**C.V. Raman College of Engineering,**
(An Autonomous Institute Affiliated to BPUT, Odisha)
Bidyanagar, Mahura, Janla, Bhubaneswar - 752 054 (Orissa)

## Third Year B.Tech Course Structure with effect from Academic Year 2015-16 Batch

## Department of Chemical Engineering

## Semester V

| Sl. No. | Code | Subject | Type | Teaching Scheme | | | Credits |
|---|---|---|---|---|---|---|---|
| | | | | L | P | T | |
| S1 | **CH30107** | Process Heat Transfer | Theory – Core | 3 | - | 1 | 4 |
| S2 | **CH30108** | Chemical Reaction Engineering | Theory – Core | 3 | - | 1 | 4 |
| S3 | **CH30109** | Chemical Engineering Thermodynamics | Theory – Core | 3 | - | - | 3 |
| S4 | **CH30110** | Mineral Processing Engineering | Theory – Core | 3 | - | - | 3 |
| S5 | **CY31101** | Industrial Chemistry | Theory – MD | 3 | - | - | 2 |
| P1 | **CH30307** | Heat Transfer Lab | Lab – Core | - | 2 | - | 1 |
| P2 | **CH30308** | Chemical Reaction Engineering Lab | Lab – Core | - | 2 | - | 1 |
| P3 | **CY31301** | Industrial Chemistry Lab | Lab – MD | - | 2 | - | 1 |
| P4 | **CH34301** | Introduction to Project Report Writing | Lab – PD | - | 2 | - | 1 |
| MP | **CH37397** | Mini Proj. | Project | - | 4 | - | 2 |
| | **CH37401** | Comprehensive Viva Voce based on S1 & S2 | Oral | - | - | - | 2 |
| P5 | **CH37403** | Technical Seminar | Lab | - | 2 | - | 1 |
| **Total** | | | | **15** | **14** | **2** | **25** |

## Third Year B.Tech Course Structure with effect from Academic Year 2015-16 Batch

## Department of Chemical Engineering

## Semester VI

| Sl. No. | Code | Subject | Type | Teaching Scheme | | | Credits |
|---|---|---|---|---|---|---|---|
| | | | | L | P | T | |
| S1 | **CH30111** | Transport Phenomena | Theory – Core | 3 | - | 1 | 4 |
| S2 | **CH30112** | Process Dynamics and Control | Theory – Core | 3 | - | 1 | 4 |
| S3 | **CH30113** | Process Equipment Design | Theory – Core | 3 | - | - | 3 |
| S4 | **CH30114** | Non-Conventional Energy and Energy Conservation | Theory – Core | 3 | - | - | 3 |
| S5 | **CS30102** | Database Engineering | Theory – MD | 3 | - | - | 2 |
| P1 | **CH30312** | Process Control Lab | Lab – Core | - | 2 | - | 1 |
| P2 | **CH30313** | Process Equipment Design Lab | Lab – Core | - | 2 | - | 1 |
| P3 | **CS30302** | Database Engineering Lab | Lab – MD | - | 2 | - | 1 |
| P4 | **CH34302** | General Seminar on Industrial Work | Lab – PD | - | 2 | - | 1 |
| MP | **CH37398** | Major Proj. (Stage - I) | Project | - | 4 | - | 2 |
| | **CH37402** | Comprehensive Viva Voce based on S2 & S3 | Oral | - | - | - | 2 |
| P5 | **IN37403** | Pre-Placement Training | Lab – Soft Skill | - | 2 | - | 1 |
| **Total** | | | | **15** | **14** | **2** | **25** |

# CH30107: PROCESS HEAT TRANSFER [3-1-0]

**Credits**: 04 **Teaching Scheme: -** Theory 3 Hrs/Week

**Prerequisites**: NIL

**Objectives:**

1. To develop a good understanding of physical principles underlying heat transfer.
2. To understand the methodology and the quantitative approach of the process engineer and to be able to use this approach in problem solving.

**Course outcomes:**

**CO1:** Define the different processes in Heat transfer

**CO2:** Study about heat transfer coefficients & thermal Diffusivity in steady state and unsteady state.

**CO3:** To find out the LMTD for heat exchanger.

**CO4:** Detail study on different types of heat exchanger

**CO5:** Define Baffle, tube pitch and baffle spacing

**CO6:** Study about fin and fin efficiency

**Unit I** **(8 Hrs)**

**U.1.1: Conduction Heat Transfer:** Introduction: Modes of heat transfer, basic laws of heat transfer, analogy between heat flow and electrical flow.

Conduction: The Fourier heat conduction equation, Steady-state one dimensional heat conduction through plane wall, cylindrical wall, spherical wall and composite structures. Heat transfer from extended surfaces, unsteady state heat conduction through a semi-infinite slab, cylindrical and sphere, Critical insulation of thickness.

**U.1.2: Self Study Topics:** Thermal conductivity of materials, insulators, engineering applications of heat transfer.

**Unit 2:** **(9 Hrs)**

**U.2.1: Convection without Phase Change:**

Convection: The convective heat transfer coefficient, introduction to thermal boundary layer, Dimensionless numbers in heat transfer and their significance. Dimensional analysis: forced Convection, Analogy between heat and momentum transfer: Reynold's Prandtl and Colburn analogies. Heat transfer to liquid metals and Heat transfer for tubes in cross flow. Natural Convection: Grashoff number, Natural convection from vertical and horizontal surfaces.

**U.2.2: Self Study Topics:** Natural and forced convection systems, different types of fins.

**Unit 3:** **(8 Hrs)**

**U.3.1: Convection with Phase Change and Radiation:** Heat Transfer with phase change: Heat transfer from condensing vapours: film and drop-wise condensation, Condensation of superheated vapours. Heat transfer to boiling liquids. Boiling of saturated liquids: Pool boiling of saturated liquid, maximum heat flux and critical temperature, minimum flux and film boiling, sub cooled boiling.

Heat transfer by radiation: Thermal radiation, Black body radiation, Kirchhoff's law, emisisivilty, grey body, laws of black body radiation, geometric factor, Radiation in enclosures with black surfaces and grey surfaces. Combined heat transfer by conduction, convection and radiation.

**U.3.2: Self Study Topics:** Condensers and boilers, radiation heat transfer systems.

**Unit – 4:** **(8 Hrs)**

**U.4.1:Heat Exchanges:** Classification of heat exchangers, double pipe heat exchangers, Shell and tube heat exchangers, fouling factors, LMTD method for heat exchanger calculation to estimate heat transfer area and overall heat transfer coefficient, Heat Exchanger effectiveness, Fouling factors.

**U.4.2: Self Study Topics:** Different types of heat exchangers, compact heat exchangers.

**Unit - 5** **(7 Hrs)**

**U.5.1: Evaporation:** Types of evaporators, capacity and economy of evaporators. Boiling point elevation and Duhring's rule Material and Energy evaporators, Methods of feeding, capacity and economy of multiple effect evaporators.

**U.5.2: Self Study Topics:** Different types of evaporators.

**Note:** Five assignments to be given to the students on Self-Study, comprising of one assignment from each unit.

**Textbooks and References:**

1. Heat Transmission, Mc Adams, W. H.,
2. A course on heat and mass transfer, A. Domkundware, Dhanpat Ray and sons publication
3. Process Heat Transfer Kern D. Q., Tata McGraw Hill, 1997
4. Heat and mass transfer, R.K Rajput, S. Chand publication
5. Engineering Heat Trasnfer (6th Edition) Gupta, C. P. & Prakash, R., Nom Chand & Bros., Roorkee (1994).

6. Mc Cabe W. L. & Smith J. C. & Harriot P, Unit Operations of Chemical Engineering (5th Edition), McGraw Hill, New York.
7. Heat Transfer, Holman J. P., McGraw Hill, 7th edition, 1993

**Open source learning:**

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

## CH30107: PROCESS HEAT TRANSFER (TUTORIAL)

**Teaching Scheme:** Tutorial 1 Hrs/Week

**Objectives:**

- To get better inside to Process dynamics through numerical.
- To develop a good understanding of physical principles underlying heat transfer.
- To understand the methodology and the quantitative approach of the process engineer and to be able to use this approach in problem solving.

**List of Assignment:**

1. Assignment based on Thermal conductivity of materials, insulators, engineering applications of heat transfer.
2. Assignment based on Natural and forced convection systems, different types of fins.
3. Assignment based on Condensers and boilers, radiation heat transfer systems
4. Assignment based on Different types of evaporators.
5. Assignment based on Different types of heat exchangers, compact heat exchangers.
6. More numerical for Natural and forced convection systems
7. Numerical for radiation heat transfer systems.
8. Numerical for evaporators.
9. Numerical based on heat exchangers
10. Numerical based on design of heat exchanger system using bode plot

**Text Books:**

1. Mc Cabe W. L. & Smith J. C. & Harriot P, Unit Operations of Chemical Engineering (5th Edition), Mc Graw Hill, New York.
2. Process Heat Transfer, Kern D. Q., Tata McGraw Hill, 1997.

