (3-1-0) 4

CH352 Simultaneous Heat & Mass Transfer (2-1-0) 3
CH354 Mass Transfer Operations Lab
Experiments based on Mass Transfer I & II.

CH355 Chemical Process Industries


CH361 Process Modeling & Simulation


CH362 Separation Processes


CH363 Fertilizer Technology


CH364 Risk and Safety Management in Process Industries


CH365 Introduction to Molecular Simulations

Allen, M. P., Tildesley, D. J. Computer Simulation of Liquids, Oxford University Press
Donald Allan McQuarrie, Statistical Mechanics, University Science Books.

CH 366 Electrochemical Engineering (3-0-0) 3

CH367 Energy Conservation and Management in Process industries (3-0-0)3

CH368 Fuel Cell Engineering (3-0-0)3
Overview of Fuel Cells: What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.
Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others.
Fuel cell electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents.
Fuel cell process design: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates, Fuel cell operating conditions: pressure, temperature, flow rates, humidity.
Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modeling.
Fuel processing: Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, CO2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal, Using renewable fuels for SOFCs
CH402 Process Design of Chemical Equipment (2-0-3)4
Detailed Chemical Engineering Process Design of the following equipments is to be carried out. Mechanical aspects of the design are not included here. Heat Exchangers; Packed and Tray towers for Absorption and distillation. Design of equipments mentioned above using simulation software.

CH403 C.R.E. & Process Control Lab (0-0-3) 2
Experiments based on Reaction Engg. I & II and Process Control courses.

CH411 Fermentation Technology (3-0-0) 3
Introduction, fermentors-principles and design, Manufacture of alcohol, pencillin, vitamins and other products.
Fermentation Technology, Whitaker.

CH412 Pollution Control & Safety in Process Industries (3-0-0) 3

CH465 Air Pollution Control and Design of Equipments (3-0-0) 3
Introduction. Air pollution laws and standards. Meteorological aspects of air pollutant dispersion, the Gaussian plume model, design of stacks and chimneys. Air pollution control methods and design of equipments- control of gaseous emissions. Air pollution control in specific industries.
Martin Crawford - Pollution control theory, , 1976, McGraw Hill, NY.
Joe Ledbetter - Air Pollution Part A&B, 1972, Marcel Dekker, NY.

CH440 Practical Training (0-0-2)1
This course is a one credit course. A student may complete the training before the beginning of 7th semester (or as stipulated by DUGC) and register for it in 7th semester. The duration and details shall be decided by the faculty advisor, with approval from DUGC.

CH448 Seminar (0-0-3) 2
This course is two credit courses to be completed during 7th semester. The student will make presentations on topics of academic interest.

CH449 Major Project - I (0-0-3) 2
The Students jointly or individually will be assigned an experimental or theoretical problem, to be carried out under the supervision of a guide. The project has to be completed in the VII & VIII semester. The students should complete the preliminary literature survey and experimental set up in the VII semester. Their work will be reviewed and evaluated.
CH499 Major Project – II  
Extension and completion of Major project -I started in the previous semester (CH449).

CH 263 Mineral Dressing Lab.  
Experiments based on Mineral dressing
Course Title: Engineering Economics
Course Code: HU 300
(L-T-P): (3-0-0)
Credits: 3
Category: HSC

Course description

The purpose of this course is to help students gain an understanding of the economic factors inherent in engineering design and decision-making. Any engineering project must be not only physically realizable but also economically feasible. The principal aim of this subject is to provide students with some basic techniques of economic analysis to understand the economic process.

Course objectives

The objectives of the course are to make students:

➢ Become acquainted with basic economic concepts such as demand and supply, price, competition, interest, taxes, profit, inflation, etc.
➢ Develop a significant understanding of the time value of money.
➢ Develop the ability to apply various methods for economic analysis of alternatives.
➢ Increase student’s knowledge of the impact that interest, taxes, inflation have on economic and engineering decisions.
➢ Develop the ability to estimate project cash flows for design alternatives including tax implications.
➢ Understand the fundamentals of profit and loss analysis and benefit –cost analysis.
➢ Become familiar with basic accounting statements and concepts such as balance sheets, income statements, depreciation methods, etc.
➢ Develop the ability to make replacement decisions.
➢ Basic understanding of project risk and uncertainty using sensitivity and break-even analysis.

Course contents


Methods of economic analysis in Engineering: including time value of money, equivalence, Interest calculations. Bases for comparison of alternatives- Present worth, Annual equivalent,
Future worth, Internal rate of return, Capitalized equivalent, Capital recovery with return. Selection among alternatives, Break-even analysis.

Evaluating replacement alternatives: Replacement analysis, the economic life of an asset, Retirement or abandonment decisions. Evaluating public activities: The nature of public activities, Benefit-cost analysis, Cost-effectiveness analysis.

Depreciation accounting: Basic depreciation methods. Basic terminology for Income taxes, Depreciation and Income taxes.


Relevant Case Studies

Texts / References:


Pedagogy

The instructional tools consists of lectures, reading concurrent articles, case studies, problem solving and group discussions.

Weightage for Assessments

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Weightage</th>
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<tbody>
<tr>
<td>Mid – Semester exams of 1 hour 30 minutes (50 Marks)</td>
<td>25%</td>
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<tr>
<td>Continuous Assessment</td>
<td>25%</td>
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<tr>
<td>End-Semester exams of 3 hours (100 Marks)</td>
<td>50%</td>
</tr>
<tr>
<td>(Full syllabus)</td>
<td>100%</td>
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</table>
Assessment

Surprise tests, quizzes, tutorials, assignments, class participation and group interaction will be considered for continuous assessment.

Attendance

Any leave of absence has to conform to regulations printed in the Curriculum.
Course Code: HU 302
(L-T-P): (3-0-0)
Credits: 3
Course Title: Principles of Management
Semester: NIL
Course Pre-requisite: NIL
Course Instructor: Dr. Bijuna C Mohan
bijunacm@gmail.com

Course Description

This course focuses on the foundation of management theory and provides an overview of management. Management is presented as a discipline and as a process. The course introduces the key issues of management from the essential skills to management ethics. Current trends in management theory and practice are examined, as well as the traditional functions of planning, organizing, leading and controlling. The course will involve an overview approach to covering the various concepts required for an overall understanding of management’s role in the contemporary organization.

Course Objectives

This is an introductory course in management theory and practices. Its main objectives are:

1. To introduce and enable students to comprehend the fundamental management concepts and the issues important to business.
2. To promote an understanding of how these management concepts and issues are applied to real business problems that students will face in their future career situations.
3. To sharpen the student’s ability to think, reason and to apply knowledge to solve real-life problems.
4. Enhance students’ interpersonal and communication skills to meet the challenges facing today’s management.
5. Encourage and support collaborative learning and teamwork as necessary management tools.

Course Contents

Management – Science, Theory and Practice,
Organizing: Nature, Entrepreneuring, Reengineering, organization structure, Departmentation, Line Staff Authority, Power, Empowerment, Decentralization, Effective organizing and Organization culture.


References:


Pedagogy

The instructional tools consist of lectures, reading concurrent articles, case studies and group discussions.

Assessment

Assignments, projects, group activities and involvement in class discussion will be considered for continuous assessment.

Weightage for Assessments

<table>
<thead>
<tr>
<th>Assessment Type</th>
<th>Weightage</th>
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<td>Mid – semester exams of 1 hour 30 minutes</td>
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<tr>
<td>Continuous Assessment</td>
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<tr>
<td>End – semester exams of 3 hours (Entire portions)</td>
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</table>

100%

Missing classes will hurt your participation grade. Note that the quality of your participation is what counts, not the amount you participate in each class. Switch off cell phones before you enter the class room.

Plagiarism, communicating with fellow students during an exam and other form of academic dishonesty will affect the grades.
Leave of Absence

Any leave of absence has to conform to regulations printed in Regulations in the curriculum.
Course Code : CH 200
Course title : Chemical Process Calculations
L-T-P : 2-2-0
Credits : 4
Category : PC
Teaching Department : Chemical Engineering

Course outcomes:

By the end of this course the student will be able to

- Mathematically represent the chemical reaction and transformations
- Interpret and analyze laws of conservation of energy and mass for the above.
- Perform material and energy balance on different unit operations of processes
- Extend the concept of material and energy balance for recycle, bypass, purge such complex systems.
- Thermo physics and thermo chemistry concepts and application of the same in energy balance calculations for different systems.
- Material and energy balance for various combustion processes.

