# CURRICULUM AND SYLLABI FOR AUTONOMOUS STREAM

## B.TECH. (CHEMICAL ENGINEERING) COURSES

(For Students Admitted From Academic Year 2014-15 Onwards)

### CURRICULUM

#### I SEMESTER

<table>
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<th>Category</th>
<th>Periods</th>
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Total Credits 30

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Total 32

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# Approved in 3rd Academic Council Meeting

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# Notes

- CA – Continuous Assessment, SE – Semester Examination, TM – Total Marks
- LB – Laboratory, EGD – Engineering Graphics / Drawing
- POD – Practice Oriented Design, TCP – Theory Combined with Practice, PR - Practice

*Approved in 3rd Academic Council Meeting*
### III SEMESTER

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**Total Credit**: 28

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**Total Credits**: 28

TX® - Theory Course (Category TA/ TB/ TC/TCP)
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<td>EIG06</td>
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## CONSOLIDATED CREDIT DISTRIBUTION

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SYLLABUS (Core Subjects)
Prerequisite

Objectives

Outcome

UNIT – I

Hours: 09

Curvature, radius of curvature, evolutes and involutes. Beta and Gamma functions and their properties.

UNIT – II

Hours: 09

Partial derivatives, Total derivative, Differentiation of implicit functions, Change of variables, Jacobians and their properties, Partial differentiation of implicit functions, Maxima and minima of functions of two variables, Lagrange’s method of undetermined multipliers.

UNIT – III

Hours: 09

Multiple Integrals, change of order of integration in double integrals, Applications: Plane areas (double integration), Change of variables (Cartesian to polar), volumes by solids of revolution, double and triple integrations (Cartesian and polar) – Center of mass and Gravity (constant and variable densities).

UNIT – IV

Hours: 09

Exact equations, First order linear equations, Bernoulli’s equation, orthogonal trajectories, growth, decay and geometrical applications. Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut’s type.

UNIT – V

Hours: 09

Linear differential equations of higher order - with constant coefficients, the operator D, Euler’s linear equation of higher order with variable coefficients, simultaneous linear differential equations, solution by variation of parameters method.

Total contact Hours: 45  Total Tutorials: 15  Total Practical Classes:  60  Total Hours: 60

Text Books:


Reference Books:

Department : Physics
Semester : One
Subject Code  Subject                        | Hours / Week | Credit | Maximum Marks |
PH101          Engineering Physics           | L 4 T - P - | C 4   | CA 40 SE 60 TM 100 |
Prerequisite    -

Objectives
• To provide a bridge between basic Physics and Engineering courses.
• To introduce the concepts and applications of Ultrasonics, Optics, Lasers, Optical Fibers, and wave mechanics and fundamentals of crystal structure.

Outcome
• At the end of the course, Students would have adequate exposure to the various topics of this Engineering Physics course and their real life applications.

UNIT – I Acoustics and Ultrasonics | Hours: 12

UNIT – II Optics | Hours: 12

UNIT – III Crystal Structure and Lattice Defects | Hours: 12
Crystal structure: Space Lattice, Unit Cell, Lattice Parameters, Crystal Systems, Bravais Lattices- Atomic Radius, Coordination Number and Packing Factor of SC, BCC, FCC, HCP structures – Miller Indices- Powder X Ray Diffraction Method; Lattice Defects: Qualitative ideas of point, line, surface and volume defects and their influence on properties of solids

UNIT – IV Wave Mechanics | Hours: 12
Matter Waves – de Broglie hypothesis – Uncertainty Principle – Schrodinger Wave Equations – Time Dependent – Time Independent – Application to Particle in a One Dimensional potential Box –Concept of Quantum Mechanical Tunneling (without derivation) – Applications of tunneling (qualitative) to Alpha Decay, Tunnel Diode, Scanning Tunneling Microscope.

UNIT – V Lasers and Fiber Optics | Hours: 12

Text Books:

Reference Books:
<table>
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<th>Department</th>
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<td>CY101</td>
<td>Engineering Chemistry</td>
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**Prerequisite**
- To know the importance of chemistry in engineering education
- To understand the chemistry of industrial processes
- To apply the knowledge of chemistry to solve engineering problems

**Objectives**
- Students will be able to understand and appreciate usefulness of chemistry concepts in the design, fabrication and maintenance of materials for engineering applications.
- Students will gain knowledge about the chemistry background of some of the important industrial processing techniques.
- With the knowledge gained in conceptual chemistry, engineering students will be able to approach confidently the design and development of futuristic materials to meet the requirement of industry and society.

**Outcome**
- To apply the knowledge of chemistry to solve engineering problems
- To understand the chemistry of industrial processes
- To know the importance of chemistry in engineering education

**UNIT – I**
**Water Treatment**

Hours: 12


**UNIT – II**
**Industrial Polymers**

Hours: 12


**UNIT – III**
**Electrochemical Cells**

Hours: 12


**UNIT – IV**
**Corrosion and Control**

Hours: 12


**UNIT – V**
**Engineering Materials**

Hours: 12


**Total contact Hours**: 60  **Total Tutorials**: -  **Total Practical Classes**: -  **Total Hours**: 60

**Text Books:**

**Reference Books:**
Department: Civil Engineering / Mechanical Engineering
Programme: B.Tech
Semester: One
Category: TC

Subject Code | Subject | Hours / Week | Credit | Maximum Marks |
-------------|---------|--------------|--------|---------------|
BE101 | Basic Civil and Mechanical Engineering | 4 - - 4 | 40 | 60 100 |

Prerequisite
- To be able to differentiate the types of buildings according to national building code.
- To understand building components and their functions as well as different types of roads, bridges and dams.
- To convey the basics of Mechanical Engineering
- To establish the necessity of basics of Mechanical Engineering to other engineering disciplines
- To explain the concepts of thermal plants used in power systems being a common issue
- To narrate the methods of harnessing renewable energies and their working principles
- To explain the role of basic manufacturing processes
- To develop an intuitive understanding of underlying working principles of mechanical machines and systems.

Objectives
- Parallels are drawn between the subject and the student’s everyday experience so that this course may be related to what the students already know.
- Students are made to understand the principles of Mechanical Engineering based on theories.
- Students are encouraged to make engineering judgments, to conduct independent exploration of topic of renewable energy systems and to communicate the findings in a professional manner.
- Students are made to develop natural curiosity to explore the various facets of mechanical equipment and machines.
- While emphasizing basic principles, students are provided with explanations used in real time engineering systems.

Outcome
- Students will be able to understand the basics of Mechanical Engineering.
- Students will be able to make engineering judgments and explore renewable energy systems.
- Students will develop curiosity to explore mechanical equipment.
- Students will understand the principles of Mechanical Engineering.

UNIT – I
Buildings and Building Materials
Hours: 10
Buildings-Definition-NBC Classification - plinth area, floor area, carpet area, floor space index-construction materials-stone, brick, cement, cement-mortar, concrete, steel- their properties and uses. Impact of manufacture and use of building materials on the environment.

UNIT – II
Buildings and their Components
Hours: 10

UNIT – III
Basic Infrastructure
Hours: 10

UNIT – IV
IC Engines and Steam Generators
Hours: 10
IC engines – Classification – Working principles - Diesel and petrol engines: two stroke and four stroke engines – Merits and demerits.
Steam generators (Boilers) – Classification – Constructional features (of only low pressure boilers) – Boiler mountings and accessories – Merits and demerits - Applications.

UNIT – V
Conventional and Non-conventional Power Generation
Hours: 10
Power Generation Systems – Conventional and Non-Conventional:
Hydraulic – Thermal – Nuclear power plants – Schemes and layouts (Description Only) Solar – wind –Geothermal - Wave – Tidal and Ocean Thermal Energy Conversion systems – Basic power plant schemes and layouts (Description only).

UNIT – VI
Introduction to Manufacturing Technology
Hours: 10
Machines: Lathe – Drilling machine – Grinding machine (Description only)
Moulding: Pattern making – Green and dry sand moulding – casting. Metal Joining – Arc and Gas welding – Brazing
## Text Books:


## Reference Books:


## Web sites:

1. [http://nptel.iitm.ac.in/courses/Webcourse-contents/](http://nptel.iitm.ac.in/courses/Webcourse-contents/)
Department: Civil Engineering  
Programme: B.Tech.  
Semester: One  
Category: TB  

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<td>Engineering Mechanics</td>
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Prerequisite: -

Objectives:
- To explain the importance of mechanics in the context of engineering.
- To understand the static equilibrium of particles and rigid bodies in two dimensions
- To introduce the techniques for analyzing the forces in the bodies.
- To study the motion of a body and to write the dynamic equilibrium equation.

Outcome:
- On successful completion of the course, a student would be able to identify and analyze the problems by applying the principles of engineering mechanics, and to proceed to advanced study on mechanical systems.

UNIT – I  
Fundamentals of Mechanics  
Hours: 09

UNIT – II  
Application of Force System  
Hours: 09
Types loads and supports – simply supported beams, cantilever beams and plane trusses – reactions (Introduction only).
Friction: Laws of friction, Static dry friction, simple contact friction problems, body on inclined planes, ladders, wedges, simple screw jack.

UNIT – III  
Properties of Surfaces  
Hours: 09
Properties of sections – centroids, center of gravity, area moment of inertia, product moment of inertia, polar moment of inertia, radius of gyration, mass moment of inertia.
Principle of virtual work – work done – application to simple structural arrangements.

UNIT – IV  
Kinematics and Kinetics of Particles  
Hours: 09

UNIT – V  
Kinematics and Kinetics of Rigid Bodies  
Hours: 09

Text Books:

Reference Books:
**Department:** Humanities and Social Sciences  
**Programme:** B.Tech.

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**Prerequisite**

- To improve the LSRW skills of I. B.Tech students
- To instill confidence and enable the students to communicate with ease
- To equip the students with the necessary skills and develop their language prowess

**Objectives**

On successful completion of the module students should be able to:

- communicate effectively in English
- get rid of their inhibitions
- possess effective language skills
- improve their career prospects

**Outcome**

**UNIT – I**  
**Basic Concepts of Communicative English**  
**Hours:** 12


**UNIT – II**  
**Comprehension and Analysis**  
**Hours:** 12


**UNIT – III**  
**Writing**  
**Hours:** 12


**UNIT – IV**  
**Oral Communication**  
**Hours:** 12


**UNIT – V**  
**Vocabulary and Language Through Literature**  
**Hours:** 12

Analysis of

1. “English in India”, R.K. Narayan
3. “Politics and the English Language”, George Orwell


**Total contact Hours:** 60  
**Total Tutorials:** -  
**Total Practical Classes:** -  
**Total Hours:** 60

**Text Books:**


**Reference Books:**

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**Prerequisite**
To provide a practical understanding of some of the concepts learnt in the theory course on Physics and Materials Science.

**Outcome**
The Students would have gained practical experience about some of the Theoretical concepts learnt in the Physics and Materials Science courses.

**List of Experiments:**
(Any 10 experiments including a maximum of 2 Demonstration experiments are to be performed.)

1. Radius of curvature of a Lens - Newton’s rings
2. Thickness of a thin object by Air – wedge
3. Spectrometer – Resolving power of a Prism
4. Spectrometer – Resolving power of a Transmission grating
5. Determination of wavelength of a Laser source using transmission grating, reflection grating (vernier calipers) & particle size determination
6. Determination of numerical aperture & Acceptance angle of an optical fiber.
7. Laurent’s Half shade polarimeter – Determination of specific rotatory power*
8. Spectrometer - Hollow prism / Ordinary & Extraordinary rays by Calcite Prism*
9. Determination of optical absorption coefficient of materials using laser*
10. Coefficient of Thermal conductivity - Radial flow method
11. Coefficient of Thermal conductivity – Lee’s Disc method
12. Jolly’s Bulb Apparatus experiment – determination of α
13. Magnetism: I – H curve
14. Field along the axis of a coil carrying current
15. Vibration magnetometer – calculation of magnetic moment & pole strength
16. Electrical conductivity of semiconductor – two probe / four probe method*
17. Hall effect in a semiconductor*
18. Michelson’s Interferometer*

*Demonstration Experiments.

**Total contact Hours:** - **Total Tutorials:** - **Total Practical Classes:** 45 **Total Hours:** 45

**Reference Book:**
Department: Chemistry  
Programme: B.Tech.  
Category: LB

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Prerequisite: -

Objectives:
- To educate the principles involved in chemical analysis.
- To provide practical knowledge of handling chemicals and chemical analysis.
- To understand the importance of chemical analysis in various fields.

Outcome:
- Students will be able to understand chemical analysis and its usefulness in engineering, industry and other fields.
- Students will gain laboratory skills and that will give confidence in analyzing samples in engineering, industry and other fields.
- Students will gain knowledge about the principles and methods of listed methods of quantitative analyses.

List of experiments: (Any 10 experiments)
1. Determination of total, permanent and temporary hardness of water by EDTA method.
2. Determination of magnesium in water by complexometry.
3. Determination of calcium in lime stone by complexometry.
4. Determination of alkalinity of water.
5. Determination of percentage of acetic acid in vinegar.
6. Determination of ferrous ion in Mohr’s salt.
7. Determination of lead dioxide by permanganometry.
8. Determination of ferrous and ferric ions in a solution by dichrometry.
10. Determination of dissolved oxygen in water.
11. Determination of COD of water sample.
12. Determination of available chlorine in bleaching powder.
13. Determination of chloride content in water by argentometry.
14. Determination of lead in polluted water by conductometry.
15. Preparation of potash alum from scrap aluminium.

Total contact Hours: -  
Total Tutorials: -  
Total Practical Classes: 45  
Total Hours: 45

Text Books:

Reference Books:
**Department:** Mechanical Engineering  
**Programme:** B.Tech.  
**Semester:** One  
**Category:** LB

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**Prerequisite:**
- To convey the basics of mechanical tools used in engineering
- To establish hands on experience on the working tools
- To develop basic joints and fittings using the hand tools
- To establish the importance of joints and fitting in engineering applications
- To explain the role of basic workshop in engineering
- To develop an intuitive understanding of underlying physical mechanism used in mechanical machines.

**Objectives:**
- Parallels are drawn between the subject and the student’s everyday experience so that this course may be related to what the students already know.
- Students are introduced to basic hand tools used in various mechanical cutting operations.
- Students are encouraged to make simple joints and fittings.
- Students are made to develop natural curiosity to explore the various facets of basic cutting operations.
- While emphasizing basic operations, students are provided with modern hand tools to use in real time engineering jobs.
- Students are exposed to make objects like tray, welded joints.

**Outcome:**
- Parallels are drawn between the subject and the student’s everyday experience so that this course may be related to what the students already know.
- Students are introduced to basic hand tools used in various mechanical cutting operations.
- Students are encouraged to make simple joints and fittings.
- Students are made to develop natural curiosity to explore the various facets of basic cutting operations.
- While emphasizing basic operations, students are provided with modern hand tools to use in real time engineering jobs.
- Students are exposed to make objects like tray, welded joints.

**UNIT – I**  
**Fitting**  
Hours: 11

1. Study of tools and machineries
2. Symmetric fitting
3. Acute angle fitting
4. Obuse angle fitting

**UNIT – II**  
**Welding**  
Hours: 11

1. Study of arc and gas welding equipment and tools
2. Simple lap welding (Arc)
3. Single V butt welding (Arc)
4. Corner joint (Arc)

**UNIT – III**  
**Sheet Metal**  
Hours: 11

1. Study of tools and machineries
2. Funnel
3. Waste collection tray
4. Rectangular Box

**UNIT – IV**  
**Carpentry**  
Hours: 12

1. Study of tools and machineries
2. Half lap joint
3. Corner mortise joint
4. Dovetail joint

**Total contact Hours:**  
**Total Tutorials:** -  
**Total Practical Classes:** 45  
**Total Hours:** 45

**Text Books:**

**Web sites:**
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<td>3 L 1 T - P C</td>
<td>40 C 60 CA 100 SE</td>
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**Prerequisite**: -

**Objectives**
- To acquaint with theory of Matrices
- Hyperbolic functions and theory of equations
- Vector calculus and statistics

**Outcome**
- Understands Matrix theory
- Solving techniques of equations
- Understands Vectors and statistics

**UNIT – I**

Hours: 09

Eigen values and Eigen vectors of a real matrix, Characteristic equation, Properties of Eigen values. Cayley-Hamilton Theorem, Diagonalisation of matrices. Reduction of a quadratic form to canonical form by orthogonal transformation and nature of quadratic forms.