**Reference Books:**

1. Heat Transmission, McAdams, W. H.,

2. A course on heat and mass transfer, A. Domkundware, Dhanpat Ray and sons publication
3. Heat and mass transfer, R.K Rajput, S. Chand publication
4. Engineering Heat Transfer (6th Edition) Gupta, C. P. & Prakash, R., Nom Chand & Bros., Roorkee (1994).
5. Heat Tranfer", Holman J. P., McGraw Hill, 7th edition, 1993

**Open source learning:**

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

## CH30108: CHEMICAL REACTION ENGINEERING [3-1-0]

**Credits:** 04 **Teaching Scheme: -** Theory 03Hrs/Week

**Prerequisites**: Chemical Kinetics

**Objectives:** Understandings with different types of reactions and design of various types of reactors in process industries

**Course Outcomes:**

**After the completion of the course, the students will be able to**:

**CO1.** Develop rate laws for homogeneous reactions.

**CO2.** Design of ideal reactors for single and complex reactions.

**CO3.** Develop skills to choose the right reactor among single, multiple, recycle reactor, etc. schemes.

**CO4.** Analyze multiple reactions carried out both isothermally and non-isothermally in flow and batch reactors.

**CO5.** Understand different steps in reaction mechanisms on catalytic surfaces and identify the rate-determining step.

**CO6.** Work together to solve both open-ended and closed-ended reaction engineering problems.

**Course Details:**

**Unit 1**

**Title: Introduction of Chemical reaction (08 Hrs)**

**U1.1.** Introduction and general overview of the subject, kinetic study of homogeneous reactions, elementary and non-elementary reactions, Concentration and temperature dependent term of a rate equation for different orders, Collision theory, Transition -

state theory and Arrhenius theory.

**U1.2. Self Study Topics:** Mechanisms for various reactions.

**Unit 2**

**Title: Batch reactor system (08 Hrs)**

**U2.1.** Analysis and Interpretation of batch reactor data for reversible and irreversible reactions, various methods of analysis of batch reactor data (including variable volume and variable pressure data), Isothermal batch reactor design.

**U2.2. Self Study Topics:** Non isothermal design.

**Unit 3**

**Title: Continuous flow reactors (CSTR and PFR) (08 Hrs)**

**U3.1.** Homogeneous flow reactors (continuous) : Design equations for steady state plug flow reactor (PFR) and steady state Continuous Stirred Tank Reactor (CSTR), data analysis in flow reactors, mean residence time, space time, space velocity

**U3.2. Self Study Topics:** Comparison of both types of reactors i.e. CSTR and PFR.

**Unit 4**

**Title: Mixed flow Reactors (08 Hrs)**

**U4.1.** Combined reactors, Reactors in parallel and in series, size comparison of single reactors, recycle reactors (PFR and CSTR).

**U4.2. Self Study Topics:** Optimization for set of different reactors.

**Unit 5**

**Title: Qualitative and Quantitative treatment and Non- ideal flow (08 Hrs)**

**U5.1.** Design for parallel reactions, product distributions, contacting patterns for reactions in parallel, quantitative treatment of product distribution, selectivity, multiple reactions, and qualitative treatment of batch, PFR and mixed reactors. Basics of non-ideal flow, RTD, Age distribution of fluid, pulse experiment, relationship between F and E curve only, Introduction to heterogeneous systems and catalysis.

**U5.2. Self Study Topics:** Study of heterogeneous reactor systems and catalysis.

**Note:** Five assignments to be given to the students on Self-Study, comprising of one assignment from each unit.

**Text Books:**

T1. "Chemical Reaction Engineering", Octave Levenspiel, Wiley, 3rd Edition, 2006.

T2. "Elements of Chemical Reaction Engineering", H. Scott Fogler, Prentice-Hall, 4th

Edition, 2009.

**Reference Book:**

R1. "Fundamentals of Chemical Reaction Engineering", Robert J. Davis, Mark E. Davis, Dover Publications, 2012.

**Open source learning**

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

## CH30108: CHEMICAL REACTION ENGINEERING (Tutorial)

**Teaching Scheme:** Tutorial 1 Hrs/Week

**Objectives:** Identification and understanding of different types numerical problems in relation to the various reaction mechanisms with different orders and design of various types of reactors.

**List of Assignments:**

1. Assignment based on kinetic study of homogeneous reactions.
2. Assignment based on a rate equation of different orders.
3. Numerical based on Arrhenius equation.
4. Assignment based on analysis and interpretation of batch reactor data for both reversible and irreversible reactions.
5. Assignment based on various methods of analysis of batch reactor data (including variable volume and variable pressure data).
4. Numerical based on isothermal batch reactor design data.
5. Assignment based on design data for steady state plug flow reactor (PFR).
6. Assignment based on design data for steady state Continuous Stirred Tank Reactor (CSTR).
7. Numerical based on selectivity, multiple reactions.
8. Assignment based on relationship between F and E curves.

**Text Books:**

T1. "Chemical Reaction Engineering", Octave Levenspiel, Wiley, 3rd Edition, 2006.

T2. "Elements of Chemical Reaction Engineering", H. Scott Fogler, Prentice-Hall, 4th Edition, 2009.

**Reference Book:**

R1. "Fundamentals of Chemical Reaction Engineering", Robert J. Davis, Mark E. Davis, Dover Publications, 2012.

**Open source learning:**

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

## CH30109: CHEMICAL ENGINEERING THERMODYNAMICS [3-0-0]

**Credits:** 3 **Teaching Scheme: Theory** 03 Hrs/Week

**Prerequisites:** Basic concept of thermodynamics.

**Objectives:**

1. Understanding the fundamental concepts of thermodynamics.
2. Understanding the significance of thermodynamics in chemical engineering.
3. Understanding the thermodynamics for application in chemical engineering.
4. Understanding the application of thermodynamics to solve complex chemical engineering problems using data, and models.

**Course Outcomes:**

**After the completion of the course, the students will be able to**:

**CO1.** Demonstrate understanding of the concepts of conservation of mass, energy and basic laws of thermodynamics.

**CO2.** Formulate and solve engineering problems in classical thermodynamics involving closed and open systems for both steady state and un steady state processes.

**CO3.** Apply Laws of Thermodynamics and entropy concepts in analyzing the thermal efficiencies of heat engines and conceptualize the design of a basic heat pump and refrigerator.

**CO4.** Understand the properties of pure substances using various equations of state and concept of fugacity, phase equilibrium and interrelationship of various thermodynamic properties.

**CO5.** Understand vapour liquid equilibria for ideal and non-ideal solution through P-T, P-x-y, T-x-y diagram and estimate vapour liquid properties.

**CO6.** Estimate equilibrium compositions of chemical reactions and two-phase liquid/vapor mixtures in both ideal and non-ideal conditions.

**Course Details:**

**Unit 1** **(08 Hrs)**

**Title: Basic Concepts of Chemical Engineering Thermodynamics**

**U1.1.** System, surrounding and processes. Closed and open system. Intensive and extensive properties. State and path functions. Equilibrium state and Phase rule. Zeroth law. Conservation of energy. Laws of thermodynamics. Law of cyclic and non-flow processes. Derivation for closed system and steady state flow processes. Thermodynamic process consideration under the effect pressure, temperature, volume, mass.

**U1.2. Self Study Topics:** Problems solving considering the effects of pressure, temperature, volume and mass in different conditions and phase rule.

**Unit 2** **(08 Hrs)**

**Title: Laws of Thermodynamics and their significances**

**U2.1.** First law of thermodynamics. Applications to steady, non-steady flow and other engineering problems. Limitations of the first law. Second law of thermodynamics. Carnot principle, heat engine, thermodynamic temperature scales, enthalpy, entropy, entropy changes, work function. Entropy balance for open system. Third law of thermodynamics. Gibbs free energy.

**U2.2. Self Study Topics:** Problems solving based on first and second laws of thermodynamics considering various thermodynamic conditions.

**Unit 3** **(08 Hrs)**

**Title: Properties of Pure Substances**

**U3.1.** PVT behaviour of pure substance. Ideal gas law, cubic equations and viral equations of state and applications. Generalized correlations for gases and liquids. Acentric factor, compressibility factor. Different processes following ideal gas law. Relationship among $C_P$ and $C_V$. Exact and inexact differentials. Polytropic processes. Chemical potential, Fugacity, Fugacity Coefficient. Gibbs-Helmholtz equation.

**U3.2. Self Study Topics:** Problems solving based on Fugacity, Fugacity Coefficient, $C_P$ and $C_V$, compressibility factor, cubic equations and viral equation of state.

**Unit 4** **(08 Hrs)**

**Title: Thermodynamic Properties of Solutions**

**U4.1.** Partial molar properties. Henry's law and dilute solutions. Criteria of phase equilibrium and stability. Gibbs-Duhem theorem. Changes in thermodynamic properties and their inter-

relationships. Residual properties. Activity and activity coefficient. Excess Gibbs energy. Lewis – Randall Rule.

**U4.2. Self Study Topics:** Problems solving based on phase equilibrium and Henry's law.

**Unit 5** **(08 Hrs)**

**Title: Solution Thermodynamics**

**U5.1.** VLE – qualitative behaviour. Vapour-liquid equilibria. VLE in ideal and non-ideal solutions. Ideal solutions use of Raoult's law. P-T, P-x-y and T-x-y diagrams. Calculation of activity coefficient using Gibbs-Duhem equation. Positive and negative deviation from Raoult's law. Azeotrope mixture, bubble pressure, dew pressure, bubble temperature, dew temperature.

**U5.2. Self Study Topics:** Problems solving based on activity coefficient and P-T, P-x-y and T-x-y diagrams and vapour-liquid equilibria under different considerations.