Syllabus


Course Coverage:

<table>
<thead>
<tr>
<th>Contents</th>
<th>Approximate No. of Lecture Hours</th>
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<tbody>
<tr>
<td>Units and Dimensions</td>
<td>2</td>
</tr>
<tr>
<td>Mass relations (mole, weight, volume percentages and their application for various mixtures like solids, gases, liquids)</td>
<td>3</td>
</tr>
<tr>
<td>Concentration representations (density, equivalent weight, normality, molality and molarity etc for liquid mixtures)</td>
<td>3</td>
</tr>
<tr>
<td>Calculations involved in ideal gases and their mixtures</td>
<td>3</td>
</tr>
<tr>
<td>Material balance calculations using “Law of conservation of mass” for various unit operations at steady state and without chemical reactions (separation units)</td>
<td>5</td>
</tr>
<tr>
<td>Material balance calculations at steady state with chemical reactions</td>
<td>5</td>
</tr>
<tr>
<td>Material balance calculations involving recycling, bypassing and purging operations in the process units</td>
<td>5</td>
</tr>
</tbody>
</table>
Vapour pressure, partial pressure, saturation, and humidification concepts | 5
---|---
Material balance calculations in combustion processes | 3
Thermo physics and thermo chemistry concepts (for mixtures) | 5
Energy balance with sensible and latent heat for different mixtures | 3
Unsteady state operations (Mass balance) | 3

**Total** | **45**

**Reference Books:**


**Evaluation Plan**

End semester Exam : 50 %
Mid semester Exam : 25%
In-semester Evaluation:
Total : 25%
Assignments : 5%
Tests/Quzzies : 20 %
Seminars: Nil
Course Code: CH 201
Course Title: Momentum Transfer
L T P: 3-1-0
Credits: 04
Category: PC
Teaching Department: Chemical Engineering

Course Outcome

At the end of this course the student is expected to have learnt the following.

• Mathematically represent and analyze the basic laws governing fluid statics and dynamics
• Understand the significance of energy losses and their calculations in fluid flow systems
• Understand the basic issues related to fluid–solid systems
• Know various principles used for flow measurement and fluid transportation
• Develop semi empirical equations using dimensional analysis and understand their significance in the context of equipment design

Syllabus


Course Coverage:

1. Properties of fluids --- 05 hours
2. Fluid statics --- 08 hours
3. Principles of fluid motion --- 10 hours
4. Laminar and turbulent flows ---12 hours
5. Flow past immersed bodies --- 06 hours
6. Dimensional analysis --- 05 hours
7. Flow measurement --- 02 hours
8. Fluid transportation --- 02 hours
   Total --- 50 hours

Reference Books:

3. J M Coulson, J H Richardson, J R Backhurst and J H Harker, Chemical Engineering, Vol.1,
Pergamon, 6th Edition

Evaluation Plan

End Semester Examination: 50% marks
Mid Semester Examination: 30% marks
In Semester Evaluation: Total- 20% marks
Assignments: 03
Test: 01
Seminars: None
Course: Particulate Technology
Code: CH202
L-T-P: (3-1-0)
Credits: 4
Category: PC
Teaching Department: Chemical Engineering

Course Objective:

The main objective of the course is to introduce various upstream and downstream processes in chemical industries and to understand the fundamentals behind them, which is used to design them.

Course Outcome

By the end of this course the student will be able to:

- Understand the physical characteristics of solid particles in the context of size reduction and solid flow.
- Gain insight into relevant methods for the analysis of particle sizes
- Apply the science and engineering principles in the energy requirement for size reduction and understand the working principles of different size reducing equipments
- Acquire skills to select and apply the various principles in the design and application of various solid/liquid, solid/gas separation techniques in chemical process industries.

Syllabus


Solid and Solid Handling (13hrs)

Introduction
Particle Characterization: - Density, specific gravity, shape, size, sphericity, etc.
Size Analysis Technique: - cumulative analysis, differential analysis.
Industrial Screens: - Types based on driving system and mechanism, Effectiveness.
Size Reduction: - Principles, Mohr circle, laws of size reduction.
Size Reducing Equipments: - Crushers, Grinders, Ultrafine Grinders, Cutting Machines.

Solid-Liquid System (13hrs)

Introduction
Flow of solid through liquids, Terminal falling velocity, Raising velocity of light particles, Wall effect on particle dynamics, Bottom effect on particle dynamics, Effect of sphericity on particle dynamics, Added mass concept.

**Separation of Solid-Liquid Mixtures** (12hrs)


Thickeners: - *Introduction, Types, Design of thickener.*

Centrifugal Separation: - *Introduction, Types, Theory of centrifuge.*

Flotation: - *Introduction, types.*

Filtration: - *Introduction, Types of Industrial filtration, Theory of Filtration.*

**Mixing and Agitation** (4hrs)

*Introduction, Types, Impellers, Turbines, Baffles, theory of mixing.*

**Conveyors** (3hrs)

*Introduction, Types of conveyors.*

**References**

**Chemical Engineering**, Coulson and Richardson's, vol2

**Unit Operations Of Chemical Engineering**, Warren Lee McCabe

**Grading:**

Assignment 1 or surprise test carries 10% weightage, mid sem carries 30% weightage, Assignment-II or surprise test-II carries 10% weightage, End sem Carries 50% weightage. Attendance will be strictly followed based on the institute norms (pls verify academic dairy).
Course code : CH203  
Course title : TRANSPORT PHENOMENA;  
L-T-P : (2-2-0)  
Credits : 4  
Category : PC  
Teaching Department : Chemical Engineering

Learning outcomes
Students will gain knowledge about momentum, heat and mass transfer, which constitutes a foundation for applied courses in chemical science and chemical engineering education.

After passing the course the students will be able to:

- Write shell balance equations for transfer of momentum, heat and mass in one dimension.
- Specify appropriate boundary conditions.
- Solve the balance equations analytically with acquired knowledge in mathematics.
- Develop thinking capability to model a given problem in Momentum, Heat and Mass Transfer.
- Introduce suitable simplifications and assess the effects of the simplifications on model applicability
- Identify and solve simple cases of problems involving more than one independent variable.


Syllabus

Shell balances for momentum, energy and mass transfer. Introduction to general transport equations for momentum, energy and mass transfer in cartesian - cylindrical and spherical coordinates – simple solutions in one dimension. Simplification of general equations with time and spatial coordinates for momentum, energy, mass transport, boundary layer concepts of momentum energy and mass transport. Macroscopic balances for isothermal systems, nonisothermal systems and multi component systems.

Topics:

- Shell Momentum Balances and Velocity Distribution for Laminar Flow.
- The Equation of Change for Isothermal Systems.
• Velocity Distribution with more than One Independent Variable.
• The Conductivity and the Mechanism of Energy Transport.
• Shell Energy Balances and Temperature Distribution in Solids and Laminar Flow.
• The Equation of Change for Isothermal Systems.
• Temperature Distribution with More than One Independent Variable.
• Diffusivity and the Mechanisms of Mass Transfer.
• Concentration Distribution in Solids and Laminar Flow.
• Concentration Distribution with More than One Independent Variable.

Evaluation Policy:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Two Tests</td>
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<tr>
<td>Midterm Exam</td>
<td>30%</td>
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<tr>
<td>Assignments</td>
<td>10%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>50%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>
Course code : CH 211
Course title : Process Instrumentation
L-T-P : 3-0-0
Credits : 3
Category : PSE
Teaching department : Chemical engineering

Course outcomes:

By the end of this course the student will be able to

- Understand the significance of instrumentation in chemical processes and familiarize with scientific principles involved.
- Understand elements of a measurement system
- Realize the major engineering principles used in the measurement of flow, temperature, pressure, level etc.
- Understand the construction and operation of the process equipment and selection of suitable instrument

Syllabus

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Content</th>
<th>Approximate No of lecture hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction- Typical applications of instruments, functional elements, classification, microprocessor-based instrumentation, standards and calibration</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Temperature measurement- Scales, measurement, Non electrical and electrical methods, pyrometry, Moisture measurement</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Pressure measurement- Moderate, high pressure and vacuum, calibration and testing, level measurement- Radar, radiation, capacitive methods.</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Flow measurement – Primary meters, positive displacement, Secondary meters, Special meters</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>Viscosity measurement- capillary tube viscometer, efflux type and variable area viscometer.</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Conductivity meter and pH meter, Liquid chromatography- HPLC, Mass spectroscopy</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>Computer aided measurements, fiber optic transducers, microsensors, Data analysis</td>
<td>7</td>
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</table>

**Reference books:**

2. Instruments for engineering measurements, second edition, James W Dally, William F Riley and Kenneth G McConnell
3. Chemical Analysis, Modern Instrumentation Methods and Techniques, Francis Rouessac and Annick Rouessac
Course Code: CH250
Course title: Chemical Engineering Thermodynamics I
L-T-P: (2-1-0)
Credits: 3
Category: PC
Teaching Department: Chemical Engineering

Course outcome:

By the end of this course the student will be able to

- Understand the importance of various thermodynamic functions
- Apply the laws of Thermodynamics to analyze flow and non-flow processes
- Use thermodynamic data from tables, diagrams and generalized correlations for making calculations related to physical principles
- Understand and make calculations pertaining to energy conversion cycles, refrigeration cycles and cycles used for producing cryogenic temperatures