**UNIT – II**

Hours: 09

Trigonometry: Hyperbolic and circular functions, logarithms of complex number, resolving real and imaginary parts of a complex quantity.

Theory of equations: Relation between roots and coefficients, reciprocal equations, transformation of equations and diminishing the roots.

**UNIT – III**

Hours: 09

Finite differences: Definitions and relation between operators (Δ, V, δ, E, μ, D), Solution of difference Equations, Solving Boundary value problems for ordinary differential equations using finite difference method.

**UNIT – IV**

Hours: 09

Gradient, divergence and curl, their properties and relations. Stoke’s theorem and Gauss divergence theorem (without proof). Simple applications involving cubes, sphere and rectangular parallelepipeds.

**UNIT – V**

Hours: 09

Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.

| Total contact Hours: 45 | Total Tutorials: 15 | Total Practical Classes: - | Total Hours: 60 |

**Text Books:**

**Reference Books:**
## Subject Code  Subject  Hours / Week  Credit  Maximum Marks
<table>
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<tr>
<th>PH102</th>
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### Prerequisite:
- To impart knowledge to the Engineering students about the significance of Materials Science and its contribution to Engineering and Technology
- To introduce the Physical concepts and properties of different category of materials and their modern applications in day-to-day life.

### Objectives:
- Engineering Students would have gained fundamental knowledge about the various types of materials and their applications to Engineering and Technology.

### Outcome:
- Engineering Students would have gained fundamental knowledge about the various types of materials and their applications to Engineering and Technology.

## UNIT – I  Dielectric Materials


NLO materials and piezoelectric actuators (introductory concepts).

## UNIT – II  Magnetic Materials and Superconductors


Superconductors - basic concepts – properties of superconductors – Meissner effect – Type I and II superconductors – BCS theory (qualitative) - High Temperature Superconductors– Qualitative ideas of Josephson effect, quantum interference and SQUID – their applications.

## UNIT – III  Semiconductors


## UNIT – IV  Nuclear Reactors & Materials


Nuclear fusion reactions for fusion reactors-D-D and D-T reactions, Basic principles of Nuclear Fusion reactors.

## UNIT – V  Smart Materials and Nanomaterials

Smart Materials: Introduction – definitions. Shape Memory alloys (SMA): One way and two way Shape memory effect, pseudoelasticity, Properties and applications of SMA- features of Ni-Ti SMA alloy. Liquid Crystals: Types – nematic, cholesteric, smectic- Application to Display Devices


### Total contact Hours

| Total contact Hours: 60 |

### Total Tutorials: -

### Total Practical Classes: -

### Total Hours: 60

### Text Books:


### Reference Books:

5. Vijayamohananan K Pillai and MeeraParthasarathy, Functional Materials, Universities Press Hyderabad,
2012.
<table>
<thead>
<tr>
<th>Department</th>
<th>Programme</th>
<th>Semester</th>
<th>Category</th>
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<tbody>
<tr>
<td>Chemistry</td>
<td>B.Tech.</td>
<td>Two</td>
<td>TA</td>
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<tr>
<td>CY102</td>
<td>Environmental Science</td>
<td>Hours / Week: 4</td>
<td>Credit: 4</td>
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</tbody>
</table>

**Prerequisite:**
- To widen the knowledge of environmental awareness and pollution
- To educate the importance of preserving the earth’s resources and ecosystem
- To highlight the modern techniques and regulations to monitor and control pollution

**Objectives:**
- Students will be able to understand about the environment and natural resources we are blessed with.
- Students will become aware of environmental issues like pollution, dwindling natural resources and degrading ecosystem.
- Students will be inspired to act as environmentally friendly and work for sustainable development of the humanity.

**Outcome:**
- Concept of an ecosystem-structure and function of an ecosystem. Producers, consumers and decomposers.

**UNIT – I**

**Ecosystem and Biodiversity**

- Concept of an ecosystem-structure and function of an ecosystem. Producers, consumers and decomposers.

**UNIT – II**

**Air Pollution**


**UNIT – III**

**Water and Land Pollution**


**UNIT – IV**

**Instrumental Pollution Monitoring**


**UNIT – V**

**Energy and Environment**


**Total contact Hours:** 60
**Total Tutorials:**
**Total Practical Classes:**
**Total Hours:** 60

**Text Books:**
1. Anubha Kaushik and C.P. Kaushik, Environmental Science and Engineering, New Age International (P) Ltd, New Delhi, 2009. (Unit I)
2. S.S. Dara, A Text Book of Environmental Chemistry and Pollution Control, S. Chand and Company Ltd, New Delhi, 2008. (Unit II, III, & V)
3. C.N. Sawyer, P.L. McCarty And G.F. Parkin, Chemistry for Environmental Engineering and Science, Tata
<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>BE102</td>
<td>Basic Electrical and Electronics</td>
<td>3 1 -</td>
<td>4</td>
<td>40 60 100</td>
</tr>
</tbody>
</table>

Prerequisite:
- To apply Kirchhoff’s law to simplify the given circuit.
- To understand the concept of AC circuit and to simplify the given RL, RC, RLC series and parallel circuits.
- To understand the principle of electromagnetic induction and the working principle of electrical machines.

Objectives:
- The students understand the working principle of transistor, FET, MOSFET, CMOS and their applications.
- To design adders, subtrators and to gain knowledge on sequential logic circuits.
- To understand the need for communication and acquire knowledge on different communication systems.
- To have an overview of different emerging technologies in day-to-day applications.

Outcome:
- The students explored the basic terminology, laws and concepts of DC and AC circuits in electrical engineering.
- The students know the principle of operation of DC and AC electrical machines and different types of power plants.
- Will understand the importance of FET’s, MOSFET’s, CMOS and their applications.
- Will be able to design Combinational and Sequential circuits.
- Awareness towards different Communication Systems.
- Gain knowledge in the working principle of real time applications used in day today life like ATM, Microwave Oven, Bluetooth, WiFi and Computer Networks.

UNIT – I  DC Circuits  Hours: 07

UNIT – II  AC Circuits  Hours: 08
Concepts of AC circuits – rms value, average value, form and peak factors – Simple RL, RC and RLC series and parallel circuits – Concept of real and reactive power – Power factor – Series and parallel resonance - Introduction to three phase system - Power measurement by two wattmeter method.

UNIT – III  Electrical Machines and Power Plants  Hours: 08
Law of Electromagnetic induction, Fleming’s Right & Left hand rule - Principle of DC rotating machine, Single phase transformer, single phase induction motor and synchronous motor (Qualitative approach only) - Layout of thermal, hydro and nuclear power generation (block diagram approach only). Components of AC transmission and distribution systems – One line diagram.

UNIT – IV  Electronics  Hours: 07

UNIT – V  Communication  Hours: 08

UNIT – VI  Overview of Emerging Technologies  Hours: 07

Microwave Ovens - RFID - Automated Teller Machines (ATM).

<table>
<thead>
<tr>
<th>Total contact Hours: 45</th>
<th>Total Tutorials: 15</th>
<th>Total Practical Classes: -</th>
<th>Total Hours: 60</th>
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</table>

Text Books:

**Electrical**

**Electronics and Communication**

Reference Books:

**Electrical**

**Electronics and Communication**

Web sites:

1. [www.electronics-tutorials.ws](http://www.electronics-tutorials.ws)
3. [www.nptel.ac.in/courses/IIT-MADRAS/Basic_Electronics../LECTURE1.pdf](http://www.nptel.ac.in/courses/IIT-MADRAS/Basic_Electronics../LECTURE1.pdf)
Subject Code | Subject | Hours / Week | Credit | Maximum Marks
--- | --- | --- | --- | ---
ME101 | Engineering Thermodynamics | 3 | 1 | 4 | 40 | 60 | 100

Prerequisite:

- To convey the basics of the thermodynamic principles
- To establish the relationship of these principles to thermal system behaviors
- To develop methodologies for predicting the system behavior
- To establish the importance of laws of thermodynamics applied to energy systems
- To explain the role of refrigeration and heat pump as energy systems
- To develop an intuitive understanding of underlying physical mechanism and a mastery of solving practical problems in real world.

Objectives:

- Parallels are drawn between the subject and the student’s everyday experience so that this course may be related to what the students already know.
- Students are made to understand the principles of thermodynamics and adjudge the viability of operation of any thermal system in real time applications
- Students are encouraged to make engineering judgments, to conduct independent exploration of topic of thermodynamics and to communicate the findings in a professional manner.
- Students are made to develop natural curiosity to explore the various facets of thermodynamic laws.
- While emphasizing basic laws, students are provided with modern tools to use in real time engineering problems.

Outcome:

- Parallels are drawn between the subject and the student’s everyday experience so that this course may be related to what the students already know.
- Students are made to understand the principles of thermodynamics and adjudge the viability of operation of any thermal system in real time applications
- Students are encouraged to make engineering judgments, to conduct independent exploration of topic of thermodynamics and to communicate the findings in a professional manner.
- Students are made to develop natural curiosity to explore the various facets of thermodynamic laws.
- While emphasizing basic laws, students are provided with modern tools to use in real time engineering problems.

UNIT – I


UNIT – II

The concept of energy, work and heat – reversible work- internal energy -Perfect gas – specific heats – Joules law - enthalpy- Conservation of Energy principle for closed and open systems - First law of thermodynamics – Application of first law to a process (flow and non-flow) – Steady flow energy equation and its engineering application - Calculation of work and heat for different processes.

UNIT – III


UNIT –IV


UNIT – V

Reverse Carnot cycle - COP - Vapor compression refrigeration cycle and systems (only theory) - Gas refrigeration cycle - Absorption refrigeration system – Liquefaction – Solidification (only theory).

Total contact Hours: 45 | Total Tutorials: 15 | Total Practical Classes: - | Total Hours: 60

Text Books:


Reference Books:

Web sites:
1. http://nptel.iitm.ac.in/courses/Webcourse-contents/
**Department:** Computer Science and Engineering / Information Technology  
**Programme:** B.Tech.  
**Semester:** Two  
**Category:** TA  

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<th>Maximum Marks</th>
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<tr>
<td>CS101</td>
<td>Computer Programming</td>
<td>3 1 - 4</td>
<td>4</td>
<td>40 60 100</td>
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</table>

**Prerequisite:**  
- To introduce the basics of computers and information technology.
- To educate problem solving techniques.
- To impart programming skills in C language.
- To practice structured programming to solve real life problems.

**Objectives:**  
- On successful completion of the course, students will be able to:
  - Understand the basics of computers and its related components
  - Have the ability to write a computer program to solve specified problems

**UNIT – I**  

**UNIT – II**  

**UNIT – III**  
Strings – String I/O functions, String Library functions – Storage classes.

**UNIT – IV**  
Structures – Arrays and Structures – Nested structures – Structure as Argument to functions– Union
Pointers – Declaration, Initialization and Accessing Pointer variable – Pointers and arrays – pointers as argument and return value – Pointers and strings - pointers and structures.

**UNIT – V**  
Dynamic Memory Allocation: MALLOC, CALLOC, FREE, REALLOC
Introduction to preprocessor – Macro substitution directives – File inclusion directives –Compiler Control directives – Miscellaneous directives.

**Total contact Hours:** 45  
**Total Tutorials:** 15  
**Total Practical Classes:** -  
**Total Hours:** 60

**Text Books:**  

**Reference Books:**  
### Course Details

**Department**: Mechanical Engineering  
**Programme**: B.Tech.  
**Semester**: Two  
**Category**: EGD  

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<td>ME102</td>
<td>Engineering Graphics</td>
<td>2 - 3 - 4</td>
<td>50 50 100</td>
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**Prerequisite**: -

**Objectives**:
- To convey the basics of engineering drawing
- To explain the importance of an engineering drawing
- To teach different methods of making the drawing
- To establish the importance of projects and developments made in drawing that are used in real systems

**Outcome**:
- Students are encouraged to make engineering drawing of physical objects representing engineering systems.
- Students are made to develop natural curiosity to explore the various facets of engineering drawings.
- Students are made to follow and understand the basic of mechanical drawing.

**UNIT – 0**
Introduction to Standards for Engineering Drawing practice, Lettering, Line work and Dimensioning.

**UNIT – I**
Projection of Points and Projection of lines  
*Hours: T-06; P-09*

**UNIT – II**
Projection of Points and Projection of lines  
*Hours: T-06; P-09*

**UNIT – III**
Projection of solids in complicated positions  
*Hours: T-06; P-09*

**UNIT – IV**
Sections of solids - Development of Surfaces  
*Hours: T-06; P-09*

**UNIT – V**
Axonometric Projections: Isometric Projections (simple solids); Perspective Projections (planes and simple solids; Orthographic Projections  
*Hours: T-06; P-09*

**Total Contact Hours**: 30  
**Total Tutorials**: -  
**Total Practical Classes**: 45  
**Total Hours**: 75

**Text Books**:
3. BIS, Engineering Drawing practices for Schools & College, SP 46 : 2003

**Reference Books**:
4. James D Bethune and et. al., Modern Drafting, Prentice Hall Int.,

**Web sites**:
Department: Computer Science and Engineering / Information Technology
Programme: B.Tech.

Semester: Two
Category: TA

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<tr>
<td>CS102</td>
<td>Computer Programming Laboratory</td>
<td>4 - - - 4</td>
<td>40</td>
<td>60 100</td>
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</table>

Prerequisite:
- To study and understand the use of OS commands
- To get familiarity on MS-Office packages like MS-Word, MS-Excel and MS-PowerPoint
- To gain a hands on experience of compilation and execution of ‘C’ programs
- To inculcate logical and practical thinking towards problem solving using C programming.

Objectives:
- On successful completion of the course, students will be able to:
  - Have the ability to write a computer program to solve specified problems
  - Problem solving ability will be gained by the students

Outcome:
- Study of OS commands
- Use of mail merge in word processor
- Use of spreadsheet to create Charts (XY, Bar, Pie) with necessary formulae.
- Use of Power point to prepare a slide show.

Cycle - I  
Fundamentals of Computing
1. Study of OS commands
2. Use of mail merge in word processor
3. Use of spreadsheet to create Charts (XY, Bar, Pie) with necessary formulae.
4. Use of Power point to prepare a slide show.

Cycle - II  
Programming Using C
1. Study of Compilation and execution of simple C programs
2. Basic C Programs
   a. Arithmetic Operations
   b. Area and Circumference of a circle
   c. Swapping with and without Temporary Variables
3. Programs using Branching statements
   a. To check the number as Odd or Even
   b. Greatest of Three Numbers
   c. Counting Vowels
   d. Grading based on Student’s Mark
4. Programs using Control Structures
   a. Computing Factorial of a number
   b. Fibonacci Series generation
   c. Prime Number Checking
   d. Computing Sum of Digit
5. Programs using String Operations
   a. Palindrome Checking
   b. Searching and Sorting Names
6. Programs using Arrays
   a. Sum of ‘n’ numbers
   b. Sorting an Array
   c. Matrix Addition, Subtraction, Multiplication and Transpose
7. Programs using Functions
   a. Computing nCr
   b. Factorial using Recursion
   c. Call by Value and Call by Reference
8. Programs using Structure
   a. Student Information System
   b. Employee Pay Slip Generation
   c. Electricity Bill Generation
9. Programs using Pointers
   a. Pointer and Array
b. Pointer to function  
c. Pointer to Structure  
10. Programs using File Operation  
a. Counting No. of Lines, Characters and Black Spaces  
b. Content copy from one file to another  
c. Reading and Writing Data in File  

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<tr>
<th>Total contact Hours: -</th>
<th>Total Tutorials: -</th>
<th>Total Practical Classes: 45</th>
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**Text Books:**


**Reference Books:**

**Department**: Electronics and Communication Engineering / Electrical and Electronics Engineering  
**Programme**: B.Tech.  
**Semester**: Two  
**Category**: LB

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<tr>
<th>Subject Code</th>
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<tr>
<td>BE103</td>
<td>Basic Electrical and Electronics Engineering Laboratory</td>
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</table>

**Prerequisite**: -

**Objectives**:
- To understand the basic electrical tools and their applications.
- To get trained in using different types of wiring.
- To find faults in electrical lamp and ceiling fan.
- To understand and apply Kirchhoff’s laws to analyze electrical circuits.
- To study the operation of CRO and principle of fiber optic communication.
- To design adder and subtractors.
- To understand the frequency response of RC coupled amplifier.