**Note:** Five assignments to be given to the students on Self-Study, comprising of one assignment from each unit.

**Text Books:**

1. Introduction to Chemical Engineering Thermodynamics, J. M. Smith, H. C. Van Ness and M. M. Abott, Tata McGraw Hill International edition, 7th ed., 2010.
2. Chemical Engineering Thermodynamics, YVC Rao, University Press, 6th ed., 2000.

**Reference Books:**

1. Thermodynamics: An Engineering Approach, Cengel YA and Boles MA, McGraw Hill, 3rd Ed., 1998.
2. Chemical Engineering Thermodynamics, Daubert T.E., McGraw Hill, 4th ed., 1986.

**Open source learning**

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

## CH30110: MINERAL PROCESSING ENGINEERING [3-0-0]

**Credits:** 03 **Teaching Scheme:** Theory 3Hrs/Week

**Prerequisites**: Nil

**Objectives:** Mineral Processing Technology lies in its clear exposition of the principles and practice of mineral processing; nowadays mineral processing is very important subject for the students as many industries like steel, aluminum and other industries developing day by day.

This course covers the extraction of minerals from ores by using different unit operations.

**Course Outcomes:**

**After the completion of the course, the students will be able to**:

**CO1.** **S**tudy about ore, mineral and mineral dressing.

**CO2.** Develop the flow sheet for mineral processing for different industrial minerals.

**CO3.** Aware on unit operations using in gravity separation process, concentration criterion.

**CO4.** Acquire the knowledge on separation of magnetic material from ore using different units, thermal treatment of magnetic materials.

**CO5.** Study the pyrometallurgical process in ore industry and application of high temperature for recovery of minerals from ores, introduction to hydrometallurgy.

**CO6.** Apply the techniques for the separation of minerals/elements and the rate kinetic study process using hydrometallurgical process.

**Course Details:**

**Unit – 1** **(8 Hrs)**

**Title: Introduction to mineral processing**

**U1.1**

Minerals and ores, Mass balancing methods, Metallurgical accounting, Use of size analyses in mass balancing, Recovery and concentrate weight equation, Mass balance in a circuit.

**U1.2 Self-Study Topics:** Plant for dressing gravel, plant for the preparation of high grade coal.

**Unit 2** **(8 Hrs)**

**Title: Gravity separation techniques**

**U2.1**

Introduction to gravity separation, Jigging (Jigs), Tabling (Shaking Tables), Dense Medium Separation Principle, Sink-float method, Principles of froth flotation, Define collectors, depressants, Frothers, activators.

**U2.2 Self-Study Topics:** Plant for the gravity concentration of a tin ore.

**Unit – 3** **(8 Hrs)**

**Title: Magnetic and electrical separation**

**U3.1**

Principles of magnetic, types of magnetic separator, low intensity separator, high intensity separator, high gradient magnetic separator, electrical separation.

**U3.2 Self-Study Topics:** Concentrating plant for a magnetic ore.

**Unit – 4** **(8 Hrs)**

**Title: Thermal methods in processing of Ores**

**U4.1**

Roasting, Sintering, Calcination, Pelletisation and briquetting. Chemical and electrochemical methods in mineral processing leaching, leaching process variables, Dump and heap leaching, Acid Leaching, Bacteria leaching.

**U4.2 Self-Study Topics:** Flow sheet for removal of iron from kaolin clay.

**Unit – 5** **(8 Hrs)**

**Title: Hydrometallurgy**

**U5.1**

Solid-liquid separation in hydrometallurgy, solution purification, Amalgamation and cyanidation.

**U5.2 Self-Study Topics:** Plant for the recovery of gold by amalgamation and flotation.

**Note:** Five assignments to be given to the students on Self-Study, comprising of one assignment from each unit.

**Text Books:**

**T1.** Mineral processing technology by B.A.Wills and T. J. Napier-Mum, 7th Edition.

**T2.** Principle of Mineral Dressing, Gaudin, A. M. and Prior, B.J.TMH Edition.

**Reference Books:**

**R1.** Handbook of hydrometallurgy.

**R2.** Introduction to mineral processing, G. Kelly, David J. Spottiswood, 3rd Edition.

**Open source learning:**

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

## CY31101: INDUSTRIAL CHEMISTRY [3-0-0]

**Credits:** 02 **Teaching Scheme:** Theory 03Hrs/Week

**Prerequisites**: Basic knowledge in Chemistry

**Objectives:**

1. To develop the different water treatment processes. .
2. To understand the different industrial fuels and its applications.

3. To understand the methods of preparation of acids, pesticides, pharmaceuticals, Fertilizers etc.

**Course outcomes:**

**After the completion of the course, the students will be able to**

**CO1.** Have basic knowledge of different material balance chemical reactions and its importance.

**CO2.** Have knowledge of water softening methods used in industries.

**CO3.** Have basic knowledge of different batteries and fuels.

**CO4.** Understand the synthesis and application of different nano materials.

**CO5.** Have basic knowledge of different industrial engineering processes.

**Course Details:**

**Unit 1**

**Title: Material Balance** **(05 Hrs)**

**U1.1.** Material Balances Involving Chemical Reactions, Definition of Terms, Electrochemical Reactions, Recycling, Parallel and Bypassing Operations, Metallurgical Applications

**U1.2.** **Self Study Topics:** Problems based on materials balance calculation.

**Unit 2**

**Title: Water Technology** **(05 Hrs)**

U2.1 Hardness of Water: Types of hardness, Units of hardness and their interrelation, Determination of hardness (EDTA method only). Disadvantage of hard water. Water softening technology (internal and external (limesoda, zeolite, and ion exchange methods) Desalination (electrodialysis, reverse osomosis, Determination of B.O.D and C.O.D of water sample.

U2.2. **Self Study Topics:** Water treatment methods adopted in Power plants

**Unit 3**

**Title: Fuels and Battery technology** **(06 Hrs)**

U3.1 **Fuels**: Classification of fuels, calorific value, (Determination by Dulong's formula), G.C.V & N.C.V Liquid fuel: Classification of petroleum, Refining of petroleum, Cracking, Knocking and anti-knocking, cetane and octane numbers. Unleaded petrol, synthetic petrol, power alcohol Gaseous Fuel: Producer gas, Water gas, LPG, CNG, Combustion Calculation.

U3.2. **Battery technology**: Batteries and cells, Chemical batteries (dry, Lead acid & gel

batteries) Alkaline batteries (Zinc-air, Aluminium-air, Nickel metal hydride battery) Reserve batteries (magnesium-copper, Gordan-magnesium battery)

U3.3 **Self Study Topics:** Application of new and renewable energy.

**Unit 4**

**Title: Polymer and Nano materials (05 Hrs)**

U4.1 **Polymer**: Polymer: Types, polymerization process and mechanisms. Synthesis and application of rubber

U4.2. **Nano materials**: Nano material; Carbon nano tube, (synthesis, properties and application.) Application of nano material in medicine, fuel cell

U4.3. **Self Study Topics:** Synthesis and application of Graphene.

**Unit 5**

**Title: Industrial Process Engineering (09 Hrs)**

U5. 1. **Industrial Process Engineering**: Fermentation industries. A general discussion on fermentation conditions, manufacturing of penicillin. Pesticides and Pharmaceutical industries: DDT manufacture, BHC manufacture, Pharmaceutical industry: Synthesis of paracitamol, Process Engineering Aspects of manufacture of: inorganic acids (sulphuric acid, nitric acid, phosphoric acid), Fertilizers (ammonia, urea, phosphates)

U5.2. **Self Study Topics:** Processes parameters for different metallurgical industries.

**Note:** Five assignments to be given to the students on self study, comprising of one assignment from each unit.

**Text Books:**

T1. Engineering Chemistry by Putti R. VIjayasararhy, PHI Ltd

T2. Engineering Chemistry by P. C. Jain and M. Jain

T3. Industrial Chemistry. By B. K. Sharma

**Reference Books:**

R1. Engineering Chemistry by N Krishnamurthy, p vallinaygam, Dmadhavan, PHI Ltd

R2. Engineering Chemistry by Mary Jane Shultz, Cengage learning publication

R3. Engineering Chemistry by R.Gopalan, D.venkaapaya, and S Nagarajan, Vikas publishing house.

R4. Encyclopedia of Chemical Technology, Kirk Othmer

R5. Ulmann's encyclopedia of Industrial Chemistry

R6. Industrial Organic Chemistry, Weissermel

R7. From Hydrocarbons to Petrochemicals, Hatch L.F. and Matar S.

R8. Chemical Process Industries, Shreve B, Austin

R9. Chemical Process Technology, Moulijn, M. and van Dippen.

## CH30307: HEAT TRANSFER LAB [0-2-0]

**Credits:** 01 **Teaching Scheme:** - Laboratory 2 Hrs/Week

**Objectives:**

To understand the basic principles heat transfer by conduction, convection and radiation.

**Course outcomes:**

**After the completion of the course, the students will be able to**

**CO1.** Determine thermal conductivity of various materials experimentally.

**CO2.** Analyze convection heat transfer process experimentally with the help of representative process equipment like double pipe heat exchanger and Shell & tube heat exchanger, etc.

**CO3.** Solve heat transfer problems using empirical correlations.

**CO4.** Validate heat transfer process by conduction experimentally with the help of representative process equipment like composite wall, thermal conductivity of liquid, etc.

**List of Experiments:** (Any Ten)

1. To find overall heat transfer coefficient in counter flow heat exchanger.
2. To find overall heat transfer coefficient in parallel flow heat exchanger.
3. To study and operate single effect evaporator and to find its steam economy.
4. To calculate the overall heat transfer coefficient in vertical condenser.
5. To calculate the overall heat transfer coefficient in horizontal condenser.
6. To determine overall heat transfer coefficient experimentally of shell and tube heat exchanger.
7. To find thermal conductivity of composite walls.
8. To find overall heat transfer coefficient, fin effectiveness and fin efficiency for finned tube heat exchanger.
9. Determination of heat transfer coefficient for film wise and drop wise condensation.
10. To study temperature distribution along the length of fin in forced convection heat transfer.
11. To study temperature distribution along the length of fin in free convection heat transfer.

12. To determine the overall heat of various degrees of agitation in a Jacketed Vessel.

13. Determination of thermal conductivity of liquid.

**Text Books:**

1. "Heat Transfer", Holman J. P., McGraw Hill, 7th edition, 1993

2. "Principles of Heat Transfer", Frank Kreith, Mark Bohn, 5th edition, PWS Publishing company, Boston (1997)

**Reference Books:**

1. "Process Heat Transfer", Kern D.Q., Tata McGraw Hill, 1997.

2. "Unit Operations in Chemical Engineering", McCabe W.L. and Smith

## CH30308: CHEMICAL REACTION ENGINEERING LAB [0-2-0]

**Credits:** 01 **Teaching Scheme:** Laboratory 02Hrs/Week

**Prerequisites**: Chemical kinetics

**Objectives:**To determine experimentally the kinetics and rate constants of reactions in different types of reactors. These studies have wide applications in various process industries such as Refineries, pharmaceuticals, Fertilizer industries and Research and Development institutes and organizations etc.

**Course Outcomes:**

**After the completion of course, the students will be able to:**

**CO1.** Determine experimentally the kinetics and rate constant of reactions in different type of reactors.

**CO2.** Analyse and comment on the selection of the reactors for the reaction and its design.

**CO3.** Make comparisons of ideal reactor types (batch, continuous) and be able to determine the best choice for simple objectives when using a single reactor or set of reactors.

**CO4.** Maintain and operate the laboratory equipment in a safe manner.

**List of Experiments:** (Any Ten)

**Experiment No.1:** To determine the Reaction Rate Constant of a second order saponification reaction in a Batch Reactor.

**Experiment No. 2:** To determine the Reaction Rate Constant of a second order saponification reaction in a Semi- Batch Reactor

**Experiment No. 3:** To determine the Reaction Rate Constant of a second order saponification reaction in a plug flow reactor.

**Experiment No. 4:** To determine the Reaction Rate Constant of a second order saponification reaction in an isothermal Batch Reactor.

**Experiment No. 5:** To determine the Reaction Rate Constant of a second order saponification reaction in a Combined Flow Reactor.

**Experiment No. 6:** To perform kinetic studies to establish rate constant using a single CSTR.

**Experiment No. 7:** To perform kinetic studies to establish rate constant using a CSTR in series.

**Experiment No. 8:** To determine the Reaction Rate Constant of a second order saponification reaction in a Packed Bed Reactor.

**Experiment No. 9:** To determine the Reaction Rate Constant in Recycle Bed Reactor.

**Experiment No. 10:** To plot RTD curve and to determine the dispersion number for a CSTR using a pulse tracer.

**Experiment No. 11:** To plot RTD curve and to determine the Dispersion No. for a Plug Flow Reactor.

**Experiment No. 12:** To plot RTD curve and to determine the Dispersion No. for a Tubular Reactor.

**Experiment No. 13:** To plot RTD curve and to determine dispersion number for a CSTR in series using pulse tracer.

**Experiment No. 14:** Study of micellar catalysis.

**Text Books:**

**T1.** "Chemical Reaction Engineering", Octave Levenspiel,Wiley, 3rd Edition, 2006.

**T2.** "Elements of Chemical Reaction Engineering", H. Scott Fogler,Prentice-Hall, 4th Edition, 2009.

**Reference Book:**

**R1.** "Fundamentals of Chemical Reaction Engineering", Robert J. Davis, Mark E. Davis,Dover Publications, 2012.

## CY31301: INDUSTRIAL CHEMISTRY LAB [0-2-0]

**Credit:** 01 **Teaching Scheme:** Laboratory 02Hrs/Week

**Prerequisites**: NIL

**Objectives:**

**1.** To develop an analytical ability.

**2.** To understand the chemistry reactions in industrial processes.

**Course Outcomes:**

**After the completion of the course, the students will be able to:**

**CO1.** Basic knowledge of different types of volumetric titrations used in chemical analysis

**CO2.** To understand the synthesis methods involved in industries.

**CO3.** Calculation of different composition and analytical accuracy.

**CO4.** To understand the synthesis and application of polymer materials.

**CO5.** Basic knowledge of surface properties of bulk and Nano compounds.

**Course Details:**

**List of Experiments:** (Any Ten)

**Experiment No. 1:** Preparation of urea-formaldehyde resin.

**Experiment No. 2:** Determination of residual chlorine in water.

**Experiment No. 3:** Determination of concentration of $H_2SO_4$ and $H_3PO_4$ in a mixture by titration method.

**Experiment No. 4:** Determination of Acid value of oil.

**Experiment No. 5:** To study the effect of additives on viscosity of a liquid (Ethanol - Water, Water- Sucrose).

**Experiment No. 6:** Preparation of paracetamol.

**Experiment No. 7:** Determination of saponication value of oil.

**Experiment No. 8:** Determination of concentration of $Na_2CO_3$ and NaOH in a mixture by titration method.

**Experiment No. 9:** Preparation of Aspirin.

**Experiment No. 10:** Determination of D.O and B.O.D of waste water sample.

**Experiment No. 11:** Determination of Calcium content in Lime stone.

**Experiment No. 12:** Determination of specific surface area of solid samples.

**Text Book:**

**T1.** "Vogel's Textbook of Quantitative Chemical analysis" Revised by G. H. Jeffery, J. Bassett, J. Mendham & R. C. Denney, 5/E, ELBS (English Language Book Society) Longman. 7th Edition, 1996.

**Reference Books:**

**R1.** Encyclopedia of Chemical Technology, Kirk Othmer.

**R2.** Ulmann's encyclopedia of Industrial Chemistry.

**R3.** Industrial Organic Chemistry, Weissermel.

**R4.** From Hydrocarbons to Petrochemicals, Hatch L.F. and Matar S.

**R5.** Chemical Process Technology, Moulijn, M. and van Dippen.

## CH34301: INTRODUCTION TO PROJECT REPORT WRITING [0-2-0]

**Credit:** 01 **Teaching Scheme:** (Laboratory) 02 Hrs / week

**Prerequisites:** Basic ideas of report writing and power point presentation**.**

**Objectives:**

1. Basic idea of project, report writing and its need in engineering education.
2. To improve the technical writing skills and its presentation of the students.
3. To build up the technical confidence of the students in front of a group.

**Course outcomes:**

**After the completion of course, the students will be able to**

**CO1.** Get familiarized with the structure and know importance of project report writing.

**CO2.** Elaborate the project work in the form of a report maintaining the format of project report and engineering ethics.

**CO3.** Be well conversant with technical report having well developed writing and grammatical skills.

**CO4.** Communicate efficiently with the engineering community, society and able to represent and explain the project report effectively and demonstrate presentation skill.

**The following points are to be followed for Project Report Writing:**

1. Prepare the whole document in word file in A4 size paper with portrait layout.
2. Preparation of cover page containing title of the project, guide name, students' name, month & year of completion, college name & logo considering the following points:
   - Centered.
   - Text size of title [Times New Roman, 18 and bold].
   - Names [Times New Roman, 14 and bold]
   - Name, month & year of completion and college name [Times New Roman, 16 and bold]
3. Certificate page containing the title of the project, signature of students, signature of the guide, HOD and external.
   - Text size [Times New Roman, 12and running font].

4. General Format for the arrangement of project Report writing should be:
   i. Cover page
   ii. Certificate
   iii. List of Figures
   iv. List of Tables
   v. List of Abbreviations
   vi. Acknowledgements
   vii. Abstract
   viii. Content page
   ix. Introduction
   x. Literature survey
   xi. Materials & methods or experimental set up
   xii. Results and Discussion
   xiii. Conclusions
   xiv. References
   xv. Publications from the work
   xvi. Future plan of the work
5. Project report writing format:
   i. Single Column Format
   ii. Text size 12.
   iii. It should be in 1.5 spacing.
   iv. Each Figure should have a Caption below & Table should have a Caption above it and each Table & Figure should find a mention in the text.
   v. Give the sections (1, 2, 3…) and subsections (1.1, 1.2.,) in report.

Note: Reference section should follow the text. References should be listed in the order in which they appear in the paper. Complete information is essential. Papers without complete references will not be accepted into the review process. References to periodical papers must include (as applicable) the authors' names, paper title, periodical title, volume number, page range, and year of publication. Book references should include (as applicable) authors' names, chapter/ section title, page range, book title, editors' names, publisher's name and location, and year of publication. Papers from proceedings should include the location and date of the relevant meeting, as well as the name and location of the publisher and the year of

publication.

## CH37397: MINI PROJECT [0-4-0]

**Credits:** 02 **Teaching Scheme:** 04 Hrs / week

**Prerequisites:** Basic ideas of project work, report writing and presentation**.**

**Objectives:**

1. Scope for creativity
2. Hands on experience
3. Academic occupancy
4. Based on all the subjects in the continuing semester
5. The Mini Project group will be of 3 to 5 students.
6. Head of the Department will appoint Mini Project Guides. 02 credits will be awarded to the candidates after the viva voce and project demonstration at the end of the semester based on the project statement and requirements. The students are advised to utilize the laboratory resources before or after their contact hours as per the prescribed module.

**Course outcomes:**

**After the completion of the course, the students will be able to:**

**CO1.** Survey literatures to know about previous and ongoing researches in various fields and therefore select the particular area to work for based on the gaps and opportunities found from literature survey and to express the findings from literature survey in written form.

**CO2.** Apply basic engineering fundamentals in the selected domain of practical applications to analyze a concept/system/machine operation/process etc. by working as an individual or in a team and contribute to the development of the project.

**CO3.** Develop engineering ideas with significant novelty and develop a techno-commercial feasibility model for its implementation.

**CO4.** Prepare project report and deliver oral presentations at the end of semester.

## CH37401: COMPREHENSIVE VIVA VOCE [ORAL]

**Credits:** 02

Compulsory for each student based on the two subjects (S1) CH30107 & (S2) CH30108.

Assessment Scheme: (100 marks).

**Course outcomes:**

**After the completion of the course, the students will be able to:**

**CO1.** Answer basic questions related to heat transfer equipment.

**CO2.** Answer questions related to basic principles in reaction engineering.

**CO3.** Acquire additional ideas related to heat transfer and various reactors.

**CO4.** Communicate confidently to the Engineering community.

## CH37403: TECHNICAL SEMINAR [0-2-0]

**Credit:** 01 **Teaching Scheme:** Laboratory 02Hrs/Week

**Prerequisites:** Basic knowledge of computer operation and applications and should have tolerable verbal proficiency.

**Objectives:**

1. Introduction to the various aspects of processes and their applications in different chemical industries.
2. Improving the pronunciation, oral communication, listening skills, technical expressions and presentation of the students.

**Course Outcomes:**

**After the completion of the course, the students will be able to:**

**CO1.** Ability to understand the different stages involved in preparing and delivering a presentation.

**CO2.** Obtain tolerable proficiency in technical communication.

**CO3.** Confident to overcome their stage fright.

**CO4.** Be prudent in making an effective technical seminar presentation.

**Course details:**

Technical seminar presentation guidelines:

**1.** The topics should be relevant to the Chemical Engineering field.

**2.** Plan on approximately a 20 minute presentation with about 10 minutes for questions.

**3.** The presentation should provide sufficient background describing the problem addressed to the topic.

**4.** Representation in front of the audience making familiar with the work.

**5.** Should able to describe the problem, probable solution and being answerable to the audience.

6. Prepare a write-up of one page, double-sided sheet containing some of the important contents of the slides and bring the same with sufficient copies to the seminar hall.
7. Make sure the slides are legible; probably around 6 slides per side. The purpose of this sheet is to give your audience the chance to look at selected slides in more detail at their own pace.
8. Students are expected to present the technical seminar having a detailed study over the matters.
9. Give reference of every journal you mentioned in your presentation.
10. The objectives of the student presentations are meant to provide useful deliberation of the technical work with sufficient necessary technical information among the viewers.

**Text Book:**

T1. "Everyone Communicates, Few Connect" by John C. Maxwell, Thomas Nelson; 1 edition, 2010.

## CH30111: TRANSPORT PHENOMENA [3-1-0]

**Credits:** 04 **Teaching Scheme:** Theory 3Hrs/Week

**Prerequisites**: Knowledge of Fluid Mechanics, Mass Transfer and Heat Transfer, Engineering Mathematics.

**Objectives:**

1. To present the unifying treatment of transport processes.
2. Develop skill for modeling of transport processes with given boundary conditions.

**Course Outcomes:**

**After the completion of the course, the students will be able to:**

**CO1.** Application of transport phenomena with respect to heat, mass and momentum

**CO2.** Study on molecular momentum transfer, momentum balance in different flow

**CO3.** Apply momentum balance and molecular energy transport in different unit operations

**CO4.** Solve the problem based on momentum balance and energy transport phenomena with boundary conditions

**CO5.** Acquire knowledge on the transport of mass and heat in different physical and chemical processes with different conditions (with and without boundary conditions)

**CO6.** Solve the problem on conduction, convection, radiation and diffusion in both heat and mass transfer.

**Course Details:**

**Unit 1** **(8 Hrs)**

**Title: Fundamentals of Transport Phenomena**

**U1.1.** Basics of momentum transport, tensors, 3 dimensional system. Equation of continuity, equation of motion, equation of mechanical energy. Newton's law of viscosity, temperature and pressure dependence of viscosity for gases and liquids

**U1.2.** Molecular theory of viscosity for gases

**Unit 2**

**Title: Shell Momentum Balances** **(8 Hrs)**

**U2.1.** Shell momentum balances and boundary conditions. Shell momentum balances for flow of falling film, flow through circular tube, flow through annulus, flow of two adjacent immiscible fluids, creeping flow around a sphere.

**U2.2**. Momentum flux and velocity distribution for flow of Newtonian in pipes

**Unit 3**

**Title: Mechanism of Energy Transport and Shell Energy Balances** **(8 Hrs)**

**U3.1.** Fourier law of energy transport and derivation for 3 coordinate system, Dependence of thermal conductivity on temperature, pressure for gases and liquids. Shell energy balances for heat conduction, heat flux and temperature distribution for heat sources such as electrical, nuclear, viscous. Heat flux through composite walls for multidimensional.

**U3.2**. Dependence of thermal conductivity on temperature for solids

**Unit 4** **(8 Hrs)**

**Title: Mass Transport and Concentration Distribution in Solid and Laminar Flow**

**U4.1.** Temperature and pressure dependence of diffusivity, Mass flux for diffusion through stagnant film, Mass flux for diffusion with homogeneous and heterogeneous chemical reaction. Mass flux for diffusion and chemical reaction inside a porous catalyst, Mass flux for diffusion in 3 component gas system

**U4.2**. Mass flux for diffusion into falling liquid film

**Unit 5** **(8 Hrs)**

**Title: Turbulence, Macroscopic balances for multicomponent system**

**U5.1.** Turbulent transport phenomena, Boundary layer theory, Macroscopic mass balances. Macroscopic momentum and angular momentum balances. Use of macroscopic balances to solve steady state and unsteady state problems viz. sulfur dioxide converter, packed bed

absorption tower, expansion of reactive gas mixture through frictionless adiabatic nozzle.

**U5.2.** Macroscopic mass balance for any industrial system**.**

**Note:** Five assignments to be given to the students on Self-Study, comprising of one assignment from each unit.

**Text Books:**

**T1.** Transport Phenomena, Bird R. B, Stewart W.E., Lighfoot E.W. John Wiley, 2nd Edition, 2000

**T2.** Transport Phenomena, Brodkey R. S., Hershey H. C., McGraw-Hill International Edition, 1988

**Reference Books:**

**R1.** Elements of Transport Phenomena, Sissom L.S., Pitts D.R., McGraw-Hill, New k, 3rd Edition, 1972

**R2.** Fundamentals of Momentum Heat and Mass Transfer, Wilty J.R., Wilson R.W., Wicks C.W., 2nd Edition. John Wiley, New York, 1973

**Open source learning:**

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

## CH30111: TRANSPORT PHENOMENA (TUTORIAL)

**Teaching Scheme:** (Tutorial) 1 Hr/Week

**Prerequisites**: Knowledge of Fluid Mechanics, Mass Transfer and Heat Transfer, Engineering Mathematics.

**Objectives:** To get better understanding of transport processes with mathematical approaches.

**List of Assignments:**

1. Numerical for momentum transport i.e calculation of viscosity.
2. Numerical based on equations giving dependence of thermal conductivity on temperature, pressure for gases.
3. Numerical based on equations giving dependence of thermal conductivity on temperature, pressure for liquids and solids.
4. Numerical based on equations giving dependence of molecular diffusivity on temperature, pressure for gases.

5. Numerical based on equations giving dependence of molecular diffusivity on temperature, pressure for liquids and solids.

6. Numerical for shell balance equations for system for momentum transport.

7. Numerical for shell balance equations for system for heat transport.

8. Numerical for shell balance equations for system for mass transport.

9. Numerical related to diffusion.

10. Numerical related to heat transfer coefficients.

11. Numerical related to shear stress.

12. Numerical related to mass transfer coefficients.

**Text Books:**

**T1.** Transport Phenomena, Bird R. B, Stewart W.E., Lighfoot E.W. John Wiley, 2nd Edition, 2000

**T2.** Transport Phenomena, Brodkey R. S., Hershey H. C., McGraw-Hill International Edition, 1988

**Reference Books:**

**R1.** Elements of Transport Phenomena, Sissom L.S., Pitts D.R., McGraw-Hill, New k, 3rd Edition, 1972

**R2.** Fundamentals of Momentum Heat and Mass Transfer, Wilty J.R., Wilson R.W., Wicks C.W., 2nd Edition. John Wiley, New York, 1973

**Open source learning:**

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

## CH30112: PROCESS DYNAMICS AND CONTROL [3-1-0]

**Credits**: 04 **Teaching Scheme:** Theory 3 Hrs/Week

**Prerequisites**: Engineering Mathematics.

**Objectives:**

- To understand mathematical modeling and solution procedures of chemical process dynamics.
- To understand design of single loop feedback control system
- To have an overview of multivariable and advanced process control systems

**Course Outcomes:**

**After the completion of the course, the students will be able to:**

**CO1.** Define the different methods in process dynamics and control.

**CO2.** Conceptualize the interacting and non-interacting system.

**CO3.** Able to describe about stability, Routh Array stability, root locus and Bode plot.

**CO4.** Describe the different types control system.

**CO5.** Ability to explain P, PI, PD, PID control mechanisms.

**CO6.** Define dead time compensation, internal mode of control, offset etc.

**Course Details:**

**Unit - I** **(8 Hrs)**

**U.1.1: Process Dynamics:** Introduction to chemical process control with examples, control strategies, process stability and concept of optimum performance of chemical process. Mathematical modeling of liquid level problems, stirred tank heater, CSTR, distillation column, absorption column. Degrees of freedom, steady state gain, time constants, input-output model and system response for first order and higher order systems (second order). Dynamics with dead time, inverse response.