Syllabus


Course Coverage:

<table>
<thead>
<tr>
<th>Contents</th>
<th>Approximate No. of Lecture Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laws of Thermodynamics</td>
<td>10</td>
</tr>
<tr>
<td>Auxilliary thermodynamic functions(^1); Spontaneous approach to equilibrium</td>
<td>5</td>
</tr>
<tr>
<td>Thermodynamic relations</td>
<td>3</td>
</tr>
<tr>
<td>Equations of state and generalised correlations for compressibility factor</td>
<td>5</td>
</tr>
<tr>
<td>Generalised correlations for thermodynamic functions</td>
<td>3</td>
</tr>
<tr>
<td>Phase equilibrium, Thermodynamic tables and diagrams for pure systems</td>
<td>4</td>
</tr>
<tr>
<td>Use of thermodynamic data for analysis of flow and non-flow processes (^2)</td>
<td>7</td>
</tr>
<tr>
<td>Analysis of Energy conversion cycles</td>
<td>8</td>
</tr>
<tr>
<td>Analysis of refrigeration and cryogenic cycles</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50</strong></td>
</tr>
</tbody>
</table>

1 Including Availability function
2 Including an introduction to compressible flow

**Reference Books:**


**Evaluation Plan:**

- End semester Exam : 50%
- Mid semester Exam : 20%
- Insemester Evaluation: 30%
- **Total** : 100%
- Assignments : 5 problem sets; no assignments
- Class Tests : 3
- Seminars : None
Course Code: CH251
Course title: Heat transfer
Semester: IV Sem. B Tech Chemical Engineering
L-T-P: 3-1-0
Credits: 4
Category: PC
Teaching Department: Chemical Engineering

Course Outcomes

By the end of this course the student will be able to

- Differentiate the modes of heat transfer and apply mathematical equations governing the rate of heat transfer.
- Develop equations to describe steady and unsteady state heat conduction systems in one and multi-dimensions and to apply boundary conditions to solve the equations.
- Apply the science and engineering principles governing the heat transfer during the phase change.
- To understand principle of analogy of heat transfer to other transport processes.
- Apply fundamentals of heat transfer to design heat transfer equipments to satisfy the needs of the chemical engineering process applications.

Syllabus


Reference Books

Evaluation Plan

End semester Exam-50%
Mid semester Exam-25%
In-semester Evaluation: Total : 25%
  • Assignments : 10
  • Tests/Quzzies : 15

Courses Contents:

<table>
<thead>
<tr>
<th>Contents</th>
<th>Approximate No. of Lecture Hours</th>
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<tbody>
<tr>
<td>Introduction,</td>
<td>1</td>
</tr>
<tr>
<td>Modes of heat transfer, basic laws for conduction, convection and radiation, combined heat transfer processes</td>
<td>5</td>
</tr>
<tr>
<td>Steady state conduction-conduction through plane ,curved surfaces-derivations of relations-multilayer walls, problems various types – transient conduction with infinite K ,and finite K-insulation- critical thickness of insulation –heat transfer with heat generation.</td>
<td>10</td>
</tr>
<tr>
<td>Heat transfer with change of phase- conduction- condensation- Nusselt’s equation derivation- boiling heat transfer- correlations radiation heat transfer type of radiation bodies- Kirchhoff’s law – view factor calculation- radiation exchange between gray bodies- radiation shield- radiation from flames- gases temperature measurement and radiation errors.</td>
<td>8</td>
</tr>
<tr>
<td>Process design of heat exchangers like D.P.H.E, shell and tube heat exchanger and condensers .simple designs only.</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>47 Hours</strong></td>
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</tbody>
</table>
Course Code: CH 252  
Course title: Mass transfer - I  
L-T-P: 3-1-0  
Credits: 4  
Category: PC  
Teaching Department: Chemical Engineering

Course outcomes:

By the end of this course the student will be able to

- Understand the principles involved in mass transfer and concepts of inter phase mass transfer.
- Derive and develop expressions for diffusive, convective mass flux and rate of mass transfer
- Understand the working of continuous and differential contactors for mass transfer operations
- Design tray tower and packed tower contactors for mass transfer.
- Understand the equilibrium characteristics, working principles, and application of absorption and adsorption processes.
- To determine the height of packed bed adsorber from the breakthrough curve

Course Coverage:

<table>
<thead>
<tr>
<th>Contents</th>
<th>Approximate No. of Lecture Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Mass Transfer operations and separation techniques</td>
<td>4</td>
</tr>
<tr>
<td>Mass transfer principles including equilibrium and non-equilibrium operation</td>
<td>2</td>
</tr>
<tr>
<td>Diffusion mechanism</td>
<td>5</td>
</tr>
<tr>
<td>Convective mass transport and mass transfer coefficient</td>
<td>3</td>
</tr>
<tr>
<td>Analogics</td>
<td>3</td>
</tr>
<tr>
<td>Inter phase mass transport and overall mass transfer coefficient concept</td>
<td>5</td>
</tr>
<tr>
<td>Mass transfer theories (Film, penetration, surface renewal theories etc.)</td>
<td>5</td>
</tr>
<tr>
<td>Stage concepts and cascades including co-current, counter-current and cross current operation with equilibrium characteristics representation</td>
<td>5</td>
</tr>
<tr>
<td>HTU, HETP and NTU concepts for gas/liquid dispersing equipments</td>
<td>3</td>
</tr>
<tr>
<td>Classification and of Gas-liquid contactors and their working and design principles</td>
<td>2</td>
</tr>
<tr>
<td>Equilibrium characteristics, working principles, and application of Absorption and desorption processes</td>
<td>7</td>
</tr>
<tr>
<td>Equilibrium characteristics, working principles, and application of Adsorption processes</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>51</td>
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</table>

**Reference Books:**


**Evaluation Plan:**

End semester Exam: 50%, Mid semester Exam: 25%, In-semester Evaluation: 25% (Assignments: 5%, Tests/Quizzes: 20%, seminars: Nil)
Learning outcomes

Students will gain knowledge about the importance of chemical kinetics, interpreting kinetic data and understand how to design Ideal reactors under isothermal conditions for various reactions, which is essential in chemical engineering education.

After completing the course the students will be able to:
Interpret experimental kinetic data and find out the rate equation for the given reaction.

- Interpret experimental kinetic data and mathematically represent the rate equation for homogeneous chemical reactions
- Develop design equations for ideal reactors. h reactor, CSTR or PFR for isothermal conditions.
- Analyse a given reaction system and be able to use multiple reactors where appropriate.
- Able to design appropriate reactor system for multiple reactions to maximize product yield.

Syllabus


Topics:
- Thermodynamics and Reaction Kinetics
- Interpretation of Batch Reactor data
- Flow Reactors: CSTR & PFR
- Multiple Reactors
- Multiple Reactions

Evaluation Policy:

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Two Tests</td>
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<tr>
<td>Midterm Exam</td>
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<td>Assignments</td>
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<tr>
<td>Final Exam</td>
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<td>Total</td>
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</table>
Course Code : CH 254  
Course title : Fluid and Fluid Particles Systems Lab  
L-T-P : (0-0-3)  
Credits : 2  
Category : PC  
Teaching Department : Chemical Engineering

Course outcomes

By the end of this course the student will be able to

- To apply the momentum transfer fundamentals to plan and conduct the experiments
- To gain hands on experience and visualization of the working principles of pumps, flow meters, valves and pipe fittings.
- To gain the experience into the relevant methods for the size reduction, separation and size analysis of particulate systems.
- To plan and conduct experiments on laboratory scale systems generate, analyze and interpret the experimental data
- To acquire skills for technical report preparation with relevant conclusions
- To demonstrate skills to work in a team

Syllabus

Experiments based on Momentum Transfer and Particulate Technology

Course Coverage:

<table>
<thead>
<tr>
<th>Contents</th>
<th>Approximate No. of Laboratory Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow through pipes and fittings</td>
<td>03</td>
</tr>
<tr>
<td>Flow through orificemeter &amp; Flow through Rotameter</td>
<td>03</td>
</tr>
<tr>
<td>Flow through packed bed</td>
<td>03</td>
</tr>
<tr>
<td>Flow through fluidized bed</td>
<td>03</td>
</tr>
<tr>
<td>Characteristics of a centrifugal pump</td>
<td>03</td>
</tr>
<tr>
<td>Screen effectiveness &amp; Air permeability</td>
<td>03</td>
</tr>
<tr>
<td>Jaw crusher</td>
<td>03</td>
</tr>
<tr>
<td>Air elutriation</td>
<td>03</td>
</tr>
<tr>
<td>Batch sedimentation</td>
<td>03</td>
</tr>
<tr>
<td>Leaf filter</td>
<td>03</td>
</tr>
<tr>
<td></td>
<td>Total 30</td>
</tr>
</tbody>
</table>
Reference Books:

1. Unit operations in Chemical Engineering by McCabe and Smith, McGraw Hill.
2. Chemical Engineering by Richardson and Coulson, Butterworth-Heinmann Ltd.