**Outcome**:
- The students get exposure on the basic electrical tools, applications and precautions.
- The students are trained for using different types of wiring for various purposes in domestic and industries.
- The students are taught to find faults in electrical lamp and ceiling fan.
- Will be able to learn and use equipments like Signal Generator, Power Supply and CRO.
- To apply Kirchhoff's law for simplification of circuits.
- To design combinational circuits.
- To obtain the frequency response of Amplifiers.

**Electrical Lab**
1. Electrical Safety, Precautions, study of tools and accessories.
2. Practices of different joints.
3. Wiring and testing of series and parallel lamp circuits.
4. Staircase wiring.
5. Doctor’s room wiring.
7. Go down wiring.
8. Wiring and testing a ceiling fan and fluorescent lamp circuit.
9. Study of different types of fuses and A.C. and D.C. meters.

**Electronics and Communication Lab**
1. Study of Kirchoff’s Laws.
2. Study of Fiber Optic Communication.
4. Zener Diode as Voltage Regulator.
5. Design of Adder and Subtractor Circuits.

**List of Experiments**
- Electrical Lab
- Electronics and Communication Lab

**Total contact Hours**: -  
**Total Tutorials**: -  
**Total Practical Classes**: 45  
**Total Hours**: 45
Department: Mathematics  
Programme: B.Tech.  
Semester: Three  
Category: TB  

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<tr>
<td>MA103</td>
<td>Mathematics - III</td>
<td>L 3  T 1  P  -  C 4  CA 40  SE 60  TM 100</td>
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Prerequisite

- To introduce the ideas of Laplace and Fourier Transforms
- To familiarize students with Complex Analysis
- To introduce Fourier series.

Objectives

- Understands Transform Calculus
- Understand Complex Analysis
- Able to apply Fourier series

Outcome

- Understands Transform Calculus
- Understand Complex Analysis
- Able to apply Fourier series

UNIT – I  
**Laplace Transform**  
Hours: 09  

UNIT – II  
**Complex Variable- Analytic Functions**  
Hours: 09  
Analytic functions – Necessary conditions Cauchy-Riemann equations (Cartesian and polar form) and sufficient conditions (excluding proof) – Harmonic and orthogonal properties of analytic function – Construction of analytic functions. Conformal mapping – Simple and standard transformations like \( w = z+c, cz, \sin z, 1/z \) Bilinear transformation. (excluding Schwarz- Christoffel transformation)

UNIT – III  
**Complex Integration**  
Hours: 09  
Complex integration, Cauchy’s Integral theorem , Cauchy’s integral formula and problems, Taylor’s and Laurent’s theorem (without proof) Classification of singularities.. Residues and evaluation of residues – Cauchy’s Residue theorem – Contour integration:) Application of residue theorem to real integrals – unit circle and semicircular contour (excluding poles on boundaries)

UNIT – IV  
**Fourier Series**  
Hours: 09  

UNIT – V  
**Fourier Transform**  
Hours: 09  
Fourier integral theorem (statement only), Fourier transform and its inverse, properties. Fourier sine and cosine transforms, their properties, convolution and Parseval’s identity.

Total contact Hours: 45  
Total Tutorials: 15  
Total Practical Classes: -  
Total Hours: 60

Text Books:


Reference Books:

Department: Chemistry  
Programme: B.Tech. (CH)

Semester: Three  
Category: TA

Course Code | Course Name | Hours / Week | Credit | Maximum Marks |
---|---|---|---|---|
CY104 | Physical Chemistry | L T P C CA SE TM |

Prerequisite:  

Objectives:  
- To Provide Solid background in the fundamental concepts of physical chemistry needed for Chemical Engineers.

Outcome:  
At the end of the semester students should be able to understand  
- The properties of matter in its different states  
- The theories, which offer molecular level explanation to the properties of matter  
- Concepts which are relevant to industrial processes  
- Gives the foundation to understand advanced chemical engineering concepts

UNIT – I  
Gaseous State  

UNIT – II  
Conductance of Electrolytes  
Specific and equivalent conductance and their variation with concentration, Strong and weak electrolytes, measurement of electrolytic conduction, Arrhenius theory of ionization, Kohlrausch’s law and its applications. Ionic Equilibria – Ostwald’s dilution law and its limitations, Debye-Huckel-Onsagar theory, Common Ion effect, factors influencing degree of dissociation, Solubility and Solubility product, Selective precipitation.

UNIT – III  
Solutions  

UNIT – IV  
Chemical kinetics  
Zero, First, Second, Third order reaction equations, Effect of temperature on reaction rates, Arrhenius equation, Energy of activation theories of reaction rates- Collision theory, absolute reaction rate theory and Lindemann theory of unimolecular reaction.

CATALYSIS  

UNIT – V  
Adsorption  

COLLOIDS: Types of Colloids systems, preparation, purification and properties of sols, charge on Sols, gold umber, stability of sols.

Total contact Hours: 60  
Total Tutorials: -  
Total Practical Classes: -  
Total Hours: 60

Text Book:  

Reference Books:  
**Course Code**: CE103  
**Course Name**: Mechanics of Solids-I  
**Hours / Week**: L 3, T 1, P -  
**Credit**: 4  
**Maximum Marks**: 40, CA 60, SE 100, TM -

**Prerequisite**: Nil

**Objectives:**
- To develop an understanding of the relationship between external loads applied to a deformable body and the internal stress, strain induced in the body.
- To show proficiency in mathematics and basic sciences required to solve structural engineering and mechanics problems.
- To develop analytical and graphical problem solving skills.

**Outcome:**
On successful completion of the course, students will be able to:
- Calculate and understand the concepts of stress and strain;
- Calculate, describe, and estimate external loadings, including axial load, shear force, bending, and torsion;
- Calculate internal stresses and strains through the application of stress transformation equations and Mohr’s circle;
- Understand stability and buckling phenomena for a slender member under an axial load.

**UNIT – I**  
**Stresses & Strains**  
**Hours**: 09

Simple Stresses and Strains – Tension, compression and shear stresses - Hooke’s law - Elastic constants, Relationship between Elastic constants- compound stresses - thermal stresses – Compound bars.

**UNIT – II**  
**Bending Stress**  
**Hours**: 09

Shear force and bending moment diagrams for beams and frames- Theory of simple bending – Bending stress distribution at sections. Beams of uniform strength.

**UNIT – III**  
**Shear Stress**  
**Hours**: 09

Shear stress distribution due to bending – Shear Centre. Springs – Stiffness – open & closed coil springs- problems in parallel, series springs-Complex stresses – Principal planes and stresses-Mohr’s circle.

**UNIT – IV**  
**Torsion**  
**Hours**: 09


**UNIT – V**  
**Columns**  
**Hours**: 09


**Text Books:**

**Reference Books:**
Department: Electrical and Electronics Engineering  
Programme: B.Tech. (CH)

<table>
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<td>EE136</td>
<td>Electrical and Electronics Engineering</td>
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**Prerequisite**: -

**Objectives**
- To understand the construction and operation of Transformers & Induction machines
- To solve problems of electric circuit analysis.

**Outcome**
At the end of the semester students should be able to
- Understand the construction and operation of Transformers & Induction machines
- Solve problems of electric circuit analysis.
- Acquire knowledge about the operation and applications of operational amplifiers, 555 IC and Logic circuits

**UNIT – I**  
Hours: 12

**UNIT – II**  
Hours: 12

**UNIT – III**  
Hours: 12
Thevenin, Norton, Maximum power transfer, Super position theorems for DC circuits only – Series resonance – Parallel resonance – Introduction to 3-phase system – Two watt meter method of power measurement.

**UNIT – IV**  
Hours: 12

**UNIT – V**  
Hours: 12

**Total contact Hours**: 60  
**Total Tutorials**: -  
**Total Practical Classes**: -  
**Total Hours**: 60

**Text Books**
2. B.L. Theraja, Fundamental of Electrical Engineering & Electronics, S.Chand & Company, 2010

**Reference Books**
2. V.K. Metha and Rohit Mehta, Principles of Electronics, S.Chand & Company, New Delhi, 2010
<table>
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<th>Credit</th>
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<tr>
<td>CH101</td>
<td>Process Calculations</td>
<td>L 3 T 1 P</td>
<td>C 4</td>
<td>CA 40 SE 60 TM 100</td>
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</table>

**Prerequisite**
- To Provide Solid background in the fundamental concepts of Process Calculations needed for Chemical Engineers.

**Objectives**
- At the end of the semester students should be able to
  - Read any problem, understand it, analyze it, and write an algorithm to solve it.
  - Apply the laws of conservation of mass and energy, and chemical, and physical concepts to solve problems.
  - Understand the use of each of the chemical engineering unit operations.

**Outcome**

### UNIT – I
**Hours: 09**
Introduction to Chemical engineering calculations, units and dimensions, mole and molecular weight, properties of gases, vapors, liquids, solutions and solids, gas laws, partial pressures, vapor pressures, saturation and equilibria, Raoults law, partial saturation and humidity

### UNIT – II
**Hours: 09**
Material balances without chemical reactions, stoichiometry and unit operations - distillation, absorption, stripping, extraction, leaching, crystallization, drying, and psychrometry. Recycle, purge and bypass calculations.

### UNIT – III
**Hours: 09**
Material balances involving chemical reactions, simple oxidation reaction, calculations involving combustion of gaseous, liquid and solid fuels. Recycle, purge and bypass calculations.
Introduction to unsteady state material balances.

### UNIT – IV
**Hours: 09**
Energy balance - heat capacity and calculation of enthalpy changes, Enthalpy changes for phase transitions, evaporation, Clausius - Clapeyron equation.

### UNIT-V
**Hours: 09**
Energy balances with chemical reaction - heat of reaction and adiabatic flame temperature calculations

**Total contact Hours:** 45
**Total Tutorials:** 15
**Total Practical Classes:** -
**Total Hours:** 60

**Text Books:**

**Reference Books:**
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<tr>
<th>Subject Code</th>
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<td>Momentum Transfer</td>
<td>3</td>
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**Prerequisite**

- To Provide Solid background in the fundamental concepts of Momentum Transfer needed for Chemical Engineers.

**Objectives**

- Understand principles of fluid pressure, static equilibrium, buoyancy, compressible and incompressible fluids, Newtonian and non-Newtonian fluid motion, laminar and turbulent flow.
- Have knowledge of various flow and pressure measuring devices, pumps used for transportation of fluids.

**Outcome**

At the end of the semester students should be able to

**UNIT – I**

Fluid Statics – Fluid density, compressible and incompressible fluids; Pressure, relationship between pressure and density for ideal gas; Hydrostatic equilibrium in gravitational and centrifugal force fields; Gravity decanters and centrifuge; Pascal’s law, hydraulic lever; Measurement of fluid pressure, manometers, Archimedes principle and buoyancy.

Fluid Dynamics – ideal flow of fluids (non-viscous and incompressible fluids), Continuity equation and energy equation (Bernoulli’s equation), applications.

**UNIT – II**

Shear rate, Shear stress, Newton’s law of fluid motion, Viscosity, concept of momentum transfer, Rheology of fluids - Newtonian and non-Newtonian fluids, laminar and turbulent flow, Reynolds number and transition from laminar to turbulent flow.

Momentum balance equation, laminar flow of fluids through circular pipe and between parallel plates, Hagen-Poiseulle equation, flow through non circular cross section – equivalent diameter, Correction of Bernoulli’s equation for velocity and friction, friction factor, friction factor Vs Reynold’s number correlation for turbulent flow through pipes, Dimensional analysis, friction loss across sudden expansion, contraction, valves and fittings.

**UNIT – III**

Transportation and metering of fluid - Orificemeter, Venturimeter, Pitot tube, Rotameter, Wiers and Notches, pumps and compressors, Performance and characteristics of centrifugal pumps, NPSH, Cavitation, Priming.

Flow of Compressible fluids – Thermodynamics of ideal gas, isentropic process, wave propagation through compressible fluids, sonic velocity, Mach number, flow through variable area conduits (Nozzle), Equations for isentropic flow, Equations for isothermal frictional flow.

**UNIT – IV**

Turbulent flow - Velocity fluctuations in turbulent flow, statistical nature of turbulence, Reynold’s stresses, empirical theories, eddy viscosity, Prandtl’s mixing length theory, Velocity distribution for turbulent flow – 1/7th power law, Logarithmic velocity distribution, Universal velocity distribution; Relationship between friction factor and Reynold’s number, Von karman correlation.

Laminar flow of non-Newtonian (power law) fluids through circular pipe, friction factor and Reynold’s number for power law fluid, Metzner Reed’s approach, capillary tube experiment.

**UNIT-V**

Flow past immersed bodies - Boundary layer, drag and drag coefficient, Stokes law and terminal settling velocity.

Flow of fluids through bed of solids - Darcy’s law, Ergun’s equation, Fluidization, minimum fluidization velocity, pneumatic transport.

**Text Books:**


**Reference Books:**

Department: Chemistry  
Programme: B.Tech. (CH)  
Semester: Three  
Category: LB

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>CY105</td>
<td>Physical Chemistry Laboratory</td>
<td>-</td>
<td>3</td>
<td>60</td>
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</tbody>
</table>

| Prerequisite | -                                          |

Objectives
- To educate the principles involved in Physical chemistry.
- To provide practical knowledge of handling instruments.

Outcome
At the end of the semester the student should be able to
- Understand method of determination of physical properties
- Students will gain laboratory skills in analyzing samples using various instruments

List of experiments: (Any 10 experiments)
1. Study of simple eutectic formed by naphthalene-biphenyl system.
2. Study of simple eutectic formed by naphthalene-Diphenylamine system.
3. Critical solution temperature of phenol – water system.
4. Acetic acid – chloroform – water three component system.
5. Rate constant of hydrolysis of ethyl acetate by an acid.
6. Rate constant of a second order reaction – Saponification
7. Partition coefficient of iodine between carbon tetra chloride and water.
8. Partition coefficient of benzoic acid between benzene and water.
9. Determination of molecular weight from depression of freezing point.
10. Transition Temperature of Na₂S₂O₃·5H₂O
11. Adsorption of acetic acid on charcoal – Freundlich adsorption isotherm.
13. Conductometry titration – Strong acid Vs Strong base
14. Conductometry titration – mixture of hydrochloric acid and acetic acid vs sodium hydroxide.
15. Determination of lead by conductometry titration.

Text Books:

Reference Books:
**Department:** Electrical and Electronics Engineering  
**Programme:** B.Tech. (CH)  
**Semester:** Three  
**Category:** LB

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>EE137</td>
<td>Electrical and Electronics Engineering Lab</td>
<td>-</td>
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</table>

**Prerequisite:**
- To introduce load test methods
- To verify important principles in basic electrical and Electronics Engineering

**Objectives:**
- At the end of the semester the student should be able to
- Design and conduct experiments on Transformers, AC and DC electrical machines for their performance analysis,
- Understand theorems for electric circuit analysis, logic gates to analyze and interpret results.

**Outcome:**

**List of experiments: (Any 10 experiments)**
1. Performance characteristics of transformers through OC and SC test.
2. Load test on single-phase transformer.
3. Load test on DC shunt motor.
4. Load test on single phase IM.
5. OCC of DC generator.
7. Verification of logic gates.
8. Verification of Thevinin and Norton theorem.
9. Verification of superposition theorem.
10. Series and parallel resonance.