**U.1.2: Self-Study Topics:** Control valves – sizing and valve characteristics

**Unit - 2** **(8 Hrs)**

**U.2.1: Stability check for feedback control systems:** Stability of closed loop control systems, Routz-Hurwitz test, Root locus analysis, Frequency response, Bode plot. Feedback controller design, controller tuning, Ziegler-Nichols rules, Cohen and Coon rules, Integral error criteria, controller selection, process identification.

**U.2.2: Self-Study Topics:** Process identification

**Unit – 3** **(8 Hrs)**

**U.3.1: Control system instrumentation:** sensors for liquid level, flow, pressure, temperature, and pH measurement, transmission line, comparator, controller, and final control elements, control valve sizing, pneumatic and electronic controllers.

**U.3.2: Self-Study Topics:** Industrial PID controllers

**Unit – 4** **(8 Hrs)**

**U.4.1:** Closed loop control systems, transfer function of individual elements, servo and regulator problems, dynamics of P, PI and PID controllers. Internal model control, controller tuning and process identification, control valves.

**U.4.2: Self-Study Topics:** ratio control, selective control, digital control

**Unit - 5** **(8 Hrs)**

**U.5.1: Introduction to advance control strategies:** Preliminary treatment for feed forward control, cascade control, ratio control, adaptive control and inferential control. Digital computer control, Z-transformation.

**U.5.2:Self-Study Topics:** Plant wide control, Distributed control systems

**Note:** Five assignments to be given to the students on Self-Study, comprising of one assignment from each unit.

**Text Books:**

1. Process Systems Analysis and Control, Coughnowr, D. R., McGraw Hill Publication.
2. Chemical Process Control, George Stephenopoulos, Prentice Hall.

**References Book:**

3. Process Dynamics & Control, J. M. Douglas, Prentice Hall.

**Open source learning:**

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

## CH30112: PROCESS DYNAMICS AND CONTROL (TUTORIAL)

**Teaching Scheme:** Tutorial 1 Hr/Week

**Objectives:** To get better inside to Process dynamics through numerical analysis.

**List of Assignments:**

1. Assignment based on Instruments for temperature, pressure, flow, level compositions, their performance criteria and graphs.
2. Numerical for Laplace transform revision Process Flow Diagram.
3. Numerical for first and second order system operation.
4. Numerical for interacting and no interacting systems.
5. Numerical for single loop feedback control.
6. Numerical for Routh stability criteria.
7. Numerical using root locus technique.
8. Numerical based on design of feedback system using Bode plot.
9. Numerical using Zigler-Nichols parameters for system tuning.
10. Assignment based on advanced control system.

**Text Books:**

1. 'Process Systems Analysis and Control', Coughanowr, D.R., 2nd ed, McGrawHill, 1991.

2. 'Industrial Instrumentation', Ekmann, D. P, Fifteenth Wiley Eastern Reprint, Wiley Eastern Ltd, 1991

**Reference Books:**

1. Chemical Process Control, George Stephanopolous, Eastern Economy edition, Prentice-Hall, 2005.

2. Instrument Engineer's Handbook, Liptak, B.G, Volume I: Process Measurement and Analysis', 4th Ed, CRC Press, 2005.

**Open source learning**

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

## CH30113: PROCESS EQUIPMENT DESIGN [3-0-0]

**Credits:** 03 **Teaching Scheme:** Theory 03Hrs/Week

**Prerequisites**: Fluid Mechanics, Mass Transfer, Heat Transfer, Engineering Mathematics.

**Objectives:** To get acquainted with the design procedure of equipments used in chemical industries.

**Course Outcomes:**

**After the completion of the course, the students will be able to:**

**CO1.** Design various heat transfer equipments (viz. Heat exchanger, Evaporator and Condenser) considering the overall heat transfer coefficient and pressure drop as a parameter.

**CO2.** Get acquainted with the process design of some important mass transfer equipments (viz. Distillation Column and Absorption column).

**CO3.** Understand various mechanical properties of materials to be used as material of construction, resistance of metals to corrosion under varying conditions of temperature and pressure.

**CO4.** Design various equipments such as storage tanks and pressure vessels considering the environmental, safety and health concerns.

**CO5.** Congregate data from the literature, Handbook, Code etc and carry out process and mechanical design of Chemical engineering equipment aided by relevant Industry software.

**CO6.** Get exposure to various codes and standards in design and their application in designing new processes.

**Course Details:**

**Unit1**

**Title: Design of Pressure vessels and Storage tanks (08Hrs)**

**U1.1.** Design of pressure vessels and storage tanks with mechanical properties, Rotary dryers, Isothermal reactors design.

**U1.2.** Mechanical design of various storage vessels used in industries.

**Unit2**

**Title: Heat Exchanger Design (06Hrs)**

**U2.1.** Detailed process design of the following equipments; Heat exchangers – Types of heat exchanger, Process design of shell and tube heat exchanger, Condenser and reboilers.

**U2.2.** Design study of a Co-centric / Double pipe heat exchanger.

**Unit3**

**Title: Evaporator Design (06Hrs)**

**U3.1.** Evaporators – Introduction, types of evaporators, Methods of feeding of evaporators, General design consideration of evaporator, single and multi-effects.

**U3.2.** Heat transfer study of Evaporators.

**Unit4**

**Title: Absorber Design (Packed and Tray) (06Hrs)**

**U4.1.** Absorbers – for binary systems without reactions for packed and tray Column.

**U4.2.** Desorption study for both co-current and counter current flow.

**Unit5**

**Title: Distillation Column Design (06Hrs)**

**U5.1.** Distillation columns – for binary mixtures along with tray hydraulics and for packed column

**U5.2.** Types of distillation- Flash, azeotropic and steam.

**Note:** Five assignments to be given to the students on Self-Study, comprising of one assignment from each unit.

**Text Books:**

**T1.** Chemical Engineering Design, R.K. Sinnot and Gavin Towler,Coulson and Richardson, 5th Edition, 2009

**T2.** Process Equipment Design, M.V Joshi, Mac Millan India, 4th Edition

**Reference Book:**

**R1.** "Process Heat Transfer", D. Q. Kern, Tata McGraw Hill, 1st Edition, 1950

**Open source learning:**

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

**CH30114: NON-CONVENTIONAL ENERGY AND ENERGY CONSERVATION [3-0-0]**

**Credit:** 03 **Teaching Scheme:** Theory 03hrs/week

**Prerequisites:** Knowledge about conventional fuel and energy.

**Objective:** To study various types of non-conventional energy resources including solid, liquid and gaseous fuels and their applications in different fields and conservation.

**Course Outcomes:**

**After the completion of the course, the students will be able to:**

**CO1.** Acquire awareness about the challenges and problems associated with the use of various energy sources, with regard to future supply and the environment, and to have a overview of the promising areas of new and renewable sources of energy.

**CO2.** be conversant with the analysis of energy conversion, utilization and storage for renewable technologies such as solar, biomass, wind, Tidal and other state of art hybrid systems for emerging non-conventional fuel-based technologies.

**CO3.** Conceptualize the analysis of an engineering problem to provide a solution by designing a solar drying and a distillation unit and acquire the knowledge of modern energy conversion technologies

**CO4.** Understand and perform the analysis and characterization of different types of Fuel for its sustainable use.

**CO5.** Identify available nonconventional (renewable) energy resources and techniques to utilize them effectively for further analysis and evaluation.

**Course Details:**

**UNIT 1: Introduction to Energy** **(6 Hrs)**

**U1.1** Introduction to conventional and non-conventional energy sources; Advantages and disadvantages, Role of non-conventional energy; Classification of non-conventional energy sources;

**U1.2 Self-Study topic:** Environmental impact.

**UNIT 2: Solar Energy** **(6 Hrs)**

**U2.1**Introduction to solar energy, radiation, constant, power and its measurement; Solar storage, collectors and classification; Solar PV cell; Domestic and industrial uses of solar energy; Applications of solar energy: Heating, cooling, pumping and cooking; Solar drying and distillation;

**U2.2 Self-Study topic:** Solar pond.

**UNIT 3: Bio-Energy** **(6 Hrs)**

**U3.1** Introduction to biomass energy and conversion processes; Biodigestion and processes; Gasification of biomass; Biogas and classification of biogas plants, advantages and disvantages; Types of bio-gasifiers; Characteristics of biogas.

**U3.2 Self-Study topic:** Factors affecting biogas production; Biogas, biomethane, biohydrogen, biodiesel and their applications.

**UNIT 4: Extended Non-Conventional Energies-I** **(6 Hrs)**

**U4.1**Wind energy: Introduction to wind energy; Wind energy conversion system and its classification; Basic ideas of wind machines and types; Applications. Ocean energy: Introduction to ocean thermal energy; Methods and classification of power generation from ocean thermal energy;

**U4.2. Self-Study topic:** Applications of Tidal energy.

**UNIT 5 Extended Non-Conventional Energies-II** **(6 Hrs)**

**U5.1** Introduction to tidal energy; Basic ideas of power generation from tidal energy and tidal power plants; Advantages and disvantages of tidal power generation; Uses of tidal energy. Geothermal energy: Introduction to geothermal energy; Sources and types geothermal energy;

**U5.2 Self-Study topic:** Basic ideas of power generation methods from geothermal energy and its utilizations.

**Note:** Five assignments to be given to the students on self-study, comprising of one assignment from each unit.

**Text Books:**

**T1** Renewable Energy Resources; Twidell and Wier

**T2** Non-Conventional Energy Systems; K Mittal

**T3** Renewable energy sources and emerging technologies; D. P. Kothari and K. C. Singhal

**T4** Solar Energy; S.P. Sukhatme

**Reference Books:**

**R1** Non-Conventional Energy Sources; G.D. Rai

**R2** Biogas systems: Principles and Applications; Mital K.M.

**Open source learning:**

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemical-engineering/

## CS30102: DATABASE ENGINEERING [3-0-0]

**Credits: 0**2 **Teaching Scheme:** Theory 3 Hrs/Week

**Prerequisites**:

1. Knowledge of computer fundamentals.
2. Knowledge of Data Structures

**Objectives:** To introduce the major techniques of databases, data retrieval, and database design strategies.

**Course Outcomes:**

**After the completion of the course, the students will be able to**

**CO1.** Applies the concept of DBMS and differentiate Database Management System and file management system.

**CO2.** Analyze and design using different techniques like E-R diagram, normalization etc to get a good and reliable database.

**CO3.** Implement a back-end tool to be connected with another language and to know how to store and retrieve data by using queries.

**CO4.** Use transaction processing systems and how to recover data if failure occurs.

**Course Details:**

**Unit 1** **(8 Hrs)**

**Title: Introduction to DBMS and ER Data Model**

**U1.1**

Data Storage: File processing system, Disadvantages; DBMS: Need of DBMS, Terms: Data, Database, Metadata, Data Dictionary, Database System, Database Management System, Data Abstraction, Data Independence, System Architecture of DBMS;

**U1.2**

Data Model: Definition, ER and Relational Data Model, Object Oriented, Object Relational

Models; ER Model: Entity, Entity Set, Attributes, Primary Key, Relationship, Types and Attributes of Relationship, Cardinality Ratio, Participation Constraint, Weak Entity Set, EER Features.

**Self-Study**

Hierarchical and Network Data Models, Comparison of Different Data Models, Selection as 1. Entity Vs Attribute, 2. Entity Vs Relationship, 3. Binary Vs Ternary Relationship, Tools for Designing ER Model, Introduction of Popularly used Relational Database.

**Unit2** **(8 Hrs)**

**Title: Relational Data Model.**

**U2.1**

Relational Data Model: Terms: Relation, Schema, Attributes, Tuples, Domains, Relation Degree (or Arity) and Cardinality, Relation Intention and Extension, Super Key, Candidate Key, Primary Key and Foreign Key, Relational Model Constraints, Schema Diagram, ER to Relation Mapping.

**U2.2**

Detailed storage architecture, Magnetic disk RAID Storage Access, File & Record Organization Indexing and order indices Database Query Languages: Relational Algebra, Tuple Relational Calculus, DDLC.

**Self-Study**

Characteristics of Relation, Codd's Twelve Rules for Relational DBMS, Domain Relational Calculus, Reverse Engineering: Relational Database into ER/ EER Model.

**Unit3** **(8Hours)**

**Title: Normalization**

**U3.1**

Normalization: Anomalies of un-Normalized Relation, Need of Normalization, Pros and Cons of Normalization, Denormalization; Functional Dependency: Trivial, Full, Partial, Transitive, Multivalued, Join, Inclusion Dependency, Dependency Diagram, Inference Rules for Functional Dependencies, Closure of Functional Dependencies, Algorithms to find: 1. Candidate Key, 2. Closure of Attribute Set, 3. Minimal Cover of Functional Dependencies;

**U3.2**

Normal Forms: Checking of Lossless Join Decomposition and Dependency Preservation, Normal Forms: 1NF, 2NF, 3NF, BCNF, 4NF.

**Self-Study**

Normal Forms: 5NF and DKNF, Normalization at Conceptual Level.

**Unit4** **(9 Hrs)**

**Title: Structured Query Language (SQL)**

**U4.1**

SQL: Introduction, Types of queries: DDL, DML, Select, TCL, DCL, Advantages and Disadvantages of SQL; DDL: Create, Drop, Alter Various Database Objects (Table, Table Constraints, View etc.); DML: Insert, Delete and Update Queries.

**U4.2**

TCL; SELECT Queries: Simple and Nested Queries, Set Membership, Aggregate Functions, Group-by, Having Construct, Join Types, Set Operations, Set Comparison, SQL String Functions.

**U4.3**

PL/SQL: Block, Cursor, Cursor Types, Procedure, Trigger, Row-level, Statement-level Triggers.

**Self-Study**

DCL-Security and Authorization, SQL Date-Timestamp and Numerical Functions, PL/SQL Function, Mapping of Relational Algebra to SQL.

**Unit5** **(7 Hrs)**

**Title- Transaction Management**

**U5.1**

**Complexity Theory:** Transaction: Concept, ACID properties, Transaction States; Schedule: Definition, Types, Serializability, Conflict and View Serializability, Precedence Graph, un/Recoverable Schedule, Cascade less Schedule.

**U5.2**

Deadlock; Concurrency Control Protocols: Lock Based, Timestamp Based Protocol; Recovery System: Log Based.

**Self-Study**

Tree and Multiversion Protocol for Concurrency Control, ARIES Recovery Technique, Deadlock Handling.

**Note:** Five assignments to be given to the students on Self-Study, comprising of one assignment from each unit.

**Text Books:**

1. "Database System Concepts", Silberschatz, Korth, Sudarshan, McGraw Hill International Edition, ISBN- 0-07-228363-7, 4th Edition

2. "Fundamentals of Database Systems", Elmasri and Navathe, Pearson Education, ISBN 81-297-0228-2, 4th Edition

**Reference Books:**

1. "Database Systems", Thomas Connolly and Carolyn Begg, Pearson Education, ISBN 81-7808-861-4, 3rd Edition
2. "Database Management Systems", Ramakrishnan and Gehrke, McGraw-Hill, International Edition, ISBN 0-07-115110-9, 3rd Edition
3. An introduction to Database System – Bipin Desai, Galgotia Publications

## CH30312: PROCESS CONTROL LAB [0-2-0]

**Credit:** 01 **Teaching Scheme:** (Laboratory) 2 Hrs/Week

**Prerequisites**: Knowledge of process control theories.

**Objectives:**

1. Carry out experiments to understand:
    a. Process dynamics
    b. P, PI and PD modes of PID controller
    c. PID controller tuning
2. Carry out design of feedback control systems using Matlab.

**Course outcomes:**

**After the completion of the course, the student will be able to:**

**CO1.** Tune different types of control system & control the process using P, PI and PID controllers.

**CO2.** Set up and run basic laboratory experiments using a variety of instrumentation.

**CO3.** Use instruments to measure pressure, temperature, flow and level.

**CO4.** Understand practical aspects of industrial processes, process measurements and process control theory.

**List of Experiments:** (Any ten)

1. To study the response of a single tank with step change in inlet flow and to find out time constant graphically.

2. To study the transient response of two interacting tanks with step change in inlet flow rate and to find out the time constant graphically.
3. To study the transient response of two non-interacting tanks with step change in inlet flow rate and to find out the time constant graphically.
4. To study the transient response of two interacting tanks with impulse change in inlet flow rate and to find out time constant graphically.
5. To study the transient response of two non-interacting tanks with impulse change in inlet flow rate and to find out time constant graphically.
6. To study of effect of PD, PI and PID controller on a temperature control trainer.
7. To study of effect of PD, PI and PID controller on a pressure control trainer.
8. To study of effect of PD, PI and PID controller on a level control trainer
9. To study the stability of a temperature control trainer.
10. To study the stability of a pressure control trainer.
11. To study the stability of a level control trainer.
12. To study the dynamic characteristics of a mercury in glass thermometer.

**Text Books:**

1. Process Systems Analysis and Control, Coughanowr, D.R., 2nd ed, McGrawHill, 1991

2. Industrial Instrumentation, Ekmann, D. P, Fifteenth Wiley Eastern Reprint, Wiley Eastern Ltd, 1991

**Reference Books:**

1. Chemical Process Control, George Stephanopolous, Eastern Economy edition, Prentice-Hall, 2005

2. Instrument Engineer's Handbook, Liptak, B.G, Volume I: Process Measurement and Analysis', 4th ed, CRC Press, 2005

## CH30313: PROCESS EQUIPMENT DESIGN LAB [0-2-0]

**Credit:** 01 **Teaching Scheme:** (Laboratory) 02Hrs/Week

**Prerequisites**: Fluid Mechanics, Mass Transfer, Heat Transfer, Engineering Mathematics.

**Objectives:** This course will guide the students to develop the key concepts and techniques to design process equipments and the knowledge can be utilized further for the process industries.

**Course outcomes:**

**After the completion of the course, the student will be able to:**

**CO1.** Design the process equipment with proper sketch based on available specifications.

**CO2.** Analyze, interpret, and design of important heat and mass transfer equipment.

**CO3.** Use software tools for the analysis of design parameters required for process equipment.

**CO4.** Apply safety rules and incorporate various codes and standards for the design of storage units or pressure vessels.

**List of Experiments:** (Any Ten)

**Experiment No. 1:** Design of a continuous tray type Distillation columns – for binary mixtures.

**Experiment No. 2:** Design of a continuous packed type Distillation columns – for binary mixtures.

**Experiment No. 3:** Analysis of design parameter of a distillation column using CHEMCAD software.

**Experiment No. 4:** Process Design of a packed type Absorption column – for binary systems.

**Experiment No.5:** Process design of shell and tube heat exchanger considering overall heat transfer coefficient and pressure drop as parameter using Kern's method.

**Experiment No. 6:** Simulation of design parameters of a shell and tube heat exchanger using CHEMCAD software.

**Experiment No. 7:** Process Design study of a Concentric / Double pipe heat exchanger.

**Experiment No. 8:** General design consideration of a single effect evaporator.

**Experiment No. 9:** General design consideration of multiple effect evaporators.

**Experiment No.10:** Design of pressure vessels with mechanical properties.

**Experiment No.11:** Design of storage tanks with mechanical properties.

**Experiment No.12:** Design of an isothermal reactor.

**Experiment No.13:** Simulation of process parameters of an isothermal reactor using CHEMCAD software.

**Text Books:**

**T1.** Process Heat Transfer, D. Q. Kern, Tata McGraw Hill Publications, 2009

**T2.** Coulson & Richardson's Chemical Engineering, Volume-6, R. K. Sinnott, Elsevier Butterworth Heinemann, MA, 2005

**T3.** Joshi's Process Equipment Design, V. V. Mahajani, Fourth Edition, Macmillan Publishers India ltd, 2009. "Title of the book", Authors Name,Publishers Name, Edition, Year of Publication

**Reference Books:**

**R1.** Chemical process equipment: selection and design, Walas, S. M., Butterworth Heinemann, 1990

**R2.** Applied Process Design for Chemical and Petrochemical Plants, Vol. 1 and 2, Ludwig, E.E., 3rd Ed., Gulf Publishing Co., 1997

## CS30302: DATABASE ENGINEERING LAB [0-2-0]

**Credits:** 01 **Teaching Scheme:** Laboratory 02 Hrs/Week

**Prerequisites**: Basic Programming and Data Structure Knowledge.

**Objectives:** To implement queries by using Structured Query Language.

**Course outcomes:**

**After the completion of the course, the students will be able to:**

**CO1.** Apply the concept for database design, create database, and develop queries

**CO2.** Implement different database programs using procedures, function, and cursor.

**CO3.** Implement database features such as triggers, packages etc.

**CO4.** Implement ODBC/JDBC connectivity with programming languages and write programs to store and retrieve data by using queries

**CO5.** Use transaction management systems and recovery methods.

**List of Practicals:**

**Experiment No.1:** Use of SQL syntax: insertion, deletion, join, updation using SQL.

**Experiment No.2:** Programs on join statements and SQL queries including where clause.

**Experiment No.3:** Programs on procedures and functions.

**Experiment No. 4:** Cursor, Cursor Types

**Experiment No.5**. Programs on database triggers.

**Experiment No.6:** Programs on packages.

**Experiment No.7:** Programs on data recovery using check point technique.

**Experiment No.8:** Concurrency control problem using lock operations.

**Experiment No.9:** Programs on ODBC.

**Experiment No.10:** Programs on JDBC.

**Text Books:**

**T1.** The Programming Language Of Oracle, IVAN BAYROSS, BPB Publication, Edition, Year of Publication.

**T2.** oracle 8i-PL/SQL programming, SCOTT Urman, TMH-2000.

**T3.** ORACLE 10g Lab Guide, Rob, Coronel & Crockett, International Edition.

**Reference Books:**

**R1.** oracle 9i-the complete reference, Loney, TMH-2000.

## CH34302: GENERAL SEMINAR ON INDUSTRIAL WORK [0-2-0]

**Credit:** 01 **Teaching Scheme:** (Laboratory) 02Hrs/Week

**Prerequisites:** Basic ideas of engineering operations and general idea about different chemical industries.

**Objectives:**

1. To introduce the various aspects of application of process in different chemical industries.
2. To improve the pronunciation, oral communication, expressions and the listening skills of the students.
3. To guide the students for their technical level confidence in front of a group.

**Course outcomes:**

**After the completion of the course, the student will be able to:**

**CO1.** give students the opportunity to apply the knowledge and skills they have acquired on campus in a real-life work situation.

**CO2.** provide students with opportunities for practical, hands-on learning from practitioners in the students' areas of specialization.

**CO3.** expose students to a work environment, common practices, employment opportunities and work ethics in their relevant field.

**CO4.** enhance the employability skills of the students and provide opportunities for them to be offered jobs in the organizations in which they undergo their Industrial Training.

**Course Details:**

1. Introduction to different processes in Chemical industry.
2. Chemical Processes in Petroleum refinery operation.
3. Chemical Processes in Pharmaceutical Industry.

4. Chemical Processes in Paper and pulp industry.
5. Chemical Processes in Oil and Paint Industry.
6. Chemical Processes in Food Industry.
7. Definition of chemical operation and process (Unit Operation & Unit Process).
8. The topic may be defined by the guide.
9. A report is required to submit before the presentation.
10. The presentation may be of minimum 15 minutes duration followed by 10 minutes of interaction.
11. All other non-participating students must attend each presentation and take part in the interactive sessions.

## CH37398: MAJOR PROJECT (STAGE I) [0-4-0]

**Credits:** 02 **Teaching Scheme:** (Laboratory) 04 Hrs/Week

For 6$^{th}$ semester students a Major Project is to be carried out considering the following objectives:

1. Scope for finding innovative thoughts.
2. Finding gaps in research area.
3. Review of literature regarding the gaps find out.
4. The Major Project group will be of students comprising of 3-4 students (approx.).
5. Head of the Department will appoint Major Project Guides.
6. 02 credits will be awarded to the candidates after the viva voce and project demonstration at the end of the semester based on the project statement, report and requirements. The students are advised to utilize the laboratory resources before or after their contact hours as per the prescribed module.

**Course outcomes:**

**After the completion of the project, the students will be able to:**

**CO1.** Understand the process of conducting research in Chemical Engineering.

**CO2.** Work individually/group in solving research problems based on the suitable methodology and observation method.

**CO3.** Analyse and discuss critically research outcomes and, also to obtain information through literature survey for its development.

**CO4.** Present the research outcome scientifically through thesis/dissertation and seminar.

## CH37402: COMPREHENSIVE VIVA VOCE [ORAL]

**Credits:** 02

Compulsory for each student based on the two subjects (S2) CH30112 & (S3) CH30113.

Assessment Scheme: (100 marks)

**Course outcomes:**

**After the completion, the students will be able to:**

**CO1.** Answer basic questions related to process dynamics and control.

**CO2.** Answer questions related to basic principles in equipment design.

**CO3.** Acquire additional ideas related to design and control of equipment.

**CO4.** Communicate confidently to the Engineering community.

## IN37403: PRE-PLACEMENT TRAINING [0-2-0]

**Credit: 0**1

**Pre-requisite:** English Communication Skills knowledge of computer programming languages, Training on Life skills.

**Unit I: Verbal Ability with presentation:**

Verbal simulation practices, Reading comprehension, Articles , Prepositions & Its functionalities & Placement Exercises', Subject Verb Agreement and Parts of Speech – Functionalities', Grammar and Tenses –Functionalities' , Errors and Common Mistakes – Usages.

**Unit II: Quantitative Aptitude**

Number theory, Divisibility Rules, Number Properties, Averages, Problems on ages, Time and Work, Pipes and Cisterns , Man Days' Concept, Ratio Proportion, Allegation, Mixture, Percentages, Unit digit problems, SI & CI ,Profit, Loss, Discount, Successive Discount Techniques, Time , Speed, Distance, Train Problems, Boats and Streams.

**Unit III: Logical and Verbal Reasoning**

Syllogisms, Cubes, Number Series, Directions, Blood Relations, Seating Arrangements (Linear and Circular), Venn Diagrams, Data Sufficiency & Data Interpretation -Pie, Tabular and Bar Models, Clocks, Calendar, Coding, Decoding, Alphabet Series, Crypto Arithmetic Patterns and Strategic Approaches.

**Unit IV: Technical Training**

Basic coding practices using programming languages C, C++ and JAVA, Practices on One

database (Oracle), Practices on one operating system.

**Unit V: Group Discussion and Personal Interview**

Group Discussion: Many-on-many discussion on current topics with special focus on team work, reasoning ability, leadership, initiative, listening and awareness, assertiveness. Tips on Body Language, Eye Contact, Positive Gestures during group discussion; Resume and CV Preparation; Mock Personal Interview- Real time Interview with focus on both common interview questions and frequently asked technical questions. Real time experience on HR and MR Mock sessions with emphasis on do's and don'ts of interview, frequently asked HR sessions, Tips to handle HR and MR round, Strategies to break managerial trivia.