Evaluation Plan:

End semester Exam: 30 %
Mid semester Exam: Nil
In semester Evaluation: Total: 70 % (Assignments: Nil, Tests/Quizzes: Nil,
                Records & experimental result analysis: 60 %
                Conducting the experiment: 10 %)
Course code: CH 261
Course title: Energy Technology
L-T-P: 3-0-0
Credits: 3
Category: OE
Teaching department: Chemical engineering

Course outcomes:

By the end of this course the student will be able to

- Acquire knowledge of current energy scenario and influence of policies on society, environment and public health.
- Familiarize with the scientific principles in energy conversion.
- Understand engineering principles involved in harnessing energy from renewable and fossil fuel energy sources.
- Understand various technologies and issues in energy conversion.
- Identify and select appropriate technologies for a given location.

Syllabus


Course coverage:

<table>
<thead>
<tr>
<th>S.No</th>
<th>Contents</th>
<th>Approximate No. of lecture hours</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Conventional energy – Solid fuels- biomass, charcoal formation, coal- types of coal, composition and analysis of coal- ultimate and proximate analysis; properties of coal- high and low CV, coking index, swelling index, coal carbonization – low and high temperature reactors, coal gasification- producer gas, water gas reactions and zones</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Liquid fuels- petroleum, fractionation, and refinery processes-cracking- FCC, purification, acid treating, hydrogenation, isomerization, polymerization; properties of liquid fuels; storage.</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Gaseous fuel- LPG, bio gas, Combustion fundamentals, Excess air, flue gas calculations, chimney height and draught, adiabatic</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>flame temperature calculations, fluidized bed combustion, furnaces</td>
<td></td>
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<tr>
<td>---</td>
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<td>---</td>
</tr>
<tr>
<td>4</td>
<td>Efficient energy utilization, waste as fuel steam and gas cycles, recuperative heat exchangers, selection of energy recovery methods, energy auditing, pinch technology-basics.</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>Renewable energy sources- Solar energy- solar collectors, types of collectors, concentration ratio calculation; Wind mills- types, efficiency calculation</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>40</td>
</tr>
</tbody>
</table>

**Reference books:**

1. Energy efficiency for engineers and technologists- T.D.Eastop and D.R. Croft, Published by Longman Pub Group, 1990
2. Fuels and combustion- Samir sarkar, Gyan books pvt Ltd.
Course Code: CH300
Course title: Chemical Engineering Thermodynamics II
L-T-P: 2-1-0
Credits: 3
Category: PC
Teaching Department: Chemical Engineering

Course outcomes

By the end of this course the student will be able to understand

- Concepts related to non-ideal systems and apply them to chemical engineering problems.
- Concepts related to Phase equilibrium and apply them to single and multi-component systems.
- To generate vapor liquid equilibrium data and evaluate the consistency of the data.
- The macroscopic properties of thermodynamics systems through microscopic analysis of the components.
- The basic concepts of statistical thermodynamics and their usefulness.

Syllabus


Course Coverage:

<table>
<thead>
<tr>
<th>Contents</th>
<th>Approximate No. of Lecture Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fugacity, Fugacity coefficient, Activity, Activity Coefficient, Chemical Potential</td>
<td>10</td>
</tr>
<tr>
<td>Solution Properties: Partial Molar Properties, Property Change of Mixing, Excess Properties</td>
<td>15</td>
</tr>
<tr>
<td>Phase Equilibria: Phase equilibria, criterion of stability, Phase rule, Phase equilibria in single and multicomponent systems, Vapor – liquid equilibrium for binary systems, phase diagrams,</td>
<td>15</td>
</tr>
<tr>
<td>Statistical thermodynamics: Macroscopic and micropsopic properties of thermodynamics, probability theory, quantum mechanics and kinetics theory of particles statistical analysis of particles, degeneracy, Bose Einstein theory, Maxwell Botlzman and Fermi Dirac distribution of particles.</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
</tr>
</tbody>
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Reference Books:


Evaluation Plan:

- End semester Exam 50%
- Mid semester Exam 30%
- Insemester Evaluation Total 20 %
- Assignments 10 %
- Tests/Quzzies 10 %
- Seminars --
Course Code: CH301  
Course Title: CHEMICAL REACTION ENGINEERING -II  
L-T-P: (3-1-0)  
Credits: 4  
Category: PC  
Teaching Department: Chemical Engineering

Learning outcomes

Students will gain knowledge about non ideal flow in reactors, thermal effects in reactors and also about heterogeneous reactions, which is essential in chemical engineering education.

By the end of this course the student will be able to:

- Understand the issues related to non-ideal flow and use them in the context of design of process vessels
- Understand the issues related to thermal design of reactors in the context of energy conservation and safety
- Develop kinetic rate equations for heterogeneous catalytic and non-catalytic reactions.
- Know various types of reactors used to carry heterogeneous reactions.

Syllabus


Textbooks:


Prerequisite: Understanding of Interpretation of kinetic data, Ideal Reactors, multiple reactors and multiple reactions.

Topics:
- Non-Ideal Flow in Reactors.
- Thermal effects in Batch, CSTR and Plug Flow Reactors.
- Heterogeneous Reactions, Non-catalytic.
- Heterogeneous Reactions, Catalytic.

Evaluation Policy:

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<tbody>
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<tr>
<td>Assignments</td>
<td>10%</td>
</tr>
<tr>
<td>Final Exam</td>
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<tr>
<td>Total</td>
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</table>
Course Code: CH 302  
Course title: Mass Transfer II  
L-T-P: 3-1-0  
Credits: 4  
Category: PC  
Teaching Department: Chemical Engineering

Course outcomes

By the end of this course the student will be able to

- Understand the principles and applications of distillation, leaching and extraction
- Understand and apply the concepts of multiphase equilibrium; acquire knowledge to generate and predict the equilibrium data
- Understand the application of scientific and engineering principles in the separation of components by different mass transfer operations
- Select and design suitable equipments for mass transfer operations.

Syllabus


Course Coverage

<table>
<thead>
<tr>
<th>Contents</th>
<th>Approximate No. of Lecture Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Concepts of vapor –liquid equilibria,P-xy and T-xy diagrams,relative volatility,Raoults law applications,deviation from ideality, azeotropes – different types,Enthalpy concentration diagrams,Multicomponent systems-calculations,principles of distillation-single stage operations –flash vaporization-partial condensation-simple distillation-differential condensation,steam distillation</td>
<td>10</td>
</tr>
<tr>
<td>Continuous rectification-Binary system fractionation operations-equipments-Ponchon Savarit method-calculations for entire fractionator.Feed tray location-minimum reflux ratio-total reflux conditions-multiple feeds-side stream calculations</td>
<td>8</td>
</tr>
<tr>
<td>McCabe Thiele method-concepts of equimolal overflow and vaporization-calculation of ideal stages for different situation like total condenser-partial condenser-reflux at bubble point,subcooled etc,feed tray calculation, q-line concept, location of feed tray,minimum reflux ratio,calculations for total</td>
<td>10</td>
</tr>
</tbody>
</table>
reflux, open steam use and calculations for such situations, multiple feeds and side stream problems
Rectification of azeotropic mixtures

Tray efficiencies, packed bed distillation – introduction to transfer unit concept, Introduction to multicomponent distillation

Liquid extraction applications - equilibria - ternary systems. Triangular and other coordinates - choice of solvent - problems on single stage and multistage cross current and countercurrent contactor - extraction with reflux - problems on fractional extraction, equipments for liquid liquid extraction - mechanism and design criteria

Leaching - concepts and applications - solid preparation methods of leaching operations - Shank’s system - equipments for leaching operation, equilibria, batch and multistage cross current and countercurrent leaching operations - problems

<table>
<thead>
<tr>
<th></th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>49 Hrs</td>
</tr>
</tbody>
</table>

Reference Books:

2. Robinson and Gilliland - Elements of fractional distillation - McGray Hill
3. J.M. Coulson and J.F. Richardson - Chemical Engineering vol 2, Pergamon press
4. McCabe and Smith - Unit operations in Chemical Engg. - McGray Hill
5. Van Winkle - Distillation, McGray Hill

Evaluation Plan:

End semester Exam - 50%
Mid semester Exam - 25%
Insemester Evaluation: Total : 25%
  - Assignments: 10
  - Tests/Quzzies : 15
Course Code : CH303
Course title : Heat Transfer Operation Lab
L-T-P : 0-0-3
Credits : 2
Category : PC
Teaching Department : Chemical Engineering