**Total contact Hours:** -  
**Total Tutorials:** -  
**Total Practical Classes:** 45  
**Total Hours:** 45

**Text Books:**

**Reference Books:**
<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA106</td>
<td>Partial Differential Equations and Numerical Methods</td>
<td>3 L, 1 T, 0 P, 4 C</td>
<td>4 CA, 60 SE, 100 TM</td>
<td></td>
</tr>
</tbody>
</table>

### Prerequisite

- To introduce the ideas of Partial Differential Equations
- To familiarize students Boundary value problems related to PDE
- To solve problems in ordinary and partial differential equations by some basic numerical methods

### Objective

- Understands how to solve first order Partial Differential Equations
- Gain knowledge on solving Boundary Value Problems
- Will be able to solve ordinary and partial differential equations numerically

### Outcome

- Understands how to solve first order Partial Differential Equations
- Gain knowledge on solving Boundary Value Problems
- Will be able to solve ordinary and partial differential equations numerically

### UNIT – I

**Solution of Partial Differential Equations**

Formation of PDE by elimination of arbitrary constants and arbitrary functions – General, Singular, Particular and complete integrals – Lagrange’s linear first order equation – Higher order differential equations with constant coefficients.

### UNIT – II

**Solution of Boundary Value Problems I**

Solution of partial differential equation by the method of separation of variables – Boundary value problems – Fourier series solutions – Transverse vibration of anelastic string.

### UNIT – III

**Solution of Boundary Value Problems II**

Fourier series solution for one dimensional heat flow equation – Fourier series solution for two dimensional heat flow equations under steady state conditions (Cartesian and polar forms).

### UNIT – VI

**Numerical solution of Ordinary Differential Equations**


### UNIT – V

**Numerical solution of Partial Differential Equations**


### Totalcontact Hours: 48 | Total Tutorials: 12 | Total Practical Classes: | Total Hours: 60

### Text Books:


### Reference Books:


### Web sites: (optional)

1. www.math.niu.edu
2. nm.mathforcollege.com

### Reference Books:
<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>CY106</td>
<td>Organic Chemistry</td>
<td>L: 4</td>
<td>T: -</td>
<td>P: -</td>
</tr>
</tbody>
</table>

- **Prerequisite**: -

- **Objectives**
  - To introduce basics of organic chemistry
  - To familiarize students with mechanisms of various reactions

- **Outcome**
  - At the end of the semester the student should be able to
  - Various types of organic compounds and their properties
  - Various types of chemical reactions
  - Biologically and industrially important organic molecules
  - Gives the foundation to understand advanced chemical engineering concepts

### UNIT – I: Fundamentals of Organic Reactions

- **Hours**: 12

### UNIT – II: Monohydric Alcohols

- **Hours**: 12
- General methods of preparation, general properties – Saytzeff rule, methods of distinguishing the three classes of alcohols – Lucas test, Dichromate test

### UNIT – III: Benzene

- **Hours**: 12

### UNIT – IV: Carbohydrates

- **Hours**: 12

### UNIT – V: Heterocyclic compounds

- **Hours**: 12
- Preparation and properties of furan, thiophene, pyrrole and pyridine. Dyes – colour and constitution, Classification of dyes by structure, Classification of dyes based on application.

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**Total contact Hours**: 60  
**Total Tutorials**: -  
**Total Practical Classes**: -  
**Total Hours**: 60

**Text Books**:

**Reference Books**:
<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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</thead>
<tbody>
<tr>
<td>CH103</td>
<td>Chemical Engineering Thermodynamics</td>
<td>L 3 T 1 P - C 4</td>
<td>CA 40</td>
<td>SE 60 TM 100</td>
</tr>
</tbody>
</table>

Prerequisite -

Objectives

- To Provide Solid background in the fundamental concepts of Chemical engineering Thermodynamics needed for Chemical Engineers.

Outcome

At the end of the semester the student should be able to

- Thoroughly understand the properties of ideal and non-ideal solutions.
- Understand the equilibrium between vapor-liquid, liquid-liquid, solid-liquid and solid-vapor systems.
- Understand and apply the various activity coefficient models to solve a non-ideal solution problem.

UNIT – I

The behavior of fluids - PVT properties of fluids, equations of state, ideal and non-ideal gas, the and compressibility factor, critical properties, generalized equations of state.

UNIT – II

First law of thermodynamics - Types of energy, work, heat and energy changes, application of first law to different processes.

Second law of thermodynamics and its applications - Entropy, reversible and irreversible processes, Carnot cycle, T-S diagrams, enthalpy of mixing and disorder, refrigeration, liquefaction.

UNIT – III

Thermodynamic properties and relations among them, mathematical relationships among basic properties, Maxwell relations, changes in properties, temperature and pressure effects, thermodynamic diagrams, construction of thermodynamic diagrams.

UNIT – IV

Solution properties - partial molal properties and chemical potential, concept of fugacity and activity and their calculations, ideal and nonideal solutions, Gibbs-Duhem equations, property change of mixing and excess properties.

UNIT-V

Phase equilibria - Phase rule, fundamentals of vapour - liquid equilibria, Vanlaar, Margules and Wilson equations for binary mixture, liquid - liquid, solid - liquid and solid - vapour equilibria, Introduction to group contribution methods (UNIFAC).

Text Books:


Reference Books:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
<th>Maximum Marks</th>
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<tr>
<td>CH104</td>
<td>Process Heat Transfer</td>
<td>3</td>
<td>1</td>
<td></td>
<td>4</td>
<td>40 60 100</td>
</tr>
</tbody>
</table>

**Prerequisite**
- To Provide Solid background in the fundamental concepts of Process Heat Transfer needed for Chemical Engineers

**Objectives**
- At the end of the semester the student should be able to
- Model basic heat transfer processes and identify modes and calculate thermal resistances, and write an algorithm to solve it.
- Perform an energy balance to determine temperature and heat flux
- Solve lumped parameter transient heat transfer problems and heat exchanger problems

**Outcome**

**UNIT – I**
Hours: 09
Steady state conduction - Fourier's law, thermal conductivity, conduction through composite multilayer plane walls, spherical walls and cylindrical walls, insulation and critical thickness of insulation, heat conduction in rods with heat generation. Heat transfer in extended surfaces - equation for heat transfer in rectangular and cylindrical fins, fin effectiveness and fin efficiency. Unsteady state heat conduction – lumped parameter model, Derivation of unsteady state equation with boundary condition (Solution not included).

**UNIT – II**
Hours: 09

**UNIT – III**
Hours: 09
Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, effect of non-condensable gasses on rate of condensation. Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling.

**UNIT IV**
Hours: 09
Radiation heat transfer - Emissive power, Black body radiation, Emissivity, Stefan - Boltzman law, Plank's law, radiation between surfaces, View factor calculations - view factor for infinitely parallel grey planes, view factor from a plane to a hemisphere, Radiation in absorbing gases.

**UNIT V**
Hours: 09
Heat exchange equipments - Double pipe and shell and tube heat exchangers, concept of log mean temperature difference (LMTD), LMTD correction factor, overall heat transfer coefficient, dirt factor, heat exchanger effectiveness. Evaporators - single effect and multiple effect evaporators, boiling point rise, capacity and economy of multiple effect evaporators, evaporation equipments.

**Total contact Hours**: 45  
**Total Tutorials**: 15  
**Total Practical Classes**: -  
**Total Hours**: 60

**Text Books**:

**Reference Books**:
Department: Chemical Engineering  
Programme: B.Tech. (CH)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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</thead>
<tbody>
<tr>
<td>CH105</td>
<td>Mass Transfer I</td>
<td>3</td>
<td>1</td>
<td>4</td>
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</tbody>
</table>

Prerequisite: -

Objectives:
- To Provide Solid background in the fundamental concepts of Mass Transfer I needed for Chemical Engineers

Outcome:
- At the end of the semester the student should be able to
  - Read any problem, understand it, analyze it, and write an algorithm to solve it.
  - Apply the laws of conservation of mass and energy, and chemical, and physical concepts to solve problems.
  - Understand the use of each of the chemical engineering unit operations.

UNIT – I

<table>
<thead>
<tr>
<th>Hours: 09</th>
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</thead>
</table>

UNIT – II

| Hours: 09 |
Mass transfer in turbulent flow, eddy diffusion, mass transfer coefficients, film theory, penetration theory and surface renewal theories of mass transfer, estimation of mass transfer coefficient in wetted wall column, correlations for the calculation of mass transfer coefficients. Theory of interface mass transfer, Individual and overall mass transfer coefficients, steady state co-current and countercurrent mass transfer processes, stages and stage efficiencies, cross flow and counter current cascades of stages, Kremser equations for the calculation of number of theoretical stages.

UNIT – III

| Hours: 09 |
Equipments for gas-liquid contact operations – Gas dispersed – Sparged vessels, mechanically agitated vessels, Tray towers; Liquid Dispersed – Venturi Scrubber, Wetted Wall Tower, Spray Tower, packed Towers; Correlations for Mass Transfer Coefficients.

UNIT – IV

| Hours: 09 |
Gas Absorption - Tray tower absorber, absorption factor, calculation number of theoretical stages, Murphree efficiency - point efficiency, tray efficiency and overall tray efficiency, calculation of actual number of trays.

Packed tower absorber - HETP, HTU and NTU calculations Non-isothermal absorber, absorption with chemical reaction.

UNIT-V

| Hours: 09 |
Adsorption – Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Freundlich equation. Adsorption operation – stage wise operations, steady state moving bed adsorbers, unsteady state fixed bed adsorbers, break through curves, rate of adsorption in fixed beds, design of fixed bed adsorbers. Ion exchange – Principle of Ion exchange.

Total contact Hours: 45  
Total Tutorials: 15  
Total Practical Classes: -  
Total Hours: 60

Text Books:

Reference Books:
<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
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<th>Credit</th>
<th>Maximum Marks</th>
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</thead>
<tbody>
<tr>
<td>CY107</td>
<td>Organic Chemistry Laboratory</td>
<td>L 3</td>
<td>2</td>
<td>60</td>
</tr>
</tbody>
</table>

**Prerequisite**

Objectives

- To provide on hand on experience on various organic reactions.

Outcome

At the end of the semester the student should be able to

- Understand the concepts of organic chemistry through experiments

List of experiments: (Any 10 experiments)

1. Organic preparations:
   Preparations of compounds involving the following reactions (a) Oxidation (b) Reduction (c) Bromination (d) Nitration (e) Acetylation (f) Hydrolysis

2. Organic qualitative analysis:
   The following classes of compounds are to be analysed (a) Aldehydes (b) Ketones (c) Acids (d) Amides (e) Esters (f) Amines (g) Ethers (h) Alcohols (i) Hydrocarbons (j) Sugar (k) Phenols

3. Determination of physical constants:
   Boiling point and melting point determination.

**Total contact Hours:** -  
**Total Tutorials:** -  
**Total Practical Classes:** 45  
**Total Hours:** 45

**Text Books:**


**Reference Books:**
<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>CH106</td>
<td>Momentum Transfer Laboratory</td>
<td>-</td>
<td>3</td>
<td>60</td>
</tr>
</tbody>
</table>

**Prerequisite**

- 

**Objectives**

- To educate the principles involved in momentum transfer through experiments.
- To provide practical knowledge of handling fluid flow systems.

**Outcome**

At the end of the semester the student should be able to

- Students will be able to understand momentum transfer and its usefulness in industry.
- Students will gain laboratory skills and that will give confidence in analyzing sample data in engineering.

**List of experiments: (Any 10 experiments)**

1. Laminar flow of Newtonian and non Newtonian fluids;
2. Flow through pipes and fittings;
3. Flow through annulus;
4. Orifice meter;
5. Venturi meter;
6. Rotameter;
7. Weirs and notches;
8. Packed bed;
9. Fluidized bed;
10. Centrifugal pump characteristics.

**Total contact Hours:** -  
**Total Tutorials:** -  
**Total Practical Classes:** 45  
**Total Hours:** 45

**Text Books:**


**Reference Books:**

-
### Course Information

**Department:** Chemical Engineering  
**Programme:** B.Tech. (CH)  
**Semester:** Five  
**Category:** TA

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<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
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<tr>
<td>CH107</td>
<td>Mass Transfer II</td>
<td>3 L 1 T 0 P</td>
<td>4 C</td>
<td>40 CA 60 SE 100 TM</td>
</tr>
</tbody>
</table>

### Prerequisite
- 

### Objectives
- To Provide Solid background in the fundamental concepts of Mass Transfer II needed for Chemical Engineers

### Outcome
- At the end of the semester the student should be able to
  - Read any problem, understand it, analyze it, and write an algorithm to solve it.
  - Apply the laws of conservation of mass and energy, and chemical, and physical concepts to solve problems.
  - Understand the use of each of the chemical engineering unit operations.

#### UNIT – I

**Hours: 09**
- Vapour liquid equilibria - Raoult’s law, relative volatility, vapour liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential or simple distillation, steam distillation, multistage continuous rectification, calculation of number of ideal stages by Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio.

#### UNIT – II

**Hours: 09**
- Number of ideal stages by McCabe - Thiele method, effect of operating conditions on the number of ideal stages, Murphree stage and overall efficiency, calculation of actual number of stages, batch distillation with reflux, packed bed distillation, NTU and HTU calculations. Introduction to Multicomponent distillation - key components, minimum number of plates, minimum reflux ratio, Azeotropic and Extractive distillation.

#### UNIT – III

**Hours: 09**
- Liquid - liquid extraction - ternary liquid liquid equilibrium, solvent characteristics, equipments for liquid liquid extraction, stage wise contact - cross current and counter current extraction, continuous contact extraction, packed bed extraction with reflux. Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank’s system), equipments for leaching operation, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.

#### UNIT – IV

**Hours: 09**
- Humidification operations - humidity chart, adiabatic saturation curves, wet bulb temperature and measurement of humidity, Lewis relation, equipments for humidification operations, water cooling towers and spray chambers. Theory and calculation of humidification processes - gas liquid interaction, conditions in the top and bottom of cooling towers, design of cooling towers and dehumidifiers.  
Drying - equipments for batch and continuous drying of solids, principles and theories of drying - drying rate curve, critical and equilibrium moisture content, calculation of drying time under constant drying conditions. Mechanism of batch drying - cross-circulation drying, through circulation drying. Continuous drying - material and energy balances in continuous dryers, rotary dryer - design of rotary dryer.

#### UNIT-V

**Hours: 09**
- Crystallization - principles of crystallization, types of crystals, nucleation theories, crystal growth and L law, particle size distribution of crystals, Yields, heat and material balances in crystallization, equipments for crystallization.

**Total contact Hours: 45**  
**Total Tutorials: 15**  
**Total Practical Classes: -**  
**Total Hours: 60**

### Text Books:

### Reference Books:
<table>
<thead>
<tr>
<th>Subject Code</th>
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<th>Credit</th>
<th>Maximum Marks</th>
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<td>C</td>
</tr>
<tr>
<td>CH108</td>
<td>Mechanical Operations</td>
<td>3</td>
<td>1</td>
<td>-</td>
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</tbody>
</table>

**Prerequisite:**

- To Provide Solid background in the fundamental concepts of Mechanical Operations needed for Chemical Engineers

**Objectives:**

- At the end of the semester the student should be able to
  - To provide necessary background in handling of solid particles
  - To Provide training to choose methods and solve problems relevant to general practice of chemical engineering

**UNIT – I**

<table>
<thead>
<tr>
<th>Hours: 09</th>
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</thead>
</table>

**UNIT – II**

<table>
<thead>
<tr>
<th>Hours: 09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size reduction - Energy relationships in size reduction, size reduction equipment and selection, closed circuit and open circuit operation. Size enlargement - Principle of granulation, briquetting, pelletisation, flocculation, typical equipments used.</td>
</tr>
</tbody>
</table>

**UNIT – III**

<table>
<thead>
<tr>
<th>Hours: 09</th>
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</thead>
<tbody>
<tr>
<td>Classification - Application of Stoke’s equation, types of classifiers - gravity settling, settling tanks, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - Principles, separation of solids from fluids, separation of immiscible liquids, continuous centrifuges, super centrifuges, design of basket centrifuges, cyclones and hydro cyclones. Gas cleaning - Gravity and momentum separators, cyclone separators, design of cyclones, liquid washing, electrostatic precipitators.</td>
</tr>
</tbody>
</table>

**UNIT – IV**

<table>
<thead>
<tr>
<th>Hours: 09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid - Liquid separation-Filtration, flow through filter cake and filter media, compressible and incompressible filter cakes, filtration equipments - selection, operation and design of filters and optimum cycle of operation, filter aids. Thickening - Batch and continuous thickeners, design of continuous thickeners.</td>
</tr>
</tbody>
</table>

**UNIT-V**

<table>
<thead>
<tr>
<th>Hours: 09</th>
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</thead>
<tbody>
<tr>
<td>Froth flotation - Principles and theories of collection, flotation cell and typical circuit. Magnetic separation, Electrical separation. Sorting (separation of solids) - principles of jiggers, types of jiggers, performance characteristics, principles of flowing film concentrators, tabling, heavy liquid and heavy media separation. Mixing and agitation - Mixing of liquids (with or without solids) which are viscous but are pourable after mixing, mixing of liquids (with solids) which form stiff pastes, mixing of powders, selection of suitable mixers, power requirement for mixing.</td>
</tr>
</tbody>
</table>

**Total contact Hours: 45 | Total Tutorials: 15 | Total Practical Classes: - | Total Hours: 60**

**Text Books:**


**Reference Books:**

Department : Chemical Engineering  
Programme : B.Tech. (CH) 

Semester : Five  
Category : TB

<table>
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<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
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<tr>
<td>CH109</td>
<td>Chemical Reaction Engineering I</td>
<td>3 L 1 T -</td>
<td>4 C</td>
<td>40 60 100</td>
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</tbody>
</table>

Prerequisite -

Objectives

- To Provide Solid background in the fundamental concepts of Chemical Reaction Engineering I needed for Chemical Engineers

Outcome

- Understand the concept of equilibrium involving chemical reactions in the gas, liquid and solid phases
- Apply the law of conservation of mass to develop the performance equation for single ideal isothermal homogeneous reactors
- Decide suitable reactor for the given reaction system

UNIT – I  
Hours: 09

Chemical equilibria - Free energy and chemical reactions, feasibility of chemical reaction, calculation of free energy of homogeneous reactions, equilibrium constants and evaluation from thermodynamic data, effect of different variables on reaction equilibria, calculation of equilibrium composition for single and multiple reactions, equilibria of heterogeneous reactions.

UNIT – II  
Hours: 09

Kinetics of homogeneous reactions - introduction, single and multiple reactions, elementary and nonelementary reactions, rate equations, kinetic models for nonelementary reactions, testing kinetic models, temperature dependence of rate - Arrhenius, collision and activated complex theories, Interpretation of batch reactor data for single and complex reactions under constant volume and variable volume conditions, differential and integral analysis, half life period.

UNIT – III  
Hours: 09

Design of single homogeneous reactors - ideal reactors, design equations for ideal batch reactor, PFR and CSTR, size comparison of single reactors, optimum reactor size problems.

UNIT – IV  
Hours: 09

Multiple reactor systems - plug flow reactors in series and / or parallel, CSTRs in series, reactors of different types in series, recycle reactor, auto catalytic reactions, optimum recycle ratio for an auto catalytic reaction.

UNIT – IV  
Hours: 09

Multiple reaction systems - series and parallel reactions in CSTRs and PFRs, product distribution, fractional yields, maximization of fractional yield in multiple reactions, series - parallel reactions.

Total contact Hours: 45  
Total Tutorials: 15  
Total Practical Classes: -  
Total Hours: 60

Text Books:


Reference Books:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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</thead>
<tbody>
<tr>
<td>CH110</td>
<td>Heat Transfer Laboratory</td>
<td>-</td>
<td>3</td>
<td>60</td>
</tr>
</tbody>
</table>

**Prerequisite:**
- 

**Objectives:**
- To educate the principles involved in heat transfer through experiments.
- To provide practical knowledge of handling heat transfer systems.

**Outcome:**
- Students will be able to understand basic principles of heat transfer through experiments.
- Students will gain laboratory skills and that will give confidence in analyzing samples in engineering and other fields.

**List of experiments: (Any 10 experiments)**
1. Heat Transfer through Composite Wall;
2. Transient Heat Conduction;
3. Heat Transfer in a Shell and Tube Heat Exchanger;
4. Heat Transfer through Packed Bed;
5. Heat Transfer in a Double Pipe Heat Exchanger;
6. Heat Transfer in a Vertical Condenser;
7. Heat Transfer in a Horizontal Condenser;
8. Heat Transfer in Helical Coils;
9. Heat Transfer with Natural Convection;

**Text Books:**

**Reference Books:**
Department: Chemical Engineering  Programme: B.Tech. (CH)

Semester: Five  Category: LB

<table>
<thead>
<tr>
<th>Subject Code</th>
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<th>Hours / Week</th>
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</thead>
<tbody>
<tr>
<td>CH111</td>
<td>Mass Transfer Laboratory</td>
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<td>3</td>
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</tbody>
</table>

Prerequisite: -

Objectives:
- To educate the principles involved in Mass Transfer.
- To provide practical knowledge of handling mass transfer systems.

Outcome:
- Students will be able to understand basic principles of mass transfer through experiments.
- Students will gain laboratory skills and that will give confidence in data analyzing in engineering.

List of experiments: (Any 10 experiments)
1. Stefan’s tube experiment-diffusivity of vapour in air;
2. Liquid liquid diffusion-diffusivity of salt in water;
3. Surface Evaporation;
4. Sublimation of naphthalene ball;
5. Packed bed absorber;
6. Hydrodynamic /flooding characterization of packed tower;
7. Hydrodynamic /flooding characterization of tray tower;
8. Adsorption isotherm;
9. Multistage adsorption ;
10. Vapour liquid equilibrium;
11. Simple distillation;
12. Steam distillation I and II;
13. HETP;
14. Liquid liquid equilibrium ;
15. Liquid liquid extraction;
16. Leaching.

Total contact Hours: -  Total Tutorials: -  Total Practical Classes: 45  Total Hours: 45

Text Books:

Reference Books:
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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</thead>
<tbody>
<tr>
<td>CH112</td>
<td>Mechanical Operations Laboratory</td>
<td>- L - T 3 P</td>
<td>2</td>
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</tr>
</tbody>
</table>

**Prerequisite**
- 

**Objectives**
- To educate the principles involved in Mechanical Operations.
- To provide practical knowledge of handling size reduction equipments.

**Outcome**
- Students will be able to understand practically the basic principles of Mechanical Operations
- Students will gain laboratory skills and report writing skills

**List of experiments: (Any 10 experiments)**
1. Screen effectiveness;
2. Jaw crusher;
3. Ball mill;
4. Drop weight crusher;
5. Beaker decantation;
6. Air elutriation;
7. Vacuum leaf filter;
8. Plate and frame filter press;
9. Batch sedimentation;
10. Terminal settling velocity-Stokes law.

**Total contact Hours:** -  
**Total Tutorials:** -  
**Total Practical Classes:** 45  
**Total Hours:** 45

**Text Books:**

**Reference Books:**
### Industrial Engineering and Management

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
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<tr>
<td>ME129</td>
<td>Industrial Engineering and Management</td>
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</table>

#### Prerequisite
- To provide the students with the knowledge of productivity techniques and systems, industrial engineering and management disciplines so as to fully equip them to take up challenging assignments as industrial engineers, systems managers, productivity advisers, managers of management services or training officers.

#### Objectives
- Competently employ broad-based analytical tools and computers for decision-making and system design, analysis and performance.
- Assume managerial and leadership roles in their chosen professional careers while working in multidisciplinary teams.
- Engage in continuous learning by seeking out opportunities for higher education or ongoing training related to their employment.
- Effectively adapt to the changing demands in workplace and are able to perform increasingly complex tasks, and tasks outside their field of expertise.

#### Outcomes
- Students will learn how to improve the productivity of managers and systems.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Subject Description</th>
<th>Hours</th>
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</thead>
</table>

#### Contact Hours: 60
- Total Tutorials: -
- Total Practical Classes: -
- Total Hours: 60

#### Text Books:

#### Reference Books:

Web Sites:
1. www.nptel.ac.in
### Subject Code: CH113  
### Subject: Chemical Reaction Engineering II

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</table>

**Prerequisite:**

- To Provide Solid background in the fundamental concepts of Chemical Reaction Engineering II needed for Chemical Engineers

#### Objectives

- To understand non-ideal fluid mixing and flow patterns in reactors and account for it calculating the conversion.
- To write heat balance equations to account for effect of temperature on conversion in batch and flow reactors and to analyze the stability of non-isothermal reactors.
- To apply the principle of rate controlling step in deducing global rate expressions for heterogeneous chemical reactions involving reaction kinetic rates and mass transfer rates.

#### Outcome

At the end of the semester the student should be able to

- Understand non-ideal fluid mixing and flow patterns in reactors and account for it calculating the conversion.
- Write heat balance equations to account for effect of temperature on conversion in batch and flow reactors and to analyze the stability of non-isothermal reactors.
- Apply the principle of rate controlling step in deducing global rate expressions for heterogeneous chemical reactions involving reaction kinetic rates and mass transfer rates.

#### UNIT – I

**Hours:** 09

Non-isothermal reactions - temperature effects on chemical reaction rates, design procedures for adiabatic and non-isothermal operation of batch and flow reactors, optimum temperature progression, operating temperature for favorable product distribution in multiple reactions, reactor stability.

#### UNIT – II

**Hours:** 09


#### UNIT – III

**Hours:** 09

Fluid-solid noncatalytic reactions - shrinking core model, determination of the rate controlling step, conversion in reactors with constant fluid composition, conversion in reactors with variable fluid composition - fixed bed reactor, moving bed reactor. Gas-liquid non-catalytic reactions - models for transfer at gas-liquid interface, enhancement factor, Hatta number, Derivation of overall rate equation for first order irreversible reaction and instantaneous reaction, design of packed bed reactors for gas-liquid non-catalytic reactions (simple cases).

#### UNIT – IV

**Hours:** 09


#### UNIT – V

**Hours:** 09

Reaction and diffusion in porous catalysts - effectiveness factor, Thiele modulus, non-isothermal effectiveness factor, Global rate equations. Heterogeneous catalytic reactors - Fixed bed reactors, fluidized bed reactors, slurry reactors, Trickle bed reactors, design aspects with some simple examples.

**Total contact Hours:** 45  
**Total Tutorials:** 15  
**Total Practical Classes:** 0  
**Total Hours:** 60

### Text Books:


### Reference Books:

### Subject Code: CH114

**Subject:** Chemical Process Industries  
**Hours / Week:** L 4, T - , P -  
**Credit:** C 4, CA 40, SE 60, TM 100  
**Maximum Marks:** 100

**Prerequisite:** -

**Objectives:**  
- To Provide Solid background in the fundamental concepts of Chemical Process Industries needed for Chemical Engineers

**Outcome:**  
At the end of the semester the student should be able to:
- Read, understand, and use process flow diagrams.
- Apply the basic principles of chemistry and engineering to design a chemical plant.
- Choose an economic and environment friendly method of industrial production
- Draw a flow chart for converting the raw material into end product

**UNIT – I**  

**UNIT – II**  

**UNIT – III**  

**UNIT – IV**  
Sugars and Paints: Manufacture of sugar, starch and starch derivatives-Manufacture of paints – Pigments. Vegetable oil, Cottonseed Oil and Soybean Oil by Solvent Extraction.

**UNIT – V**  

**Text Books:**

**Reference Books:**
<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>CH115</td>
<td>Process and Mechanical Design of Chemical Equipment</td>
<td>2 - 3 - 4</td>
<td>60 40 100</td>
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</tbody>
</table>

### Prerequisite

- To Provide Solid background in the fundamental concepts of Process and Mechanical Design of Chemical Equipment needed for Chemical Engineers

### Objectives

At the end of the semester the student should be able to

- Understand the roles and responsibilities of a process design engineer
- Read any problem, understand the design logic and write an algorithm to solve it.
- Apply the basic concepts of material and energy balances, heat transfer and mass transfer to design various related equipments.

### Outcome

Detailed Process Design and Mechanical Design of the following equipments:

(i) Heat exchangers

- Double pipe heat exchangers
- Shell and Tube heat exchangers

(ii) Condensers

- Horizontal Condenser
- Vertical Condenser

(iii) Evaporators

- Multiple Effect Forward feed Evaporator (with and without boiling point rise)
- Multiple Effect Backward feed Evaporator (with and without boiling point rise)

(iv) Absorption Tower

- Plate Column
- Packed column

(v) Distillation Tower

- Plate Column
- Packed column

(vi) Rotary Drier

(vii) Cooling Tower

(viii) Reactors

(ix) Storage Tanks

Total contact Hours: 30  | Total Tutorials: -  | Total Practical Classes: 45  | Total Hours: 75

### Text Books:


### Reference Books:

# Chemical Reaction Engineering

**Subject Code**: CH116  
**Subject**: Chemical Reaction Engineering Laboratory  
**Hours / Week**: L - T - P 3  
**Credit**: C 2  
**Maximum Marks**: CA 60, SE 40, TM 100

## Prerequisite
- To educate the principles involved chemical reaction engineering.
- To provide practical knowledge of handling chemicals.

## Objectives
- Students will be able to understand basics of chemical reactions engineering.
- Students will be able to validate various theoretical model studied.
- Students will gain laboratory skills and report writing skills.

## Outcome
- Students will be able to understand basics of chemical reactions engineering.
- Students will be able to validate various theoretical model studied.
- Students will gain laboratory skills and report writing skills.

## List of experiments: (Any 10 experiments)
1. Isothermal Batch reactor – Determination of order and reaction rate constant;
2. Semi batch reactor- Determination of conversion and reaction rate constant;
3. Determination of activation energy;
4. CSTR- Determination of conversion and reaction rate constant;
5. PFR- Determination of conversion and reaction rate constant;
6. PFR and CSTR in series- Comparison of conversion;
7. Three CSTRs in series- Comparison of conversion;
8. Residence Time Distribution in CSTR;
9. Residence Time Distribution in packed bed reactor;
10. Heterogeneous catalytic reaction.

## Text Books:
<table>
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<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>CH117</td>
<td>Computational Laboratory</td>
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<td>- 3</td>
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</table>

**Prerequisite**
- 

**Objectives**
- To educate the role of computer in solving iterative problems
- To provide practical knowledge of handling chemical engineering problems with modern tools.

**Outcome**
- Students will be able to understand coding of iterative calculations.
- Students will gain confidence in analyzing chemical problems using computers

**List of experiments: (Any 10 experiments)**
- Solutions to linear equations
- Solutions to non linear equations
- Solutions to Simultaneous Equations (Material and Energy Balances)
- Cubic Equation solving (EoS Equations)
- Bubble point and dew point Calculations
- VLE calculations
- Interpolation of chemical data from steam table etc
- Regression Analysis of linear data systems
- Regression Analysis of non linear data systems
- Solutions to Transient state problems (Heat and Mass Transfer examples)
- One dimensional optimization problems (Simplex algorithm, LM algorithm)

**Total contact Hours:** -  
**Total Tutorials:** -  
**Total Practical Classes:** 45  
**Total Hours:** 45  

**Text Books:**

**Reference Books:**
<table>
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<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tr>
<td>HS102</td>
<td>General Proficiency</td>
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</table>

**Prerequisite**
- To enhance the students’ communication and language skills and make them industry-ready.
- To encourage brainstorming discussions and team work.
- To train students to master soft skills through various activities.

**Art of communication**:
- Verbal and Non-verbal Communication
- Barriers to Communication
- Importance of Body Language
- Effective Listening
- Feedback
- Presentation skills.

**Introduction to soft skills**:
- Self-Confidence
- Leadership Qualities
- Emotional Quotient
- Time Management
- Stress Management
- Interpersonal Skills.

**Comprehension and Analysis**:
- British and American English
- GRE based comprehension
- Analytical writing
- Analyzing contemporary issues
- Current English usage.