Course outcomes:

By the end of this course the student will be able to

- To apply the Heat Transfer fundamentals to plan and conduct the experiments
- To gain hands on experience and visualization of the working principles of Heat transfer equipments, auxiliary units and utilities.
- To plan and conduct experiments on laboratory scale systems generate, analyze and interpret the experimental data
- To acquire skills for technical report preparation with relevant conclusions
- To demonstrate skills to work in a team

List of Experiments

S.No  Experiment

1. Thermal Conductivity Of Insulating Powder
2. Thermal Conductivity Of Liquid (Guarded Plate Method)
3. Transient Conduction With Constant Heat Flux
4. Stefan Boltzmann Apparatus
5. Natural And Forced Convection In Air
6. Natural And Forced Convection In Water
7. Heat Losses By Combined Convection And Radiation (For Cylinder And Sphere)
8. Pool Boiling Apparatus
9. Heat Transfer Through Coils
10. Double Pipe Heat Exchanger
11. Spiral Plate Heat Exchanger
12. Packed Bed Heat Exchanger
13. Vertical And Horizontal Condensor
14. Shell and Tube Heat Exchanger

Evaluation Plan:

End semester Exam-:40 %; In-semester Evaluation: 60%  (Conducting Experiments: 20%; Calculation and interpretation of data : 20%; Record preparations: 20%)
Course Code : CH 311
Course title : Petroleum Engineering
L-T-P : 3-0-0
Credits : 3
Category : OE
Teaching Department : Chemical Engineering

Course outcomes:

By the end of this course the student will be able to

- Understand the basic principles and the development of energy policies for sustainable development
- Acquire knowledge on the scientific principles involved in fossil fuel formation and their characterization.
- Understand the various unit operations/processes involved in the pre-treatment and refining of petroleum.
- Familiarize with the design principles and operating conditions of important unit operations involved in refining of petroleum.
- Familiarize with the issues on risk and safety with respect to storage transport and handling of crude and petro products

Syllabus


Course Coverage:

<table>
<thead>
<tr>
<th>Contents</th>
<th>Approximate No. of Lecture Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude oil occurrence, composition, classification, properties</td>
<td>5</td>
</tr>
<tr>
<td>Crude oil Evaluation</td>
<td>3</td>
</tr>
<tr>
<td>Impurities present in the crude and pre-treatment processes</td>
<td>3</td>
</tr>
<tr>
<td>Refinery products and their specifications</td>
<td>2</td>
</tr>
<tr>
<td>Crude oil Refining operations: ADU, VDU, Thermal cracking, Catalytic cracking, Hydro cracking, Vis-breaking, lube oil processing and related reactions.</td>
<td>10</td>
</tr>
<tr>
<td>Product treatment processes: polymerization, Isomerisation, Hydro treating processes and their reactions</td>
<td>6</td>
</tr>
<tr>
<td>Additives used in different petro-products and their functions</td>
<td>3</td>
</tr>
<tr>
<td>Crude and petro-products Storage and handling techniques</td>
<td>3</td>
</tr>
<tr>
<td>---------------------------------------------------------</td>
<td>----</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
</tr>
</tbody>
</table>

**Reference Books:**


**Evaluation Plan:**

End semester Exam:- 50 %
Mid semester Exam: 25%
In-semester Evaluation: Total: 25 %
Assignments: 5 %
Tests/Quzzies: 20 %
Course Code : CH312
Course title : Biochemical Engineering
L-T-P : 3-0-0,
Credits : 3
Category : PSE
Teaching Department : Chemical Engineering

Course outcomes

By the end of this course the student will be able to

- Apply the knowledge of chemical engineering principles to biological systems.
- Understand the role of microorganisms and their metabolism for bioprocess development.
- Analyze and interpret kinetic nature of a given biological system and learn principles of bioreactor design.
- Develop mathematical model of growth and production kinetics

Syllabus


Course Coverage:

<table>
<thead>
<tr>
<th>Content</th>
<th>Lecture hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to biochemical engineering and its applications</td>
<td>1</td>
</tr>
<tr>
<td>Role of microbes and microbiology in development of biochemical engineering. Types of organisms, their nomenclature.</td>
<td>2-4</td>
</tr>
<tr>
<td>Chemicals of life, proteins, lipids, carbohydrates</td>
<td>5-6</td>
</tr>
<tr>
<td>Enzymes as biocatalysts and comparison with chemical catalysts, examples on enzyme catalyzed reactions</td>
<td>7-9</td>
</tr>
<tr>
<td>Enzyme catalysed reactions and kinetics associated with them. Examples on enzyme kinetics</td>
<td>10-18</td>
</tr>
<tr>
<td>Basics of cell death kinetics and its application to Sterilization process development, e.g., batch and continuous. Examples on cell death kinetics and sterilization process development</td>
<td>19-25</td>
</tr>
</tbody>
</table>
Introduction to medium formulation for microorganisms and types of media used. Examples on media development from using stoichiometry of biological reaction 26-33

Growth kinetics of microorganisms in various bioreactor configurations. Various yield coefficients and its importance in media development. Examples on growth kinetics. 34-44

Introduction to downstream processing and unit operations used in downstream processes. Examples on downstream processing 45-48

Reference Books:

- Biochemical Engineering Fundamentals, James Edwin Bailey, David F. Ollis, 2nd Edn, McGraw-Hill, USA
- Bioprocess Engineering Principles, Pauline M. Doran, Academic Press
- Bioprocess Engineering, Michael L. Shuler, Fikret Kargi, Prentice Hall PTR

Evaluation Plan:

End semester Exam----50%; Mid semester Exam- ---25%, Insemester Evaluation: Total : 25%

( Assignments: 0, Tests/Quizzes : 2, Seminars: 0)
Course Code: CH351
Course title: Process Dynamics and Control
Credit: (3-1-0)
Credits: 4
Category: PC

Course Description: Design and analysis of feedback control systems in chemical and natural systems. Topics include formulation of dynamic models, time and Laplace domain analysis of open-loop and closed-loop systems, and design of single variable and multivariable controllers.

Course Objective: The main objective of the course is to teach design methodology of control strategies of chemical process and analysis of closed loop system.

Course Outcome: Upon completion of this course, students should:

- Apply the physico-chemical principles to develop the mathematical model to represent the process dynamics
- apply the mathematical principles to predict and analyze the transient response of the systems
- understand the limitations and advantages of various control strategies in chemical process
- Acquire skills in the design and development of controllers for chemical engineering systems.

Syllabus


Topics to be covered:

1. Introduction, Control objectives and benefits
2. Process Dynamics
3. Modes of Controller and its response
4. Laplace Transform
5. Open loop first order system and its transfer function
6. Transient response of first order system
7. First order system in series and parallel
8. Open loop second order system and its transfer function
9. Transient response of 2nd order system
References


Course Code : CH352
Course title : Simultaneous Heat and Mass Transfer
L-T-P : 2-1-0
Credits : 3
Category : PC
Teaching Department : Chemical Engineering

Course outcomes

By the end of this course the student will be able to gain

- Gain knowledge on the scientific and engineering principles of unit operations in chemical engineering processes involving both heat and mass transfer (Evaporation, Crystallization, Humidification and drying).
- Gain the skills in the use of charts monograms and other resources for extracting required data.
- Familiarize with the mathematical analysis of engineering principles involved in the unit operations.
- Understand the selection criteria for choosing particular equipment for specific application in chemical process industries.
- Develop skills in the processes design of equipments used for Evaporation, Crystallization, Humidification and drying.

Syllabus

Evaporation -Concept and applications. Humidification and Dehumidification. Crystallisation. Drying Operations

Course Coverage

<table>
<thead>
<tr>
<th>Contents</th>
<th>Approximate No. of Lecture Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principles of boiling of liquids, different modes and type of evaporators. Concepts of evaporation capacity, heat transfer coefficients, temperature difference summary, boiling point raise, circulation of liquor, hydrostatic head etc. in industrial evaporators. Evaporator accessories. Working principles of single and multiple effect evaporators. Evaporation by thermocompression.</td>
<td>15</td>
</tr>
<tr>
<td>Concepts of supersaturation, Meir’s Theory, types of crystals and crystallizers. Types, nucleation, crystal habit, crystal growth, size distribution of crystals, Delta L law of crystal growth and its significance. MSMPR crystallizer.</td>
<td>10</td>
</tr>
</tbody>
</table>
### Principles of drying, drying conditions, drying rates, drying material. Types of moisture content, types of drying and design of some industrial dryers. Special trying techniques.

10

### Concepts of humidification and dehumidification processes. Wet bulb theory, Psychometric Chart, Adiabatic cooling lines and Lewis Relationship. Design aspects of air conditioners and cooling towers.