**Adapting to corporate life**:
- Group discussions
- Meetings
- Public Speaking
- Debate
- Intercultural communication
- Etiquettes
- Interviews
- Email writing.

**Aptitude**:
- Vocabulary building
- Verbal and Numerical aptitude.

**Total contact Hours**: Total Tutorials: Total Practical Classes: 45 Total Hours: 45

**Reference Books**:

**Websites**
1. www.cambridgeenglish.org
<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tr>
<td>CH118</td>
<td>Transport Phenomena</td>
<td>3 L 1 T 1 P 4</td>
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<td>40 60 100</td>
</tr>
</tbody>
</table>

Objectives
- To Provide Solid background in the fundamental concepts of Transport Phenomena needed for Chemical Engineers

Outcome
At the end of the semester, the student should be able to
- Understand the various coordinate systems such as rectangular and curvilinear coordinates
- Transform one coordinate system to another
- Comprehend the transport of momentum, heat and mass transport through different geometries

Note: Table containing the Transport Phenomena equations is permitted in the examination.

UNIT – I
Hours: 09
Viscosity, temperature effect on viscosity of gases and liquids, Newton’s law, mechanism of momentum transport, Velocity distribution in laminar flow- shell momentum balance-flow through tubes-surfaces-flow of Newtonian fluid.

UNIT – II
Hours: 09
Equation of change for isothermal process – one dimensional equation of motion and continuity – Euler and Navier Stokes equation, dimensional analysis of equation of change.

UNIT – III
Hours: 09
Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier’s law, mechanism of energy transport, shell energy balance, temperature distribution in solids and laminar flow with electrical, nuclear, viscous heat source, heat conduction through composite walls, cylinders, spheres, fins, slits.

UNIT – IV
Hours: 09
Energy equations, special forms, use of equations of change, dimensional analysis of equations of change, time-smoothed equations of change, empirical expressions, temperature distribution for turbulent flow in tubes, jets.

UNIT – V
Hours: 09
Diffusivity, temperature and pressure effect, Fick’s law, mechanism of mass transport, theory of diffusion in gases and liquids, shell mass balances, concentration distribution in solids and in laminar flow: Stagnant gas film, heterogeneous and homogeneous chemical reaction systems, falling film, porous catalyst. The equation of continuity, summary of equations of change and fluxes, use of equations of change, dimensional analysis, time smoothed equations of change, empirical expressions for turbulent mass flux.

Text Books:

Reference Books:
Department: Chemical Engineering    Programme: B.Tech. (CH)

Semester: Seven    Category: TB

<table>
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<tr>
<th>Subject Code</th>
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<th>Hours / Week</th>
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<tr>
<td>CH119</td>
<td>Process Dynamics and Control</td>
<td>3 1 -</td>
<td>4 40</td>
<td>60 100</td>
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</table>

Prerequisite: -

Objectives
- To Provide Solid background in the fundamental concepts of Process Dynamics and Control needed for Chemical Engineers

Outcome
At the end of the semester the student should be able to
- Write unsteady state material and energy balance equations for a number of systems and deduce transfer function models.
- Deduce closed loop transfer function models for feedback control systems with PID controller and analyze the transient behavior.
- Analyze the stability of control systems using Routh, Bode and Nyquist criteria.

UNIT – I
Introduction - Control system, components of a feed back control system, Lags in the control system – transfer lag, transportation lag, Pneumatic PID controller, control valve – valve characteristics
Laplace transforms - properties of laplace transform, solution of linear differential equations using laplace transform techniques, piecewise continuous functions.

UNIT – II
Dynamic behaviour of systems - derivation of transfer functions for first and second order systems, liquid level, temperature, pressure, flow and concentration control processes, linearisation of nonlinear systems, interacting and non-interacting systems.Transient response of first and second order systems, natural frequency, damping factor, overshoot, decay ratio, rise time and settling time.

UNIT – III
Transient analysis of control systems - block diagram algebra, overall transfer function of closed loop control systems, regulator and servo problems, transient response of first and second order systems with P, PI and PID controller.Definition of stability of control systems, Routh test, limitations of Routh test, Pade’s approximation of time delay systems.

UNIT – IV

UNIT – V
Nyquist stability criteria, calculation of phase margin, gain margin, peak gain and resonant frequency using nyquist plot. Introduction to advanced control techniques - feed forward control, cascade control, ratio control, adaptive control, inferential control, selective control.

Total contact Hours: 45       Total Tutorials: 15       Total Practical Classes: -       Total Hours: 60

Text Books:

Reference Books:
## Subject Code: CH120  
Subject: Process Engineering Economics  

<table>
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<th>Hours / Week</th>
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### Prerequisite
- To Provide Solid background in the fundamental concepts of Process Engineering Economics needed for Chemical Engineers.

### Objectives

- At the end of the semester, the student should be able to
  - Estimate the capital investment, cost of production, depreciation and cash flows of Chemical Engineering Processes.
  - Make decisions about the profitability of Chemical Engineering Processes by applying discounted profitability analysis including net present value, internal rate of return and discounted payback period.
  - Analyze and calculate depreciation of processes equipments and take decisions on the replacement of existing equipments.

### Unit I
- Hours: 09
  - Time value of money - simple and compound interest - discrete, nominal and continuous rate of return and their relationships, issue and evaluation of bonds, concept of equivalence.

### Unit II
- Hours: 09
  - Depreciation and Amortization - classification of depreciation and methods of uniform, rapid and slow write off techniques and their comparison, depreciation accounting procedures, taxes and insurance, implication of taxes in selecting alternates.

### Unit III
- Hours: 09
  - Economics of selection of alternates - criteria, annual cost, present worth, rate of return, capitalized cost methods, extra investment analysis, mutually exclusive basis, replacement economy.

### Unit IV
- Hours: 09
  - Cost estimation - equipment costs, cost indices, William’s point sixth rule, methods of estimation of fixed capital, product cost estimation.
  - Bookkeeping - ledgers and journals, financial statements, balance sheet, principles and application of project execution techniques, PERT and CPM, preparation of project feasibility reports, selection of plant location and layout.

### Unit V
- Hours: 09
  - Optimization - procedure involving single and two variables, optimum number of units required for maximum profit and minimum cost, determination of optimum parameters in selected unit operations - fluid flow (optimum pipe diameter), heat transfer (optimum thickness of insulation), evaporation, filtration, break-even analysis.

### Total contact Hours: 45  
Total Tutorials: 15  
Total Practical Classes: -  
Total Hours: 60

### Text Books:

### Reference Books:
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<th>Subject Code</th>
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<tbody>
<tr>
<td>CH121</td>
<td>Process Control and Simulation Laboratory</td>
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<td>2</td>
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**Prerequisite**
- To educate the principles involved in Process Control.
- To provide practical knowledge of handling data.

**Outcome**
- Students will be able to understand Process Control concepts.
- Students will gain laboratory skills and working knowledge about various simple systems.

**List of experiments: (Any 10 experiments)**

**Process Dynamics and Control Experiments**
1. Time constant of a thermometer;
2. Transient response of a mercury manometer;
3. Transient response of a pressure vessel system;
4. Transient response of a mixing vessel;
5. Transient response of an interacting liquid level system;
6. Transient response of a non-interacting liquid level system;
7. Control valve characteristics;
8. On–Off Control system behaviour.
9. Level controller
10. Temperature controller

**Text Books:**

**Reference Books:**
<table>
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<tr>
<th>Subject Code</th>
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<th>Hours / Week</th>
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<tbody>
<tr>
<td>CH122</td>
<td>Project Work (Phase I)</td>
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Prerequisite: -

Objectives:
- To learn the technique of collecting literature pertaining to the propose project
- To gain knowledge to summarize the literature

Outcome:
At the end of the semester the student should be able to:
- Reinforce classroom theory by collecting literature pertaining to the propose project
- Write technical report
- Work in teams.

The objective of the project is to enable the students to work in groups of not more than four members in each group on a project involving analytical, experimental, design or combination of these in the area of Chemical Engineering. Each project shall have a guide. The student is required to do literature survey, formulate the problem and form a methodology of arriving at the solution of the problem.

Total contact Hours: - | Total Tutorials: - | Total Practical Classes: 45 | Total Hours: 45
### Department: Chemical Engineering  
**Programme:** B.Tech. (CH)  
**Semester:** Seven  
**Category:** PR

<table>
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<tr>
<th>Subject Code</th>
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<tr>
<td>CH123</td>
<td>Professional Ethics and Practice</td>
<td>-</td>
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**Prerequisite:** -

**Objectives:**
- To provide the need of ethics in technical profession
- To gain importance of safety

**Outcome:** At the end of the semester the student should be able to
- Know the code of ethics and safety
- To gain proficiency in writing technical reports
- Work in teams

The course should cover the following topics by way of Seminars, Expert Lecturers and Assignments.
- Engineering Ethics – Moral Issues, Ethical theories and their uses
- Engineering as Experimentation – Code of Ethics
- Engineer’s Responsibility for Safety
- Responsibilities in Rights
- Global issues of engineering ethics

**Total contact Hours:** -  
**Total Tutorials:** -  
**Total Practical Classes:** 45  
**Total Hours:** 45

**Text Books:**

**Reference Books:**
Subject Code | Subject                          | Hours / Week | Credit | Maximum Marks |
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<td>CH124</td>
<td>Comprehensive Test and Viva-Voce</td>
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Prerequisite
- 

Objectives
- To recollect the basic concepts learn in the curriculum
- To help the student in preparing for competitive examinations

Outcome
At the end of the semester the student should be able to
- Understand all basic principles of core chemical engineering
- Fine tune their fundamentals

The student will be tested for his/her understanding of the basic principles of the core chemical engineering subjects through a series of tests and viva voce.

Total contact Hours: - | Total Tutorials: - | Total Practical Classes: 45 | Total Hours: 45
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<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tr>
<td>CH125</td>
<td>Project Work (Phase II)</td>
<td>L  T  P</td>
<td>C</td>
<td>CA  SE  TM</td>
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<tr>
<td></td>
<td></td>
<td>9</td>
<td>6</td>
<td>60  40  100</td>
</tr>
</tbody>
</table>

**Prerequisite**
- 

**Objectives**
- To learn the technique of collecting literature pertaining to the propose project
- To gain knowledge to summarize the literature and findings

**Outcome**
At the end of the semester the student should be able to
- Reinforce classroom theory by collecting literature pertaining to the propose project
- To gain proficiency in writing technical reports
- Work in teams

Project work phase II will be an extension of the project work phase I started in the seventh semester. On completion of the work, a project report should be prepared and submitted to the department.

**Total contact Hours: 135**  **Total Tutorials: -**  **Total Practical Classes: -**  **Total Hours: 135**
SYLLABUS (Elective Subjects)
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<thead>
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<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tr>
<td>CHP01</td>
<td>Energy Technology and Management</td>
<td>L 4 T 4 P 0 C 4</td>
<td>60</td>
<td>100</td>
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</table>

**Prerequisite**
- 

**Objectives**
- To Understand & utilize the various forms of energies.
- To have a knowledge to function on various combustion equipments.

**Outcome**
At the end of the semester the student should be able to
- Understand about Energy Technology and Management.
- Understand various processes, and equipments

---

### UNIT – I
**Hours: 12**
Fuels - Classification, Properties, tests and analysis. Solid Fuels - Coal, origin, classification, storage and handling, carbonization, gasification and briquetting - gasification of biomass.

### UNIT – II
**Hours: 12**

### UNIT – III
**Hours: 12**
Combustion - Air requirement for solid, liquid and gaseous fuels, Combustion equipment Solar energy, Wind energy, Tidal energy.

### UNIT – IV
**Hours: 12**
Geothermal energy, Magneto hydrodynamics, Nuclear energy. Energy Management-Principles need, initiating and managing an energy management program.

### UNIT – V
**Hours: 12**
Energy audit – elements, and concepts, types of energy audits, energy audit with respect to industries like sugar, paper etc., Energy Conservation-Thermodynamics of energy conservation, cogeneration, waste heat recovery technologies. Industrial insulation - material selection, economical thickness.

**Total contact Hours: 60**
**Total Tutorials: -**
**Total Practical Classes: -**
**Total Hours: 60**

**Text Books:**

**Reference Books:**
<table>
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<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
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<tr>
<td>CHP02</td>
<td>Bioprocess Engineering</td>
<td>4 L - - -</td>
<td>4 C</td>
<td>40 CA 60 SE 100 TM</td>
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</tbody>
</table>

**Prerequisite:**
- 

**Objectives:**
- To educate basics of principles of bio process engineering
- To outline the various practices in the bio process industry

**Outcome:**
At the end of the semester the student should be able to
- Understand about bio processes engineering principles.
- Understand various processes, products, reactions and equipments involved

**UNIT – I**
Introduction to bioprocess engineering, story of Penicillin, regulatory constraints of bioprocess engineering, microbial diversity, biomolecules, Recombinant DNA technology, Cell Mutation

**UNIT – II**
Enzymes: Introduction, types, industrially and medically important enzymes, Enzyme kinetics for SSSE system, Methods of Enzyme Immobilisation.

**UNIT – III**
Metabolic Pathways: Bioenergetics, glucose metabolism, glucoysis, TCA cycle, Respiration, Anaerobic Metabolism, Batch Cellular growth kinetics, cell growth nutrients.

**UNIT – IV**
Principles of Fermentation: types of industrial fermentation, fermentation media, sterilization, inoculum development, instrumentation and control of Fermentor, bioreactor types, down stream processing.

**UNIT – V**
Traditional Industrial Bioprocess: Ethanol Production, Bakers Yeast production, Penicillin Production, Beer Production, wine production and cheese production.

**Text Books:**

**Reference Books:**
<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tr>
<td>CHP03</td>
<td>Risk and Safety Management in Process Industries</td>
<td>4</td>
<td>4</td>
<td>40 60 100</td>
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</table>

**Prerequisite**

**Objectives**
- To educate basics of principles of Risk and Safety Management
- To outline the various practices in process industry

**Outcome**
At the end of the semester the student should be able to
- Understand about risk and safety management practices in process Industries.
- Legal aspects

**UNIT – I**
Hazard identification methodologies, risk assessment methods - PHA, HAZOP, MCA, ETA, FTA, consequence analysis, probit analysis

**UNIT – II**
Hazards in work places - nature and type of work places, types of hazards, hazards due to improper house-keeping, hazards due to fire in multi-floor industries and buildings, guidelines and safe methods in the above situations.

**UNIT – III**
Workers' exposures to hazardous chemicals, TLVs of chemicals, physical and chemical properties of chemicals leading to accidents like fire explosions, ingestion and inhalation, pollution in work places due to dangerous dusts, fumes and vapours, guidelines, fundamentals of pressure relief devices and safe methods in chemicals handling, storage and entry into confined spaces.

**UNIT – IV**
Hazards peculiar to industries like fertilizer, heavy chemicals, petroleum, pulp and paper, tanneries, dyes, paints, pesticides, glass and ceramics, dairy and sugar industries, guidelines for safeguarding personnel and safeguarding against water, land and air pollution in the above industries.

**UNIT – V**

**Text Books:**

**Reference Books:**
<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
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<tr>
<td>CHP04</td>
<td>Nano Technology</td>
<td>4</td>
<td>40</td>
<td>60</td>
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</table>

**Prerequisite:**
-  

**Objectives:**
- To educate basics of principles of Nano science and technology
- To outline the various products & practices in the Nano technology

**Outcome:**
At the end of the semester the student should be able to
- Understand about Nano materials, Nano tubes.
- Various application of Nano materials and characterization techniques

**UNIT – I**  
Hours: 12

**UNIT – II**  
Hours: 12

**UNIT – III**  
Hours: 12

**UNIT – IV**  
Hours: 12

**UNIT – V**  
Hours: 12

**Text Books:**

**Reference Books:**
Process Modeling and Simulation

Objectives
- To educate basics of principles of modeling & Simulation
- To outline the various modeling aspects in process engineering

Outcome
At the end of the semester the student should be able to
- Understand about fundamentals of process modeling and simulation.
- Write modeling equations for various processes from first principles

UNIT – I
Introduction - models and model building, principles of model formulation, fundamental laws - continuity equation, energy equation, equations of motion, transport equations, equations of state, equilibrium and kinetics, classification of mathematical models. Numerical solutions of model equations – Linear and non linear algebraic equations in one and more than one variables, ordinary differential equations in one and more than one variables.

UNIT – II
Lumped Parameter Models: Formulation and solution techniques to be discussed for Vapour liquid equilibrium models, dew point and flash calculations for multicomponent systems, boiling operations, batch and continuous distillation models, tank models, mixing tank, stirred tank with heating, CSTR with multiple reactions. Non-isothermal CSTR - multiplicity and stability, control at the unsteady state. Non-ideal CSTR models - multi-parameter models with dead space and bypassing, staged operations.

UNIT – III
Distributed Parameter Models (Steady State): Formulation and solution of split boundary value problems - shooting technique, quasi-linearization techniques, counter current heat exchanger, tubular reactor with axial dispersion, counter current gas absorber, pipe line gas flow, tubular permeation process, pipe line flasher.

UNIT – IV

UNIT – V

Practice: It will include case studies involving the various application discussed in theory

Text Books:

Reference Books:
**Department**: Chemical Engineering  
**Programme**: B.Tech. (CH)  
**Semester**: Category: TA  

<table>
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<tr>
<th>Subject Code</th>
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<tr>
<td>CHP06</td>
<td>Polymer Science and Technology</td>
<td>L4 T - P -</td>
<td>4</td>
<td>40</td>
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</table>

**Prerequisite**: -

**Objectives**
- To educate basics of principles of Polymer Science & Technology
- To outline the various practices in polymer process

**Outcome**
At the end of the semester the student should be able to
- Understand about Polymer Industry.
- Understand various processes, products, reactions and equipments involved

**UNIT – I**  
**Hours**: 12  
Introduction - Definitions and concepts, polymerisation reactions, polymer structure, functionality and degradation, Characterisation of polymers.

**UNIT – II**  
**Hours**: 12  
Different types of polymers - natural and modified natural products, synthetic polymers, addition and condensation products and their preparations.

**UNIT – III**  
**Hours**: 12  
Methods of polymerisation - mass, solution, emulsion and suspension polymerisation processes, reactions and equipments used.

**UNIT – IV**  
**Hours**: 12  
Polymer processing - Molding, cold and hot compression molding, injection and jet type molding, extruding, calendering and skiving.

**UNIT – V**  
**Hours**: 12  
Polymer processing - sheet forming, atmospheric and fluid pressure forming, lamination and impregnating, coating, expanding, casting, embedding, spinning and finishing.

**Total contact Hours**: 60  
**Total Tutorials**: -  
**Total Practical Classes**: -  
**Total Hours**: 60

**Text Books:**

**Reference Books:**
Department : Chemical Engineering  
Programme : B.Tech. (CH)  
Semester :  
Category : TA  

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<td>C  CA  SE  TM</td>
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<tr>
<td>CHP07</td>
<td>New Separation Techniques</td>
<td>4  -  -</td>
<td>4  40  60  100</td>
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</table>

Prerequisite: -

Objectives:
- To educate basics of principles of New Separation Technique
- To outline the various membrane processes and models

Outcome:
At the end of the semester the student should be able to
- Understand various new separation techniques.
- Write performance equations for various processes from first principle.

UNIT – I

Hours: 12

Adsorption separations - Review of fundamentals, mathematical modeling of column contactors, pressure swing adsorption, ion chromatography, affinity chromatography, gradient chromatography, parametric pumping, counter-current, simulated counter-current and multidimensional chromatography.

UNIT – II

Hours: 12

Membrane separation processes – basic concepts, membrane modules, structure and characteristics of membranes, design considerations of Reverse Osmosis, Ultra Filtration, Electro Dialysis, Gas permeation membranes, Pervaporation, Nano filtration and micro filtration.

UNIT – III

Hours: 12

Detailed theories for membrane separations – concentration polarization, gel formation and fouling, mathematical models for membrane systems with and without concentration polarization, Transport inside the membranes, solution diffusion membranes, porous membranes.

UNIT – IV

Hours: 12

Surfactant based separations - fundamentals of surfactants at surfaces and in solution, liquid membrane permeation, and foam separations, micellar separations.

UNIT – V

Hours: 12

Supercritical fluid extraction - Physicochemical principles, thermodynamic modeling, process synthesis and energy analysis

Total contact Hours: 60  
Total Tutorials: -  
Total Practical Classes: -  
Total Hours: 60

Text Books:

Reference Books:
## Subject Details

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<td>CHP08</td>
<td>Petrochemical Technology</td>
<td>4</td>
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</tbody>
</table>

### Prerequisite
- 

### Objectives
- To educate basics of principles of Petrochemical Technology
- To outline the various products & processes

### Outcome
- At the end of the semester the student should be able to
  - Understand about petrochemical Industry.
  - Understand various processes, products, reactions and equipments involved.

### UNIT – I
- General Introduction - History, economics and future of petrochemicals, energy crisis and petrochemical industry, sources and classification of petrochemicals.  
- Hours: 12

### UNIT – II
- First generation petrochemicals - alkanes - C1, C2, C3, C4 petrochemicals, alkenes - C2, C3, C4 petrochemicals, alkynes - C2, C3, C4 petrochemicals, B-T-X aromatics, diene based petrochemicals.  
- Hours: 12

### UNIT – III
- Second generation petrochemicals - synthesis gas, methanol, formaldehyde chloromethanes, ethanol, acetaldehyde, acetic acid, acetic anhydride, isopropyl alcohol, ethylene oxide, propylene oxide, acetone, vinyl chloride, phenol, aniline and styrene.  
- Hours: 12

### UNIT – IV
- Third generation petrochemicals - plastics, rubbers and fibres, olefinic polymers, polyethylene, polypropylene, polyisobutylene, diene polymers - polybutadiene, neoprene, polyisoprene, SBR, synthetic fibres.  
- Hours: 12

### UNIT – V
- Miscellaneous petrochemicals - petroleum proteins, synthetic detergents, resin and rubber chemicals, explosives - TNT and RDX.  
- Hours: 12

### Total contact Hours: 60  
- Total Tutorials: -  
- Total Practical Classes: -  
- Total Hours: 60

### Text Books:

### Reference Books:
Department: Chemical Engineering  
Programme: B.Tech. (CH)  
Semester:  
Category: TA  

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<td>CA SE TM</td>
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<tr>
<td>CHP09</td>
<td>Nuclear Technology</td>
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<td>4</td>
<td>40 60 100</td>
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</tbody>
</table>

Prerequisite: -

Objectives:
- To educate basics of principles of Nuclear Engineering
- To outline the various technical aspects Nuclear processes

Outcome:
At the end of the semester the student should be able to
- Understand about Nuclear Engineering.
- Understand various processes, products, reactions, equipments and safety involved

UNIT – I
Nuclear energy fundamentals: Atomic structure, and radio isotopes, radio activity, nuclear fission, nuclear fission reactors. History of reactor development, reactors for power production.

UNIT – II

UNIT – III
Nuclear reactor theory: The neutron cycle, critical mass, neutron diffusion, the diffusion equation, slowing down of neutrons, reactor period, transient conditions and reflectors.

UNIT – IV
Engineering Considerations of Nuclear Power: Extension of theory to design, design criteria, selection of materials, reactor fuel, moderator materials, coolant system, reactor control and operation, fuel preparation, reprocessing of spent fuel.

UNIT-V
Environmental effects and safety: Radiation hazards, radiation monitoring, radio waste treatment systems, reactor shielding.

General principles of reactor safety, reactor protection system, reliability and risk assessment.

Total contact Hours: 60  
Total Tutorials: -  
Total Practical Classes: -  
Total Hours: 60

Text Books:
2. Glenn Murphy, Elements of Nuclear Engineering, John Wiley and sons Inc.

Reference Books:
<table>
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<th>Subject</th>
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<th>Credit</th>
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<tr>
<td>CHP10</td>
<td>Drugs and Pharmaceutical Technology</td>
<td>4 L - 4 P</td>
<td>4 C</td>
<td>40 CA 60 SE 100 TM</td>
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</tbody>
</table>

**Prerequisite**
- To educate basics of principles of Drugs and Pharmaceutical Technology
- To outline the various technical aspects Pharmaceutical processes

**Objectives**
1. To educate basics of principles of Drugs and Pharmaceutical Technology
2. To outline the various technical aspects Pharmaceutical processes

**Outcome**
At the end of the semester the student should be able to
1. Understand various unit processes involved in drug and pharmaceuticals.
2. Understand various products, reactions and equipments involved

**UNIT – I**

**UNIT – II**

**UNIT – III**

**UNIT – IV**

**UNIT – V**

**Text Books:**

**Reference Books:**
### Subject: Pinch Technology

**Objectives**
- To educate basics of principles of Pinch Technology
- To outline the various strategies in the design and implementation

**Outcome**
At the end of the semester the student should be able to
- Understand basics of pinch technology.
- Understand pinch application to various processes.

**UNIT – I**
Pinch Technology - an overview: Introduction, Basic concepts, How it is different from energy auditing, Roles of thermodynamic laws, problems addressed by Pinch Technology. Key steps of Pinch Technology: Concept of $\Delta T_{\text{min}}$, Data Extraction, Targeting, Designing, Optimization - Supertargeting

**UNIT – II**
Basic Elements of Pinch Technology: Grid Diagram, Composite curve, Problem Table Algorithm, Grand Composite Curve. Targeting of Heat Exchanger Network: Energy Targeting, Area Targeting, Number of units targeting, Shell Targeting and Cost targeting.

**UNIT – III**

**UNIT – IV**
Design tools to achieve targets, Driving force plot, remaining problem analysis, diverse pinch concepts, $MC_p$ ratio heuristics. Targeting and designing of HENs with different $\Delta T_{\text{min}}$ values, Variation of cost of utility, fixed cost, TAC, number of shells and total area with $\Delta T_{\text{min}}$ Capital Energy tradeoffs.

**UNIT – V**
Process modifications - Plus/Minus principles, Heat Engines and appropriate placement of heat engines relative to pinch. Heat pumps, Appropriate placement of heat pumps relative to pinch. Steam Rankin Cycle design, Gas turbine cycle design, Integration of Steam and Gas turbine with process. Refrigeration systems, Stand alone and integrated evaporators. Heat integrations and proper placement of Reactors for batch Processes.

**Text Books:**

**Reference Books:**
2. [http://www.nptel.iitm.ac.in/syllabus/103107094/ accessed on 22.10.2013](http://www.nptel.iitm.ac.in/syllabus/103107094/).
**Department**: Chemical Engineering  
**Programme**: B.Tech. (CH)  
**Semester**:  
**Category**: TA  

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<th>Credit</th>
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<tr>
<td>CHP12</td>
<td>Chemical Process Synthesis</td>
<td>4</td>
<td>40</td>
<td>60</td>
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</table>

| Prerequisite | -                               |              |        |               |

| Objectives   | To educate basics of principles of Chemical Process Synthesis  
To outline the various strategies in the product design |
|--------------|------------------------------------------------------------------|

| Outcome      | At the end of the semester the student should be able to  
Understand principles of Chemical Process Synthesis.  
Understand Chemical Process Synthesis application to various processes. |
|--------------|------------------------------------------------------------------|

**UNIT – I**  
**Hours**: 12

**UNIT – II**  
Reaction Path, Types of Reaction Systems, Reactor Performance, Idealized Reactor Models, Reactor Concentration, Temperature, Pressure, Phase, Catalyst. Separation of Heterogeneous Mixtures, Separations of Homogeneous Mixtures, Distillation, Azeotropic Distillation, Absorption, Evaporation, Drying etc.  
**Hours**: 12

**UNIT – III**  
Energy Targets, Composite Curves, Heat Recovery Pinch, Threshold Problems, Problem Table Algorithm, Process Constraints, Utility Selection, Furnaces, Combined Heat and Power  
**Hours**: 12

**UNIT – IV**  
Integration of Heat Pump, Integration of Refrigeration Cycles, Overall Heat Exchanger Network and Utilities  
**Hours**: 12

**UNIT – V**  
**Hours**: 12

**Text Books:**  

**Reference Books:**  
<table>
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<tr>
<th>Subject Code</th>
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<tr>
<td>CHP13</td>
<td>Enzyme Engineering</td>
<td>4</td>
<td>4</td>
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Prerequisite: 

- To educate basics of principles of Enzyme Engineering
- To outline the various parameters and their effects

Objectives:

- At the end of the semester the student should be able to
  - Understand about basics principles of enzyme engineering.
  - Understand various processes, products and reactions involved

Outcome:

- Classification of enzymes. Enzyme specificity, Enzyme units and turnover number. The mechanism of enzyme catalysis. Important industrial enzymes and their sources. General aspects of enzyme production—solid state fermentation and submerged culture methods.

UNIT – I

Classification of enzymes. Enzyme specificity, Enzyme units and turnover number. The mechanism of enzyme catalysis. Important industrial enzymes and their sources. General aspects of enzyme production—solid state fermentation and submerged culture methods.

UNIT – II


UNIT – III


UNIT – IV

Deactivation models and kinetics. Strategies for enzyme stabilization. Enzyme immobilization, covalent binding, cross-linking, adsorption, matrix entrapment, microencapsulation. Advantages and disadvantages of different immobilization techniques. Overview of applications of immobilized enzyme systems.

Mass transfer effects in immobilized enzyme systems. Analysis of film and pore-diffusion effects on kinetics of immobilized reactions.

UNIT – V


Text Books:

2. James M Lee, Biochemical Engineering, Prentice Hall.

Reference Books:

<table>
<thead>
<tr>
<th>Subject Code</th>
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<th>Hours / Week</th>
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<tr>
<td>CHP14</td>
<td>Chemical Engineering Practice</td>
<td>4</td>
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</table>

Prerequisite:

- To educate basics of Chemical Engineering Practice
- To outline the various parameters such as materials selection, pumps and their effects

Objectives:

- To outline the various parameters such as materials selection, pumps and their effects

Outcome:

At the end of the semester the student will be able
- Know the role and responsibility of a process engineer
- To read and interpret the data and symbols from a P & I diagram.
- Understand the various material of construction used in process industries and its corrosion resistant abilities.

UNIT – I

Role of a process Engineer, Process documentation, flow sheets – types, preparation, flow sheet presentation, symbols, line and equipment symbols, Piping and Equipment identification, Standards and codes, time planning and Scheduling.

UNIT – II


UNIT – III

Pumps classification and types, Pump performance characteristics and selection of pumps, packing and mechanical seals, pumping systems design, pump priming. Fans, blowers, compressor, ejectors and mechanical vacuum systems.

UNIT – IV

Piping calculations, available piping, tubing and other flow conduits, economical sizing of pipe, Valves: types, sizing and selection.

Thermal insulation, usages for thermal insulation, types of insulation, recommended thickness of insulation, Tracing- steam tracing, electric tracing, jacketing.

UNIT – V

Utilities of a chemical plant, Boilers, Cooling tower, DM water plants, Industrial water Treatment, Turbines, Chillers, Process Safety and Pressure relieving devices, Storage tanks.

Total contact Hours: 60  |  Total Tutorials: -  |  Total Practical Classes: -  |  Total Hours: 60

Text Books:


Reference Books:

**Department**: Chemical Engineering  
**Programme**: B.Tech. (CH)  
**Semester**:  
**Category**: TA

<table>
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<tr>
<td>CHP15</td>
<td>Pollution Control in Process</td>
<td>4</td>
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<td>Industries</td>
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</table>

**Prerequisite**

- To educate basic of Chemical Engineering Practice
- To outline the various parameters such as materials selection, pumps and their effects

**Objectives**

- At the end of the semester the student will be
- Able to realize the importance of the sustainable use of natural resources.
- Aware of the impacts of human actions on environment.
- Able to give solutions for environmental problems created by local, national and global developmental activities

**Outcome**

- Man and Environment, Types of pollution, Pollution control aspects, Pollution monitoring and analysis of pollutant.
- Air pollution: Sources and effects, particulate control, control of gaseous pollutants (SOx, NOx, oxides of carbon, hydrocarbon pollutants), Air Quality Management , Carbon Trading.
- Water Pollution: Types of water pollution, sources, water pollution control. Waste water treatment technologies and Recycle.
- Solid waste management: Sources, processing methods, waste disposal methods, energy recovery from solid waste and land pollution.
- Noise Pollution: Hazardous noise exposure, noise measuring instruments and noise pollution control technology.