10

### Total

45

---

**Reference Books:**

2. Unit Operations of Chemical Engineering by W L McCabe, Peter Harriot and J C Smith McGraw Hill (1976)

**Evaluation Plan:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Weightage</th>
</tr>
</thead>
<tbody>
<tr>
<td>End semester Exam</td>
<td>50%</td>
</tr>
<tr>
<td>Mid semester Exam</td>
<td>30%</td>
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</tbody>
</table>

**Insemester Evaluation:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Weightage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments</td>
<td>10%</td>
</tr>
<tr>
<td>Tests/Quizzes</td>
<td>10%</td>
</tr>
<tr>
<td>Seminars</td>
<td>--</td>
</tr>
</tbody>
</table>

Total: 20%
Course Code: CH354
Course title: Mass Transfer Operations Lab
L-T-P: 0-0-3
Credits: 2
Category: PC
Teaching Department: Chemical Engineering

Course outcomes:

By the end of this course, the student will be able to

- Apply the mass transfer fundamentals to plan and conduct the experiments
- Gain hands-on experience and visualization of the working principles of mass transfer equipment, auxiliary units, and utilities.
- Plan and conduct experiments on laboratory scale systems; generate, analyze, and interpret the experimental data
- Acquire skills for technical report preparation with relevant conclusions
- Demonstrate skills to work in a team

Syllabus:

Experiments based on Mass Transfer I & II.

List of Experiments:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Atmospheric Tray Drier</td>
</tr>
<tr>
<td>2.</td>
<td>Batch Adsorption</td>
</tr>
<tr>
<td>3.</td>
<td>Counter Current Leaching</td>
</tr>
<tr>
<td>4.</td>
<td>Cross Current Leaching</td>
</tr>
<tr>
<td>5.</td>
<td>Diffusivity</td>
</tr>
<tr>
<td>6.</td>
<td>Packed Bed Distillation</td>
</tr>
<tr>
<td>7.</td>
<td>Simple Distillation</td>
</tr>
<tr>
<td>8.</td>
<td>Steam Distillation</td>
</tr>
<tr>
<td>9.</td>
<td>Surface Evaporation</td>
</tr>
<tr>
<td>10.</td>
<td>Vapour Liquid Equilibrium</td>
</tr>
</tbody>
</table>

Evaluation Plan:

End semester Exam: 40%
In-semester Evaluation: 60% (Conducting Experiments: 20%; Calculation and interpretation of data: 20%; Record preparations: 20%)
Course Code: CH355
Course title: Chemical Process industries
L-T-P: 3-0-0
Credits: 3
Category: PC
Teaching Department: Chemical Engineering

Course outcomes

By the end of this course the student will be able to

- Apply the knowledge acquired in unit operations and unit processes in the development of industrial scale processes
- Apply the knowledge of process design in the context of industrial process to meet desired specifications
- Identify individual unit operations for a given chemical process and connect them to demonstrate entire process flow.
- Assess the role of safety and pollution control in chemical industries.
- Understand contemporary issues related to energy and environment in chemical process industries.

Syllabus


Course Coverage:

<table>
<thead>
<tr>
<th>Content</th>
<th>Approximate Lecture hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Chemical Process Industries, various unit processes and unit operations</td>
<td>1</td>
</tr>
<tr>
<td>Sulfur and sulphuric acid: sulphur manufacturing of sulfur, sulfuric acid from sulfur, sulfur pollution</td>
<td>2-4</td>
</tr>
<tr>
<td>Nitrogen industries: Manufacturing of synthetic ammonia, inorganic ammonium compounds, urea</td>
<td>5-7</td>
</tr>
<tr>
<td>Potassium industries: manufacturing of various inorganic potaasium containing chemicals</td>
<td>8-10</td>
</tr>
<tr>
<td>Phosphorus industries: Manufacturing of various phosphorus compounds</td>
<td>11-13</td>
</tr>
<tr>
<td>Chlor-alkali industries: Manufacturing of soda ash, chlorine, caustic soda</td>
<td>14-16</td>
</tr>
</tbody>
</table>
Pulp and paper industries | 17-18
Manufacturing of soap, detergents and glycerine | 19
Industrial gases | 20
Food industries: food processing, food by-products | 21-23
Water production | 24
Cement and lime industries | 25-27
Manufacturing of dyes, polymerization technology | 28-29
Coal and coal chemicals | 30-32
Synthetic organic chemical industries | 33-36

Reference Books:


Evaluation Plan:

End semester Exam----50%
Mid semester Exam- ---25%
Insemester Evaluation: Total :  25%
  Assignments: 0
  Tests/Quzzies : 4
  Seminars: 0
Course Code : CH361
Course title : Process Modelling and Simulation
L-T-P : (3-1-0)
Credits : 4
Category : PSE
Teaching Department : Chemical Engineering

Course outcome:

By the end of this course the student will be able to

- Formulate mathematical models for different Chemical Engineering systems involving steady and unsteady state, lumped and distributed parameter systems from the basics of balance laws, transport equations, thermodynamics, chemical kinetics using suitable assumptions
- Identify and choose appropriate numerical methods for solving different types of model equations.
- Write algorithms for solving the models
- Simulate different steady state and unsteady state systems by solving the model equations using appropriate software tools.

Syllabus


Course Coverage:

<table>
<thead>
<tr>
<th>Contents</th>
<th>Approx. No. of Lecture hours Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to the course</td>
<td>1</td>
</tr>
<tr>
<td>Benefits and Limitations of /Precautions in Modeling</td>
<td>1</td>
</tr>
<tr>
<td>Strategy of model building</td>
<td>2</td>
</tr>
<tr>
<td>Classification of models, General classification, Classification of Transport phenomena models- Deterministic vs stochastic models Linear vs nonlinear, Steady state vs unsteady state, Lumped parameter vs distributed parameter. Basis for mathematical model equations</td>
<td></td>
</tr>
<tr>
<td>Classification based on stratum of detail of physicochemical principles</td>
<td>5</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>---</td>
</tr>
<tr>
<td>Numerical solutions of mathematical equations</td>
<td>6</td>
</tr>
<tr>
<td>Lumped parameter systems (steady state and unsteady state)</td>
<td>16</td>
</tr>
<tr>
<td>Vapor-liquid equilibrium models-multipoint dew point and flash calculations, boiling operations</td>
<td></td>
</tr>
<tr>
<td>Batch and continuous distillation</td>
<td></td>
</tr>
<tr>
<td>Tank models-Basic tank model, tank with flow rate as a function of level, mixing tank, stirred tank with heating jacket, CSTR with multiple series parallel reactions, chlorination of Benzene, autocatalytic reactions, order of magnitude analysis, Nonisothermal CSTR-multiplicity and stability-Van heedren stability criteria-proportional control of CSTR at the unstable steady state.</td>
<td></td>
</tr>
<tr>
<td>Non ideal CSTR models-Models with dead space and bypassing, estimation of model parameters</td>
<td></td>
</tr>
<tr>
<td>Distributed parameter models (steady state)</td>
<td>8</td>
</tr>
<tr>
<td>Solution of split boundary value problems –shooting techniques, quasilinearisation solution; countercurrent heat exchanger, tubular reactor with axial dispersion, countercurrent gas absorber, pipe line gas flow, tubular permeation process, pipe line flasher, packed bed catalytic reactor</td>
<td></td>
</tr>
<tr>
<td>Unsteady state Distributed parameter models(one dimension)</td>
<td>6</td>
</tr>
<tr>
<td>Solution of partial differential equations using finite difference method-convection problems, explicit and implicit centered difference methods; diffusive problems, Crank-Nicolson finite difference scheme; combined convective and diffusive problems. Examples- Unsteady state conduction and diffusion, unsteady state heat exchangers, unsteady state gas absorbers, dynamics of a tubular reactor with dispersion</td>
<td></td>
</tr>
<tr>
<td>Stochastic models</td>
<td>4</td>
</tr>
</tbody>
</table>

**Total** 49

**Reference Books:**


Evaluation Plan:

Assignments/quizzes/Tests  25
Mid semester examination  25
End semester examination  50
Course code : CH362  
Course Title : Separation Processes  
L-T-P : 3-1-0  
Credits : 4  
Pre-requisite : Nil  
Course Instructor : Dr. Vidya Shetty K  
Teaching Department : Chemical Engineering  

Course Outcomes: 
By the end of this course the student will be able to  

By the end of this course the student will be able  

- To understand the importance, working principles and limitations of various advanced separation processes for various Chemical Engineering applications.  
- To develop and analyse the mathematical equations governing the performance of equipment used for the selected advanced separation processes  
- To understand and apply basic design criteria for equipment used for the selected advanced separation processes  

Course Coverage:  

<table>
<thead>
<tr>
<th>Contents</th>
<th>Approx. No. of Lecture and tutorial hours Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Separation Processes</td>
<td>2</td>
</tr>
<tr>
<td>Membrane separation processes</td>
<td></td>
</tr>
<tr>
<td>Different membrane separation processes and their applications, Types of membrane, Membrane modules, Membrane Gas separation, Microfiltration, Ultrafiltration, Nanofiltration, Reverse Osmosis, Pervaporation, Membrane fouling</td>
<td>23</td>
</tr>
<tr>
<td>Adsorption and Ion Exchange based separations</td>
<td>6</td>
</tr>
<tr>
<td>Surfactant based separations</td>
<td>6</td>
</tr>
<tr>
<td>External field induced separations.</td>
<td>6</td>
</tr>
<tr>
<td>Supercritical fluid extraction</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>49</td>
</tr>
</tbody>
</table>

Reference Books:  

• M.C. Porter, Hand Book of Industrial Membrane Technology, Noyes Publication, Park Ridge, New Jersey. 1990

Evaluation Plan:

Assignments/ quizzes/ Tests  25
Mid Semester examination  25
End semester examination  50
Course Code : CH364
Course title : Risk and Safety Management in Process Industries
L-T-P : 3-0-0
Credits : 3
Category : PSE
Teaching Department : Chemical Engineering

Course outcomes:

By the end of this course the student will be able to

- Understand general concepts on Hazard and Risk in chemical process industries.
- Evaluate Hazard and Risk both quantitatively and qualitatively (what if, HAZOP analysis, FTA, ETA)
- Understand the hazards arising from Fire, Explosion and toxic gas dispersion
- Acquire skills for preparation of onsite and offsite emergency plans, safety audit and use of personal protective equipments
- Learn various legislations and Acts on Risk and Safety management

Syllabus


Evaluation Plan:

- End semester Exam: 50%
- Mid semester Exam: 30%
- Insemester Evaluation: 20%

Course Coverage:

<table>
<thead>
<tr>
<th>Contents</th>
<th>Approximate No.of Lecture Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Risk and Safety</td>
<td></td>
</tr>
<tr>
<td>Differentiation between HAZARD and Risk</td>
<td></td>
</tr>
<tr>
<td>Lessons from past disasters</td>
<td>05</td>
</tr>
<tr>
<td>HAZARD identification methodologies- Checklist, what if, HAZOP</td>
<td>08</td>
</tr>
<tr>
<td>Risk quantification methods - ETA, FTA</td>
<td>08</td>
</tr>
<tr>
<td>Fire, Fire chemistry, classification, Extinguishers</td>
<td>05</td>
</tr>
<tr>
<td>Explosion, VCE, Dust, BLEVE</td>
<td>05</td>
</tr>
<tr>
<td>Topic</td>
<td>Score</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Toxic gas dispersion models</td>
<td>05</td>
</tr>
<tr>
<td>Safety Audit, use of PPE, onsite/offsite emergency plan, Reliability, Transportation of hazardous materials, ware house safety</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>46</strong></td>
</tr>
</tbody>
</table>

**Reference Books:**

**Course Code**: CH 365  
**Course title**: Introduction to Molecular Simulations  
(L-T-P) : (2-0-2)  
**Credits**: 3  
**Category**: Elective  
**Course Instructor**: Jagannathan T. K.

**Offering Department**: Chemical Engineering

**Course Outcomes**
- By the end of the course the students will be able to:
  - **CO 1**: Understand the theory and methodology behind the molecular simulation tools along with elementary basics on statistical mechanics.
  - **CO 2**: Appreciate the relevant applications of molecular simulations in chemical engineering.
  - **CO 3**: Develop computational modelling skills to begin writing efficient molecular simulation code/scripts for higher studies, research, and other purposes.

**Course Syllabus**:


*Allen, M.P., Tildesley, D.J. Computer Simulation of Liquids, Oxford University Press*


*Donald Allan McQuarrie, Statistical Mechanics, University Science Books.*

**Course Coverage**:

<table>
<thead>
<tr>
<th>Contents</th>
<th>No. of contact hours (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>2</td>
</tr>
</tbody>
</table>
Basics of Statistical Mechanics and thermodynamics | 8
Molecular Simulation Basics | 4
Molecular Dynamics Simulations | 6
Monte Carlo Methods | 5
MD/MC examples | 5
Practical/ Hands-on | 22

Total | 52

References:


Evaluation Plan:

<table>
<thead>
<tr>
<th>Tool</th>
<th>Weightage</th>
</tr>
</thead>
<tbody>
<tr>
<td>End semester Exam</td>
<td>40%</td>
</tr>
<tr>
<td>Mid semester Exam</td>
<td>20%</td>
</tr>
<tr>
<td>Quizzes/Tests (2*10)</td>
<td>20%</td>
</tr>
<tr>
<td>Tutorials/Assignments</td>
<td>20%</td>
</tr>
</tbody>
</table>
Course Code : CH367
Course title : Energy Conservation and Management in Process Industries
(L-T-P) : (3-0-0)
Credits : 3
Category : Elective
Prerequisite : Nil
Teaching Department : Chemical Engineering

Course Outcomes:

By the end of this course, the student will be able to

CO1: Understand the Energy Outlook, conservation and its importance
CO2: Gain insight into engineering fundamentals related to energy efficiency, audit and principles of management
CO3: Gain knowledge on the software tools for industrial energy efficiency and savings and energy management information systems
CO4: explore the case studies on energy conservation and management in process industries

Syllabus:


References:

Course Code : CH368
Course title : Fuel Cell Engineering
(L-T-P) : (3-0-0)
Credits : 3
Category : Elective
Prerequisite : Nil
Teaching Department : Chemical Engineering

Course Outcomes:

By the end of this course, the student will be able to understand

**CO1:** Basic understanding of fuel cell fundamentals and current scenario of this technology

**CO2:** Gain knowledge on the electrochemical reactions of fuel cells and have insights on the various voltage losses and its impact

**CO3:** Understand the various ways of production and storage of fuels for fuel cells and its processing

**CO4:** Gain knowledge of the fuel cell process and design concepts by understanding PEMFC

Syllabus:


Course Coverage:

<table>
<thead>
<tr>
<th>Contents</th>
<th>Approximate No. of Lecture Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview of Fuel Cells: What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics</td>
<td>06</td>
</tr>
<tr>
<td>Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others.</td>
<td>07</td>
</tr>
<tr>
<td>Fuel cell electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents.</td>
<td>05</td>
</tr>
<tr>
<td>Fuel cell process design: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates</td>
<td>08</td>
</tr>
<tr>
<td>Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modelling</td>
<td>07</td>
</tr>
<tr>
<td>---</td>
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</tr>
<tr>
<td>Fuel processing: Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, CO₂ and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal, Using renewable fuels for SOFCs</td>
<td>07</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>40</strong></td>
</tr>
</tbody>
</table>

**References:**


**Evaluation Plan:**

- **Minor Test - 1**  ---  10 Marks
- **Mid-Semester Examination**  ---  30 Marks
- **Surprise tests**  ---  10 Marks
- **End Semester Examination**  ---  50 Marks
- **Total**  ---  100 Marks
Course Description: Detailed Chemical Engineering Process Design of the following equipments is to be carried out. Mechanical aspects of the design are not included here. Heat Exchangers; Evaporators; Packed and Tray towers for Absorption and distillation.

Course Objective: The main objective of the course is to tech design methodology of heat and mass transfer equipments and to teach design tools like CHEMCAD.

Course Outcome: Upon completion of this course, students should:

- Understand the scientific and engineering principles in the working of heat and mass transfer equipments used in chemical process industries
- Acquire skills in the application of mathematical concepts and design methodology in designing important heat and mass transfer equipments
- Acquire skills in the application of standard simulation tools for design of heat and mass transfer equipments
- Acquire skills for interpretation and selection of appropriate design/equipment for specific chemical engineering applications.

Syllabus

Detailed Chemical Engineering Process Design of the following equipments is to be carried out. Mechanical aspects of the design are not included here. Heat Exchangers; Packed and Tray towers for Absorption and distillation. Design of equipments mentioned above using simulation software.

Topics to be covered:

1. Design consideration for heat transfer equipment.
2. Design methodology of double pipe heat exchanger (Rating)
3. Design approach of double pipe heat exchanger in CHEMCAD
4. Design methodology of shell and tube heat exchange (Designing) (Kern’s and Bell’s Method)
5. Design approach of shell and tube heat exchanger in CHEMCAD
7. Design consideration of mass transfer equipment.
10. Design approach of packed tower adsorption in CHEMCAD
11. Design methodology of tray tower adsorption.
12. Design approach of tray tower adsorption in CHEMCAD
14. Design approach of packed tower distillation in CHEMCAD
15. Design methodology of tray distillation tower.
16. Design approach of tray tower distillation in CHEMCAD

Reference textbooks

Course title: CRE AND PROCESS CONTROL LAB
Course code: CH403
L-T-P: (0-0-3)
Credits: 2
Category: PC
Teaching department: Chemical Engineering

Course Description: Experiments based on Reaction Engg. I & II and Process Control courses

Course Objective: The main objective of the course is to expose the student to different chemical reaction engineering experiment and process control experiment to understand the fundamentals learnt in the theory subject.

Course Outcome: Upon completion of this course, students will be able to:

- Apply the fundamental concepts of reaction engineering and process dynamics and control to conduct relevant experiments
- Gain hands on experience and visualization of the working principles of reactors measurement systems and controllers
- Plan and conduct experiments on laboratory scale systems generate, analyze and interpret the experimental data
- Acquire skills for technical report preparation with relevant conclusions
- Demonstrate skills to work in a team

Topics to be covered:

PROCESS CONTROL:
1. Time constant of a thermometer in a thermowell.
2. Time constant of a pressure vessel and mercury manometer.
4. Interacting tanks in series.
5. Study of Level control System.
6. Study of Pressure control System
7. Study of Flow control System
8. Pneumatic Control Valve Characteristics.

CHEMICAL REACTION ENGG:
9. Determination of rate constant using a Batch Reactor
10. Determination of rate constant using a Continuous Stirred Tank Reactor
11. Determination of rate constant using a Tubular Reactor
12. RTD Studies in a Continuous Stirred Tank Reactor
13. RTD Studies in a Plug Flow Reactor
14. RTD studies in a Packed Bed Column
References:

Course Code: CH411
Course title: Fermentation Technology
L-T-P: 3-0-0
Credits: 3
Category: PSE
Teaching Department: Chemical Engineering

Course outcomes:

By the end of this course the student will be able to

- Apply principles of chemical engineering science to develop fermentation processes for various products.
- Understand various downstream processing techniques and the engineering principles involved for the recovery of fermentation products.
- Develop mathematical models for fermentation processes.
- Acquire knowledge of contemporary issues related to energy, environment and society in context of products obtained through biological/fermentation route.

Evaluation Plan:

- End semester Exam: 50%
- Mid semester Exam: 25%
- Insemester Evaluation: Total: 25%
  Assignments: 10
  Tests/Quzzies: 15
  Seminars: None

Syllabus

Introduction, fermentors-principles and design, Manufacture of alcohol, pencillin, vitamins and other products.

Course Coverage:

<table>
<thead>
<tr>
<th>Contents</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Fermentation Technology</td>
<td></td>
</tr>
<tr>
<td>• Introduction</td>
<td></td>
</tr>
<tr>
<td>• Range of Fermentation processes</td>
<td></td>
</tr>
<tr>
<td>• Chronological development of Fermentation Industry</td>
<td>05</td>
</tr>
<tr>
<td>Microbiology</td>
<td></td>
</tr>
<tr>
<td>• Prokaryotic cells and Eukaryotic cells</td>
<td>06</td>
</tr>
</tbody>
</table>
- Bacteria, Fungi (Yeast, Molds), Algae and Protozoa, Plant Cells, Animal cells
- Microbial Growth Kinetics
- Biochemicals

### Component Parts of Fermentation Process
- Isolation, Screening, Preservation and Improvement of Industrially important microorganisms
- Media for Industrial Fermentation
- Sterilization
- Development of Inoculum for Industrial Fermentation
- Recovery and Purification of Fermentation Products
- Effluent Treatment

<table>
<thead>
<tr>
<th>Component Parts of Fermentation Process</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fermenter</td>
<td></td>
</tr>
<tr>
<td>- Components of Fermenter</td>
<td>10</td>
</tr>
<tr>
<td>- Types of Fermenters</td>
<td></td>
</tr>
<tr>
<td>- Instrumentation and Control</td>
<td></td>
</tr>
<tr>
<td>Case Studies: Production of Alcohol, Penicillin, Vitamins and other products</td>
<td>10</td>
</tr>
<tr>
<td>Fermentation Economics</td>
<td>02</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
</tr>
</tbody>
</table>

### Reference Books:

- Principles of Fermentation Technology- P. F. Stanbury, A. Whitaker and S.J. Hall
- Biochemical Engineering Fundamentals- J.E. Bailey and D. F. Ollis
- Bioprocess Engineering Principles- Pauline M. Doran
- Comprehensive Biotechnology, Volume 3- Murray Moo-Young
Course Code : CH412
Course title : Pollution Control and Safety in Process Industries
L-T-P : 3-0-0
Credits : 3
Category : PSE
Teaching Department : Chemical Engineering

Course outcomes:

By the end of this course the student will be able to

- Understand the fundamentals of pollution origin and its effects on human and environment
- Understand methods to monitor and control pollution (Air, Water and Noise pollution)
- Be familiar with contemporary issues on environmental pollution problems and legislations
- Learn scientific and engineering aspects of safety in industry
- Know the fundamental aspects of design of major equipments to handle Air and water pollutants and solid wastes

Evaluation Plan:

End semester Exam: 50%, Mid semester Exam: 30%, Insemester Evaluation: 20%

Syllabus


Course Coverage:

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<tr>
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</tr>
<tr>
<td>Energy policy</td>
<td></td>
</tr>
<tr>
<td>Demographic pattern and impact</td>
<td></td>
</tr>
<tr>
<td>International Regulations and Indian Standards</td>
<td>08</td>
</tr>
<tr>
<td>Water and waste water treatment- Origin, monitoring and characterization</td>
<td></td>
</tr>
<tr>
<td>Design principles of physical operations viz Settling/ sedimentation,</td>
<td></td>
</tr>
<tr>
<td>Screening, Filtration</td>
<td>15</td>
</tr>
</tbody>
</table>
Reference Books:

- Environmental Pollution Control Engineering- C.S Rao, Wiley Eastern, 1992
- Waste Water Engineering- Metcalf and Eddy
- Air Pollution Control Theory- Martin Crawford
Course Code: CH465
Course title: Air Pollution Control and Design of Equipments
(L-T-P): (3-0-0)
Credits: 3
Category: Open Elective for B.Tech
Teaching Department: Chemical Engineering

Course Outcomes:

By the end of this course, the student will be able to understand

CO1: Gain knowledge on the sources of air pollutants and their adverse effects.
CO2: Know about atmospheric interactions of air pollutant.
CO3: Apply the dispersion models to predict the fate of air pollutants.
CO4: Estimate the strength of various air pollutants in the ambient air in the air and stacks and ways of sampling and treatment equipments.
CO5: Design various methods/devices for control of particulates and gas emissions.
CO6: Propose suitable corrective measures to minimize the emissions of air pollutants.

Syllabus:

Introduction. Air pollution laws and standards. Meteorological aspects of air pollutant dispersion, the Gaussian plume model, design of stacks and chimneys. Air pollution control methods and design of equipments- control of gaseous emissions, Air pollution control in specific industries.

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<td>Air pollution control methods-control of gaseous emissions</td>
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</tr>
<tr>
<td>Air pollution control in specific industries</td>
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**Evaluation Plan:**

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</tr>
<tr>
<td>End Semester Examination</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
</tr>
</tbody>
</table>
**Course Code**: CH 448  
**Course title**: Seminar  
**L-T-P**: 0-0-3  
**Crédits**: 2  
**Category**: Mandatory Learning Course (MLC)  
**Teaching Department**: Chemical Engineering

**Course outcomes:**

By the end of this course, student will be able to

- By the end of this course, student will be able to acquire skills to choose a topic by understanding the contemporary issues applying reasoning and relate to professional engineering practice.
- By the end of this course, student will be able to conduct literature survey, to read scientific articles, understand and analyse the information published.
- By the end of this course, student will be able to write technical reports and prepare presentation material.
- By the end of this course, student will be able to communicate effectively in oral form with technical community.

**Course Plan:** Each student has to choose a topic, submit a seminar report and present a seminar. Student needs to give a power point presentation. Presentation is for 25 minutes followed by 5 minutes for question/answer and discussion.

Student will be awarded S or N grade based on whether the student performance is satisfactory or not. Student performance is evaluated based on the technical content of the seminar, his/her written report presentation, slide preparation, oral presentation and ability to answer the questions during the seminar.
Course Outcomes

On successful completion of the course students will be able to:

CO-1: Formulate a problem and find solution.
CO-2: Work in a team.
CO-3: Use technical knowledge gained in theory and practice to solve problems.
CO-4: Make a technical report and present it to peers and superiors.
CO-5: Be self-sufficient, as a professional engineer.
Course code: CH 499
Course title: Major Project II
L-T-P: 0-0-9
Credits: 6
Category: MP
Evaluating department: Chemical Engineering

Course Outcomes

On successful completion of the course students will be able to:

CO-1: Formulate a problem and find solution.

CO-2: Work in a team.

CO-3: Use technical knowledge gained in theory and practice to solve problems.

CO-4: Make a technical report and present it to peers and superiors.

CO-5: Be self-sufficient, as a professional engineer.