**UNIT – I**  
**Hours: 12**

**UNIT – II**  
**Hours: 12**

**UNIT – III**  
**Hours: 12**

**UNIT – IV**  
**Hours: 12**

**UNIT – V**  
**Hours: 12**

**Case Study**: Pollution (Air, Water & Solid) control in the following process industries - Fertilizers, Petroleum Refinery and Petrochemical, Pulp and Paper, Cane Sugar, Tannery, Distilleries and Pharmaceutical Industry.

**Total contact Hours**: 60  
**Total Tutorials**: -  
**Total Practical Classes**: -  
**Total Hours**: 60

**Text Books**:


**Reference Books**:

<table>
<thead>
<tr>
<th>Subject Code</th>
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<th>Hours / Week</th>
<th>Credit</th>
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<tr>
<td>CHP16</td>
<td>Sugar Technology</td>
<td>4</td>
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<td>40</td>
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</tbody>
</table>

**Prerequisite:**

- To introduces concepts of Sugar Technology
- To introduces the role of solubility, steam economy, energy and equipment

**Objectives:**

- To introduces concepts of Sugar Technology
- To introduces the role of solubility, steam economy, energy and equipment

**Outcome:**

- Able to realize the importance of various unit operations in industry.
- Understand the various equipments and material used in sugar industries

**UNIT – I**

Introduction – Sugar Industry in India. Chemical and physical properties of sucrose and reducing sugars, Source for Sucrose, Formation of sucrose plants, Non sugar compounds of sugar cane. Inorganic constituents of sugar cane juices and sugars. Analytical methods used in sugar industry.

**UNIT – II**

Purification: chemical technology of purification process, fundamental reactions and physical chemistry aspects of clarification, Liming, Sulphitation and carbonation processes, Filtration of sugar juice.

**UNIT – III**

Evaporation: Evaporation of sugar juice. Heat transfer in evaporators, evaporation equipment and auxiliaries, Method of obtaining steam and quality of steam, Steam economy, chemistry of the evaporation process, scale formation and cleaning of evaporators.

**UNIT – IV**

Solubility of Sucrose- nucleation in super saturation solutions –kinetics and growth of crystallization, chemistry of crystallization. Control methods and equipment in sugar crystallization, technology of sugar crystallization, evaporation and circulation in vacuum pans.

**UNIT – V**

Centrifugation- Theory of the centrifugal process, centrifugal operation, Engineering principles of sugar centrifugals and the centrifugal processes, Centrifugal equipment and auxiliaries, Production of final molasses and molasses utilization, grading of sugar.

**Text Books:**

Department: Chemical Engineering  
Programme: B.Tech. (CH)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credit</th>
<th>Maximum Marks</th>
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<tbody>
<tr>
<td>CHP17</td>
<td>Membrane Technology</td>
<td>4</td>
<td>4</td>
<td>40 60 100</td>
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</table>

Prerequisite:
- 

Objectives:
- To Introduces concepts of Membrane Technology
- To show the various Models and their applications

Outcome:
At the end of the semester the student should be able to
- Understand about membrane technology.
- Understand various processes of membrane technology and their design aspects.

UNIT – I  
Hours: 12

UNIT – II  
Hours: 12

UNIT – III  
Hours: 12
Design of an RO Module. Applications of reverse osmosis. The principle of nanofiltration, nanofiltration membrane, parameters affecting the performance of NF membranes. Industrial applications.

UNIT – IV  
Hours: 12
The basic principle of ultra filtration, ultra filtration membranes, configuration of UF unit, Types of devices in ultra filtration. Factors affecting the performance of ultrafiltration. Fouling and flux decline. Affinity ultrafiltration in protein purification and other applications.

UNIT – V  
Hours: 12
Dialysis, Dialysis membranes, mass transfer in dialysis, applications. Electrodialysis- principles and applications.

Total contact Hours: 60  
Total Tutorials: -  
Total Practical Classes: -  
Total Hours: 60

Text Books:

Reference Books:
1. B.Sivasanker, Bioseparations, PHI learning private limited, 2010.
Department: Chemical Engineering  
Programme: B.Tech. (CH)

Course Code | Course Name                  | Hours / Week | Credit | Maximum Marks |
-------------|------------------------------|--------------|--------|---------------|
CHP18        | Fluidization Engineering     | L 4 T - P -  | C 4    | CA 40 SE 60 TM 100 |

Prerequisite: -

Objectives:
- To introduce concepts of Fluidization
- To show the various equipments and their applications

Outcome:
At the end of the semester the student should be able to
- Understand Fluidization concepts.
- Understand various equipments and their use in Process Industry

UNIT – I  
Hours: 12
Introduction: Fluidized state, nature of hydrodynamic suspension, regimi-zation of the fluidized state, operating models for fluidization systems

UNIT – II  
Hours: 12
Hydrodynamics of Fluidisation Systems: General bed behavior, pressure drop, empirical correlations for solid holdup, flow models

UNIT – III  
Hours: 12
Solid Mixing and Segregation: Degree of Segregation, operation shifts, reversal points, mixing-segregation equilibrium, generalized fluidization of poly systems, liquid phase mixing and gas phase mixing

UNIT – IV  
Hours: 12

UNIT – V  
Hours: 12
Miscellaneous Systems: Moving bed, slurry bubble column, two phase and three phase inverse fluidized bed, typical applications.

Total contact Hours: 60  
Total Tutorials: -  
Total Practical Classes: -  
Total Hours: 60

Text Books:


Reference Books:

<table>
<thead>
<tr>
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<tr>
<td>CHP19</td>
<td>Process Optimization</td>
<td>3 2 4</td>
<td>50 50 100</td>
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</table>

**Prerequisite**
-  

**Objectives**
- To introduce concepts of optimization
- To develop analytical, numerical, and iterative problem skills

**Outcome**
At the end of the semester the student should be able to
- Understand concepts of optimization.
- Understand various optimization techniques that are relevant to chemical engineering.

**UNIT – I**
**Hours: 9**

Introduction – General concepts of optimization, classification of optimization problem – single variable and multivariable, constrained and unconstrained, continuous and discrete optimization problems; Mathematical representation, geometrical interpretation, degrees of freedom analysis, formulation of optimization problems – simple illustrations. Theory and concepts of optimization - functions and their properties – unimodal and multimodal functions, local and global minimum; Gradient vector, Hessian matrix, Positive and negative definiteness of symmetric matrix, test of convexity and concavity, Stationary points, Necessary and sufficient conditions for extremum of single and multivariable functions, illustrative problems.

**UNIT – II**
**Hours: 9**

Linear regression – method of least squares, fitting models to data, factorial design of experiments, illustrative problems. Introduction to one dimensional search – scanning and bracketing algorithms, two point equal interval search, golden section search, quadratic interpolation method, Newton and quasi Newton method, illustrative problems.

**UNIT – III**
**Hours: 9**

Constrained optimization – Equality constrained optimization, Lagrange multiplier method, inequality constrained optimization, Kun-Tucker necessary condition, sufficient condition for constrained optimization, illustrative examples. Introduction to multivariable search – Gradient descent method (line search), Hessian based search algorithms, Newton’s method, Conjugate gradient method, illustrative problems.

**UNIT – IV**
**Hours: 9**

Linear Programming – introduction, illustration of concepts using graphical approach, simplex algorithm, variables unrestricted in sign, degenerate LP problem, illustrative problems. Introduction to geometric programming, dynamic programming, and integer programming (only illustration of concepts and no problems to be asked in the university examination)

**UNIT – V**
**Hours: 9**

Application of optimization in chemical engineering – Optimal pipe diameter, optimal thickness of insulation, optimal inter stage pressure in multistage compression, optimal design of shell and tube heat exchanger, optimal reflux ratio in a binary distillation column, optimal batch time in a batch reactor, optimal temperature of progression for exothermic reversible reaction, Optimal scheduling of refinery operation, Optimum recovery of waste heat, optimal design and operation of staged distillation columns.

**Practice: It will include case studies involving the application of optimization concepts discussed in theory**

Total contact Hours: 45  Total Tutorials: 30  Total Practical Classes: -  Total Hours: 75

**Text Books:**

**Reference Books:**
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<tr>
<th>Course Code</th>
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<tr>
<td>CHP20</td>
<td>Petroleum Refinery Engineering</td>
<td>4 - - - 4</td>
<td>40 60 100</td>
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</table>

**Prerequisite:**
- To Introduce concepts of Crude Handling
- To provide fundamental knowledge of Petroleum Refining

**Objectives:**
- At the end of the semester the student should be able to
  - Understand methods of handling Petroleum Crude
  - Understand various concepts of Petroleum Refining

**Outcome:**
- Introduce concepts of Crude Handling
- Provide fundamental knowledge of Petroleum Refining

**UNIT – I**
Hours: 12

**UNIT – II**
Hours: 12
Separation: Pretreatment of crude oil – Handling – Heating of crudes
Refining of petroleum- Atmospheric and vacuum distillation – Design aspects, blending process.

**UNIT – III**
Hours: 12
Breakdown Process: Cracking, Visbreaking, Coking – types and operation
Rebuilding Process: Isomerisation, Alkylation, Polymerisation, Reforming – types and operation
Asphalt Technology.

**UNIT – IV**
Hours: 12
Treatment Techniques for the removal of Sulphur Compounds to improve the performance, storage and stability
Product Treatment processes – various solvent treatment processes, Dewaxing, clay treatment, hydro fining.

**UNIT – V**
Hours: 12
Introduction to Petrochemical – generation, Cracking of Naphtha and gas for the production of ethylene, propylene, isobutylene and butadiene. Production of acetylene from methane. Extraction of aromatics.

**Total contact Hours: 60**
**Total Tutorials:**
**Total Practical Classes:**
**Total Hours:60**

**Text Books:**

**Reference Books:**
<table>
<thead>
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<tr>
<td>CHG01</td>
<td>Process Engineering Principles</td>
<td>4</td>
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<td>100</td>
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</table>

Prerequisite:
- Develop a mastery of the first principles involved in process engineering
- Perform analyses of process problems by applying the first principles
- Provide a fundamental understanding of process equipment’s

Objectives:
- At the end of the semester the student should be able to:
  - An ability to apply knowledge of mathematics, science, and engineering
  - An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
  - An ability to implement the engineering background to other related areas

**UNIT – I**  

**UNIT – II**  
**FLUID TRANSPORT AND MECHANICAL OPERATION EQUIPMENTS** – Laminar and Turbulent flow, Flow Characteristics of fluids – Newtonian and Non-Newtonian, Friction factor, Head loss due to fluid friction pumps – different types, pump characteristics, compressors.

Size reduction of solids – crushing (Jaw crusher) and grinding (Ball mill), Size separation (screening), solid – liquid separation – filtration, settling and sedimentation, centrifuge.

**UNIT – III**  

**UNIT – IV**  

**UNIT – V**  
**CHEMICAL REACTORS** – single and multiple reactions – conversion, yield, selectivity batch and flow reactors(PFR,CSTR), catalyses, multiphase non-catalytic (gas – solid, gas – liquid) and catalytic reactors, fixed bed, fluidized bed, slurry reactors. Process flow sheets for manufacture of standard chemicals - urea, sugar, crude distillation, cement, paper and pulp.

Total contact Hours: 60  
Total Tutorials: -  
Total Practical Classes: -  
Total Hours: 60

Text Books:

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<tbody>
<tr>
<td>CHG02</td>
<td>Fundamentals of Momentum, Heat and Mass Transfer</td>
<td>4</td>
<td>4</td>
<td>40 60 100</td>
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</table>

**Prerequisite:**
- Develop a mastery of the first principles involved in Heat transfer
- Perform analyses of heat transfer problems by applying the first principles

**Objectives**
- At the end of the semester the student should be able to
  - Apply knowledge of Heat transfer in solving engineering problems
  - Use the techniques necessary for heat transfer engineering practice

**Outcome**
- At the end of the semester the student should be able to
  - Apply knowledge of Heat transfer in solving engineering problems
  - Use the techniques necessary for heat transfer engineering practice

**UNIT – I**
Hours: 12
Essentials-Models, entity balances, the continuum assumption, fluid behavior, velocity, temperature and concentration averages, scalars, vectors and coordinate systems.

**UNIT – II**
Hours: 12
Derivation of Macroscopic Mass balances, Derivations of Macroscopic energy balances and Derivations of momentum balances equation.

**UNIT – III**
Hours: 12
Application of Dimensional Analysis-System measurement, Buckingham' Theorem examples in momentum heat and mass transfer friction factors drag force ,

**UNIT – IV**
Hours: 12
Dimensionless numbers and their physical significance- Reynolds number, Nusselt number, Sherwood number, prandtl number, Schmidt number, Stanton number. Analogies of momentum heat and mass transfer- Reynolds analogy, Prandtl analogy, Chilton-Colburn analogy and their simple applications.

**UNIT – V**
Hours: 12
Fluid flow in boundary layers- Introduction to boundary layer flow, mass, momentum and kinetic energy deficits. Boundary layer equations for incompressible flow, von karman momentum integral. Laminar boundary layer growth on flat plate.

**Text Books:**

**Reference Books:**
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<th>Maximum Marks</th>
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<tbody>
<tr>
<td>CHG03</td>
<td>Heat Transfer Analysis</td>
<td>L 3 T - P -</td>
<td>C 4</td>
<td>CA 40 SE 60 TM 100</td>
</tr>
</tbody>
</table>

**Prerequisite**
- 

**Objectives**
- Develop a mastery of the first principles involved in Heat transfer
- Perform analyses of heat transfer problems by applying the first principles

**Outcome**
- At the end of the semester the student should be able to
  - Apply knowledge of Heat transfer in solving engineering problems
  - Use the techniques necessary for heat transfer engineering practice

**UNIT – I**
Introduction- the continuum postulate, the laws of continuum physics, mechanism of energy transport  
Hours: 12

**UNIT – II**
Steady state one dimensional heat conduction-rectangular, cylindrical and spherical coordinates  
Hours: 12

**UNIT – III**
Transient heat conduction –governing equation ,lumped parameter model, semi-infinite slab  
Hours: 12

**UNIT – IV**
The Basic equation of momentum and energy transfer and boundary layer equations.  
Hours: 12

**UNIT – V**
Thermal radiation and radiant energy exchange- radiation, black body, evaluation of view factor and radiant energy exchange between gray surfaces.  
Hours: 12

**Total contact Hours: 60**
**Total Tutorials: -**
**Total Practical Classes: -**
**Total Hours: 60**

**Text Books:**
1. Latif M Jiji, Heat Transfer Essentials, Jaico Publisher,2002

**Reference Books:**
<table>
<thead>
<tr>
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<tr>
<td>CHG04</td>
<td>Non-Conventional Energy</td>
<td>4</td>
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<td>40</td>
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</table>

### Prerequisite:
- To introduce various energy sources
- To provide in-depth analysis of Non-Conventional Energy

### Objectives:
- At the end of the semester the student should be able to
  - Understand various energy systems
  - Understand concepts of Non-conventional energy system

### Outcome:
- Renewable Energy- Energy Demand- Comparison of fuels on Calorific value and Cost basis- Efficiencies of various Energy.

#### UNIT – I
**Hours: 12**

#### UNIT – II
**Hours: 12**

#### UNIT – III
**Hours: 12**
Wind Energy- wind energy conversion: wind energy conversion principles, types & classification of WECS, site selection criteria – advantages – limitations

#### UNIT – IV
**Hours: 12**
Geothermal Energy- Resources- types of wells, methods of harnessing the energy, system development and limitations.

#### UNIT – V
**Hours: 12**

### Total contact Hours: 60
**Total Tutorials:**
**Total Practical Classes:**
**Total Hours: 60**

### Text Books:

### Reference Books:

### Websites: