Syllabus of Second Year

B. Tech. (Chemical Engineering)

(Revised Syllabus w. e. f. 2019-20)

Faculty of Science and Technology

University Institute of Chemical Technology
Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

(Academic Year 2019 – 20)

Semester-III (Second Year)

Course Code	Course Title	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
BSC-206	Chemistry-II	03	01	04	03	1.5	5.5
ESL-205	Engineering and Solid Mechanics	03	01	04	-	-	4.0
CHL-201	Thermodynamics-II	03	01	04	-	-	4.0
ESC-206	Engineering Workshop	01	-	01	04	02	3.0
CHC-202	Transport Phenomena	03	01	04	-	-	4.0
NC-202	Constitution of India	-	-	-		NC	NC
Total Credit							**20.5**

Course Title: Chemistry-II

Course Code: BSC-206

Theory: 04 Hours/week (Teaching Hours: 03, Tutorial: 01) **Total Credits: 04**

Course Prerequisite: Chemistry-I

Course Objectives:

1. To develop the arts and culture of organic chemical reactions and its significance in chemical and technology process industry.
2. To study how chemical reactions takes place differently in different environments i.e., reaction mechanism.
3. To study and apply the basic reactions mechanism to design synthesis of some classes of molecules.
4. To study industrially important chemical reactions, substrate and some reagents.
5. To study interconversion of functional group and their applications.
6. To study methods of determination of structure of molecules.

Course Contents:

UNIT- I

Aromatic molecules: Huckels rule of aromatic molecules, different classes of aromatic molecules, resonance.

Aromatic Electrophilic Substitution bimolecular reactions (ArSE2 reactions): Mechanism of ArSE2 reaction, Orientation of ArSE2 reaction in monosubstituted benzene, Mechanism and synthetic application of Nitration, Friedel-Craft's alkylation and acylation reactions, Gatterman-Koch reaction, Vilsmeier-Haack's reaction. (10)

UNIT-II

Aromatic amines: Methods of Preparation – benzyne mechanism, reduction of nitro aromatics, properties-basicity and application in synthesis.

Diazonium Salts: Preparation-diazotization reaction, chemical properties and reactions such as coupling, synthesis of azo dyes, replacements-Sandmeyer's reaction and deamination. Ullman's reaction and Benzidine rearrangement. (10)

UNIT-III

Reagents and Green solvents in organic synthesis:

Complex Metal hydride-DIBAL-H, Lithium dimethyl cuprate, applications in synthesis. Introduction to organoboron-diborane, organosilicon-silane. H_2O_2 and O_3(Ozone) application in organic synthesis. Introduction to Green reactions, Green and hazardous solvents. (10)

UNIT-IV

Sulphonic acids: Methods of preparation, application of sulphonic acids in synthesis.

Heterocyclic compounds: Introduction, Methods of synthesis and ArSE2 reactions such as nitration, sulphonation, halogenations, acylation and mercuration of Furan, Pyrrole and Pyridine. (10)

UNIT-V

Spectroscopy: Basic principles and applications of IR, UV-VIS and ^{1}H NMR spectroscopy to structure determination of small molecules. (10)

Text/ Reference Books:

1. S. H. Pine, Organic Chemistry, Tata McGraw-Hill Education India, 5th Revised edition-1987
2. M. B. Smith, Jerry March, March's Advanced Organic Chemistry: Reactions, Mechanism and Structure, Wiley-Interscience, 6th Edition2007.
3. R. T. Morrison, R. N. Boyd, S. K. Bhattacharjee, Organic Chemistry, Pearson, 7th Edition 2011.
4. Jonathan Clayden, N. Greeves, S. Warren, P. Wothers, Organic Chemistry, Oxford University Press, 2000.
5. W. Carruthers, I. Coldham, Modern Methods of Organic Synthesis, Cambridge University Press, 4th Edition 2012.
6. P. S. Kalsi, Spectroscopy of Organic Compounds, New Age International Pvt Ltd Publishers, 6th Edition, 2006.
7. Elementary Organic Spectroscopy, Y. R. Sharma, S. Chand & Co. 4th Edition 2007.

Course Outcomes:

1. Students completing this course will have clear basic concepts of different classes of organic molecules, their important reactions and functional group interconvertions.
2. They would know how organic reactions are takes place, how to design the desired product and factors to take care of it.
3. They will understand how to apply different concepts of reactions to workup/separation of product, to improve yields and to study structure of molecules.
4. This course provides the knowledge of organic concept to undergraduate engineering students and is designed to strengthen the fundamentals so that they can build their own interface of applied organic chemistry concept with their industrial applications in the branch of chemical engineering and Technology.

Chemistry-II Lab

Course Code: BSC-206 (PR)

Practical: 03 Hours/ week **Total Credits: 1.5**

Course Prerequisite: Chemistry-I practical

Course Objectives:

1. To develop the arts and culture of organic chemical reactions and its significance in chemical and technology process industry.
2. To study how chemical reactions are takes place differently in different environments i.e., reaction mechanism.
3. To inculcate the laboratory skills.

Course content:

1. Qualitative analysis of organic binary mixture through type determination, separation. Elemental analysis, functional group determination and physical constant of any one component (at least Two mixtures)
2. Single step preparation involving greener approach, purification and characterization (m.p.) of product (at least Three)
   - i) Preparation of dibenzalpropanone using NaOH or LiOH as base
   - ii) Preparation of p-nitro aniline from p-nitroacetanilide
   - iii) Bromination of acetanilide by CAN, KBr in water
   - iv) Preparation of Osazone from Glucose
   - v) Preparation of Sudan-I from aniline
   - vi) Preparation of p-nitrobenzoic acid from p-nitrotoluene
   - vii) Oxidation of alcohol to ketone by sodium hypochlorite (NaOCl)
3. Determinations/Estimations (Any Two)
   - i) Determination of total hardness of water
   - ii) Determination of Molecular Weight of a monobasic/ dibasic acid by volumetric method.
   - iii) Estimation of amide by hydrolysis
   - iv) Study of kinetics of hydrolysis of methyl acetate
4. Laboratory Techniques (any Three)
   - i) Thin Layer Chromatography (TLC)
   - ii) Hydrogenation of organic compound-a demonstration
   - iii) Interpretation of IR and UV-VIS Spectra
   - iv) Interpretation of ^{1}H NMR spectra

Text/ Reference Books

1. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, Pearson, 5th Edition 2005.
2. R. K. Bansal, Laboratory Manual of Organic Chemistry, New Age International (P) Limited, 5th Revised Edition 2008.

Course Outcomes:

1. Students completing this course will have clear basic concepts of different classes of organic molecules, their important reactions with developed laboratory skill and awareness.

2. Students completing this course will have basic concepts in preservation of environment by adaptation of Green Chemistry concepts.

Course Title: Engineering and Solid Mechanics

Course Code: ESL – 205

Theory: 03 Hrs + 01 Tutorial / Week **Credits: 04**

Course Pre-requisite: Physics, Mathematics and Engineering Graphics

Course Objective:

- Students would be introduced to fundamentals of Engineering Mechanics with emphasis on force systems, axioms, dynamics of rigid bodies.
- Second part of the course would be an introduction to Solid Mechanics, and students would be introduced to basic concepts of mechanics of deformable media: concept of stress tensor, strain tensor, strain rates, constitutive relations, and applications to one/two dimensional problems.

Course Contents:

Unit - I

Coplanar forces: Introduction, basic concepts, composition & resolution of forces. Resultant forces. Moment of forces, couples, equivalent force systems, free body diagrams, distributed forces. Equilibrium of coplanar force system, conditions of equilibrium. Types of supports. Support reactions for determination of beams. Problems on above topics.

Analysis of structure: Plane trusses, method of joints, cables subjected to part loads. (10)

Unit – II

Centroid &Centre of gravity of composite plane figures. Principal Moment of Inertia, Moment of Inertia of various geometry.

Friction: Laws of friction, Application of friction on horizontal & inclined planes, belt friction.

Introduction to point Kinematics: Curvilinear Motion: Moving point in various coordinate systems (Cartesian, cylindrical, path), Equation of motion.

Kinetics & Kinematics of Rigid body: Translation & Rotation motion, Linear and Angular velocity, momentum. (10)

Unit – III

Concept of stress & strain, classification, Hooke's law, Poisson's ratio, Modulus of elasticity, Modulus of rigidity, Bulk modulus, relation between elastic constants, Problems on stresses & strains for prismatic, linear varying & composites sections.

Introduction to thermal stresses& strains. Problems on simple & composite sections. (10)

Unit – IV

Concept & definition of shear force & bending moment in determinate beams due to concentrated loads, UDL, UVL, Shear force & Bending moment diagrams for cantilever & simply supported beams (with or without overhang). Theory of bending. Concept of shear stress distribution. (10)

Unit – V

Thin Cylinder: Hoop stress, longitudinal stress, riveted cylindrical vessels, wire bound thin pipes. Thin spherical shells, cylinder with hemispherical ends.

Torsion of a circular shaft: Theory of pure torsion, Assumptions. Simple problems on torsion & power transmission. Short & long columns & struts. Standard cases with axial load. (10)

Text/Reference Books

1. I. B. Prasad, "Applied Mechanics & Strength of Materials", Khanna Publishers.
2. Timoshenko, "Mechanics of Materials", CBS Publisher
3. Ramamruthan S., "Strength of Material", Dhanpat rai Publications
4. Bear & Johnson, "Mechanics of Materials", 7th edition, McGraw-Hill Education, 2015
5. R. K. Rajput, "Strength of Materials", S Chand Publications
6. R S Khurmi, "Strength of Materials", S Chand Publications

Course Outcomes:

1. Able to solve basic concept in structural members like column, beams, trusses, and concept in laws of frictions and various types of stresses and strains.
2. Able to solve shear forces and bending moment and plot diagrams.
3. Able to analyse various parameters on torsion in transmission system.

Course Title: Thermodynamics II

Course Code: CHL – 201

Theory: 03 Hrs + 01 Tutorial / Week **Credits: 04**

Course Pre-requisite: Thermodynamics I

Course Objective: To introduce the concepts of fugacity, activity and their coefficients, Phase equilibria and Chemical reaction equilibria.

Course Contents:

Unit - I

Review of basic laws of thermodynamics, intensive and extensive properties, state and path function, calculation for work, enthalpy and entropy changes. Efficiency calculation to heat engine, heat pumps. Refrigeration cycle & Carnot cycle, Throttling Process. (10)

Unit – II

Properties of pure substances: T-V, P-V, P-T diagram. Ideal gas law, compressibility factor, Van der waals equation, Viral equation, Redlich Kwong equation, Redlich Kwong Soave equation of state. P-V-T relation for isothermal, isobaric, isochoric, adiabatic & polytropic processes. (10)

Unit – III

The Maxwell relations, method of Jacobians, Gibbs & Helmotz relations, the Clapeyron equation. The general relations for du, dh, C_v, & C_p ; Mayer relation. Isothermal compressibility, volume expansivity, coefficient of linear expansion, adiabatic compressibility & adiabatic bulk modulus. The Joule Thomson Coefficient. (10)

Unit – IV

Phase Equilibria: Chemical potential, Kay's rule, Phase rule for reacting system, Duhem's theorem, boiling point and equilibrium diagram, fugacity and activity coefficient, activity coefficient equations (Wohl's three-suffix equations; Margules equation; Van Laar equation; Wilson equation; Non-random two-liquid (NRTL) euation; Universal quasi-chemical (UNIQUAC) equation; Universal functional activity coefficient (UNIFAC)), Azeotropes, consistency tests for VLE data, modified Roult's law, liquid-liquid equilibria. (10)

Unit – V

Chemical Reaction Equilibria: Chemical equilibrium criteria, Equilibrium constant, chemical equilibria for simultaneous reactions, Feasibility of a reaction, Effect of temperature and pressure on equilibrium constant, Heterogeneous reaction equilibria. (10)

Text/ Reference Books

1) J.M.Smith, H.C.Van Ness and M.M.Abbott, "Introduction to Chemical Engineering Thermodynamics", 7th edition, McGraw-Hill International Edition, 2005.
2) K.V.Narayanan, "A textbook of Chemical Engineering Thermodynamics" PHI, New Delhi, 2010.
3) Y.V.C.Rao, "Chemical Engineering Thermodynamics" , University Press, Hyderabad,1997.
4) S.Sandler, " Chemical, Biochemical and Engineering Thermodynamics" , 4th edition, Wiley, India,2014.

Course Outcomes:

On completion of the course,

1.Students would be familiar with Basics of thermodynamics

2.Students would be familiar with various thermodynamics relations

3.Students will be able to solve problems of phase equilibria

4. Students will be able to solve problems of chemical equilibria

Course Title: Engineering Workshop

Course Code: ESC – 206

Theory: 01 Hrs / Week **Credits: 01**

Course Objective:

In workshop practice, students will get familiar with use of different workshop practices like fitting, welding, tin smithy, black smithy, foundry and computer hardware workshop. Students will also get familiar with different tools, machines, equipment, and job holding devices, job drawing, job material, job manufacturing operations and processes in different workshops.

Course Contents:

Unit - I

Manufacturing Methods: Casting: Pattern Making, pattern materials, pattern allowances, Types of sand. Moulding hand tools, defect in casting.

Forming: Hot working and Cold working, forging, Drawing, Rolling, Extrusion

Machining: Lathe machine, Its major parts & operations (5)

Unit – II

Joining: Welding: (Arc welding, TIG, MIG & Gas welding, types of flames), Brazing, riveting & fastening

Advance manufacturing methods: Electrical discharge machine(EDM), laser beam welding(LBM)CNC machining: Introduction.

Fitting operation: Marking, measuring, filling, drilling, tapping, Power tool: Power hacksaw machine, Bench grinder Machine. (5)

Unit – III

Carpentry: Timber, Measuring & Marking tools, cutting tools, planning tools, boring tools, striking tools, holding tools. Use of plastics & composites as engineering materials.

Plastic Moulding: Injection moulding.

Metal casting: die casting, its advantages & dis advantages, (5)

Text/Reference Books

1. ’Elements of Workshop Technology Vol I & Vol II: Hajara Chaudhari S. K, Hajara Chaudhari A. K, Nirjhar Roy S. K, Media promoters & publishers pvt. Ltd., Mumbai
2. Manufacturing Engineering & Technology: Kalpakjin S. & Steven S. Schmid, 4th addition Pearson education India. Edition,2002
3. ’Manufacturing Technology: Gouri E. Hariharan & A. Suresh Babu, I Pearson education 2008
4. ’Processes & Material of manufacture’s: Roy A. Lindber, 4th edition, Prentice hall India 2008
5. Manufacturing Technologies I & II: Rao P. N. Tata McGraw-Hill house 2017

Course Outcomes:

Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in industries, to fabricate components using different materials.

Course Title: Engineering Workshop Lab

Course Code: ESC – 206

Practical: 04 Hrs / Week **Credits: 02**

Workshop Practice: (Any Five)

1) Machine Shop: Turning- Facing, plain turning, Step turning & Taper turning.
2) Fitting: Filling, Drilling & Tapping
3) Carpentry: (Halving, Mortise & Tenon, Bridle, Butt, Dowel, Dovetail) any one.
4) Electrical & Electronics: Common house wiring connection
5) Welding Shop: (Butt, Lap, Corner, T) Any one
6) Piping (Any Joint)
7) Plastic Moulding: Injection moulding

Examination could involve the actual fabrication of simple components, utilising one or more of the techniques covered above.

Laboratory outcomes:

1) Upon completion of this laboratory course, students will be able to fabricate components with their own hands.
2) They will also get practical knowledge of dimensional accuracies & dimensional tolerances possible with different manufacturing processes.
3) By assembling different component, they will be able to produce small devices of their interest

Course Title: Transport Phenomena

Course Code: CHL-202

Theory: -3 Hrs./week + 1Hr. **Total Credits: - 4.0**

Course prerequisites: Mathematics

Course Objectives:

1. This course will highlight coupling between three transport phenomena with applications in various disciplines in engineering and science and will demonstrate to the students the common mathematical structure of transport problems.
2. The course will deal with flow problems involving Newtonian and non-Newtonian fluids, solid-state heat conduction, forced and free convection, binary diffusion with or without chemical reaction.

Course Contents:

UNIT I:

Introduction to Transport Phenomena, Formulation of transport problems from nature

Vector and Tensor Analysis: Basic concepts (10)

UNIT II:

Basics of momentum transport: Euler/ Lagrangian viewpoint, laminar and turbulent flows, boundary layers, stress tensor

Shell momentum balances, equations of change, dimensional analysis, applications to isothermal flow of Newtonian fluids. (10)

UNIT III:

Shell momentum balances: applications to flow of non-Newtonian fluids

Basics of energy transport, conductive, convective and viscous dissipation energy fluxes. Basics of mass transport, mechanisms and mass and molar fluxes (10)

UNIT IV:

Equations of change for non-isothermal systems, dimensional analysis, and applications to steady-state conduction and convection (10)

UNIT V:

Derivation of equation of continuity for a binary mixture and its application to convection diffusion problems.

Unsteady-state momentum, heat and mass transport, formulation of basic equations and similarity transform method (10)

Text/Reference Books:

1. R. B. Bird, W. E. Stewart, and E. S. Lightfoot, "Transport Phenomena", 2nd ed., Wiley India Pvt. Ltd., 2002.
2. Welty, C. E. Wicks, R. E. Wilson, and G. L. Rorrer, "Fundamentals of Momentum, Heat, and Mass Transfer", 5th ed., Wiley India Pvt. Ltd., 2007.
3. W. M. Deen, "Analysis of Transport Phenomena", Oxford University Press, 1998.
4. W. J. Thompson, "Introduction to Transport Phenomena", Prentice Hall, 2000.

Course Outcomes:

On completion of the course, students would be familiar with

- Basics of vector and tensor analysis
- Be able to solve transport problems using shell balances
- Formulate and solve one-dimensional transport problems by using the conservation equations
- Formulate simple multi-dimensional transport problem

Course Title: Constitution of India
Course Code: NC-202

Credit: Non-credit course

Course Objectives:

To percolate & disseminate knowledge about constitution of India for imbibing & understanding importance of fundamental rights & duties so as to aware the students towards justice, equality & liberty.

Course Content:

- **Introduction to the Indian Constitution:** History and Making of the Constitution, Constituent Assembly, Salient features, The preamble
- **Fundamental Rights & Duties:** Meaning and types of fundamental rights; Fundamental duties, the Right to Equality, the Right to Freedom, the Right against Exploitation, the Right to Freedom of Religion, Cultural and Educational Rights and Right to Constitutional Remedies

- **Directive Principles and Human Right:** Meaning of Directive Principles; difference between of Fundamental Rights and Directive Principles of State Policy – Implementation of Directive Principles of State Policy
- **Union Government & Administration:** Structure of Indian union, Loksabha, Rajyasabha, Powers and Functions of the President, the Prime Minister, Council of Ministers; composition, powers and functions of the Parliament, organisation of judiciary; jurisdiction of the Supreme Court; independence of judiciary, Election Commission

- **State Government & Local Administration:** Powers and Functions of Governor, Chief Minister and Council of Minister; composition, powers and functions of State Legislature, Local administration and constitution: Panchayati, Municipalities.

Suggested Books/ Readings:

1. M. V. Pylee – An Introduction to Constitution of India, Vikas Publications, New Delhi-2005.
2. Subhash C. Kashyap – Our Constitution: An Introduction to India's Constitution & Constitutional Law, National Book Trust, New Delhi-2000.
3. Durga Das Basu – Introduction to the Constitution of India, PHI, New Delhi-2001.
4. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
5. J. C. Johari – Indian Government & Politics, Sterling Publishers, Delhi-2004.
6. V. D. Mahajan – Constitutional Development & National Movement in India, S. Chand & Company, New Delhi.
7. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
8. Granville Austin – Working of a Democratic Constitution: The Indian Experience, Oxford University Press, New Delhi-1999.
9. A. P. Avasthi – Indian Government & Politics, Naveen Agarwal, Agra-2004.
10. S. A. Palekar – Indian Constitution, Serials Publication, New Delhi-2003.

Semester-IV (Second Year)

Course Code	Course Title	Teaching Hours	Tutorial	Credits	Practical Hours	Credits	Total Credits
CHC-203	Heat Transfer	03	01	04	03	1.5	5.5
CHC-204	Fluid Mechanics	03	01	04	03	1.5	5.5
HML-202	Industrial Management and Economics	03	-	03	-	-	3.0
CHL-205	Chemical Process Technology	03	-	03	-	-	3.0
CHL-206	Material and Energy Balances Computations	03	01	04	-	-	4.0
Total Credit							**21**

Course Title: Heat Transfer

Course Code: CHC – 203

Theory: 03 Hrs + 01 Tutorial / Week **Credits: 04**

Course Pre-requisite: Transport Phenomenon

Course Objective: The objective of this course is to provide basic knowledge of various modes of heat transfer and detail design knowledge of various heat exchangers and evaporators.

Course Contents:

Unit - I

Concept of heat transfer and transport of heat. Fourier's law, significance of thermal conductivity of solid, liquid and gases, heat transfer through plane and composite wall, sphere and cylinder, problem related to this case. Thermal diffusivity, differential equation of heat conduction, lagging of pipes and other equipment, optimum lagging thickness, critical radius of insulation. Heat Transfer from extended surfaces (fins). (10)

Unit – II

Convection: Individual and overall heat transfer coefficients, natural and forced convection, laminar and turbulent flow, significance of dimensional numbers, dimensional analysis and heat transfer analogy, flimwise and dropwise condensation (horizontal & vertical Surfaces). (10)

Unit – III

Design aspects of condensers reboilers and evaporators, Concept of Boiling and their types, Nussult Equation. Evaporation: Single and Multiple effect evaporator. B.P.R. and hydrostatic head. Economy and capacity of evaporator. Problem based on single effect evaporator. (10)

Unit – IV

Radiation: Laws of radiation, radiation from solid surfaces, types of surfaces. Heat exchange by radiation between two finite black surfaces, between two infinite parallel surfaces, shape factor. Laws of shape factor, solid angle and radiation intensity, Green House effect. Electrical analogy of radiation shield. (10)

Unit – V

Heat Exchangers: classification, overall heat transfer coefficient, fouling factor, LMTD in single pass parallel, counter and cross flow arrangements. N.T.U.- effectiveness method for parallel and counter flow heat exchangers, general design aspect of heat exchangers. Problem based on LMTD and NTU effectiveness method. (10)

Text/ Reference Books

1. Holman,J..P.,S. Bhattacharya, Heat Transfer,10th edition, Tata McGraw-Hill,2011.
2. D.Q.Kern, Process heat transfer, Tata-McGraw Hill,1997.
3. R.Welty, C.E. Wicks, R.E.Wilson, G.Rorrer, Fundamentals of Momentum, Heat and Mass Tranfer, 4th edition, Wiley,2007.
4. W.J.Mccabe, J.Smith, P.Harriot, Unit Operations of Chemical Engineering, 6th edition, McGraw Hill, 2005.

Course Outcomes:

On completion of the course, students will be able to

1) Understands the various modes of heat transfer.
2) Understands the basics of fins
3) Design double pipe heat exchanger, shell and tube heat exchanger.
4) Design single effect evaporator

Heat Transfer Lab

Course Code: CHC-203 (PR)

Practical: 03 Hours/ week **Total Credits: 1.5**

Course Contents:

1. To determine the heat transfer coefficient of air by using natural convection.
2. To determine the Stefan Boltzmann constant for radiation.
3. To determine the thermal conductivity of metal bar.
4. To determine the thermal conductivity of liquid (Lubricating oil).
5. To determine the heat transfer coefficient of double pipe finned tube heat exchanger.
6. To determine the log mean temperature difference in double pipe heat exchanger for parallel flow arrangement.
7. To determine the log mean temperature difference in double pipe heat exchanger for counter flow arrangement.
8. To Study the drop-wise and film-wise condensation.

Course Outcome

- To enhance the knowledge and clear the theoretical concepts of heat transfer by performing the hands-on experiments in the laboratory for detail understanding of the topic.

Text/ Reference Books

1. Holman,J..P.,S.Bhattacharya, Heat Transfer,10th edition, Tata McGraw-Hill,2011.
2. D.Q.Kern, Process heat transfer, Tata-McGraw Hill,1997.
3. R.Welty, C.E. Wicks, R.E.Wilson, G.Rorrer, Fundamentals of Momentum, Heat and Mass Tranfer, 4th edition, Wiley,2007.
4. W.J.Mccabe, J.Smith, P.Harriot, Unit Operations of Chemical Engineering, 6th edition, McGraw Hill, 2005.

Course Title: Fluid Mechanics

Course Code: CHC-204

Theory: 04 Hours/week (Teaching Hours: 03, Tutorial: 01) **Total Credits: 04**

Pre-requisites: Transport Phenomena

Course Objectives

The objective of this course is to make student well acquainted with different concepts in fluid mechanics like fluid statics, kinetics, dynamics, hydrostatic forces on submerged bodies, flow through pipes, instruments for flow & pressure measurement, types of flows, boundary layer theory, dimensional analysis & transportation of fluids by pumps, blowers and compressors etc & their applications particularly in chemical engineering.

Course Contents:

UNIT I

Concept of Fluid, Properties of Fluids, Viscosity, Newton's Law of Viscosity, Types of Fluids, Measurement of Pressure, Fluid Pressure at a Point, Pascal's Law, Hydrostatic Law, Absolute, Gauge, Atmospheric & Vacuum Pressures, Measurement of Pressure, Simple Manometers, Differential Manometers, Total Pressure & Centre of Pressure for a Vertical, Horizontal Surface Submerged in Liquid, Buoyancy, Centre of Buoyancy, Stability of Floating & Submerged Body.
Problems Based on All the Topics in a Unit. (10)

UNIT II

Kinematics of Flow: Types of Fluid Flows, Continuity Equation, Continuity Equation in Three Dimensions, Continuity Equation in Cylindrical Polar Coordinates, Velocity & Acceleration Concept, Stream Functions, Potential Flow & Its Important Cases.
Dynamics of Flow: Euler's Equation, Bernoulli's Equation, Applications of Bernoulli's Equation (Venturi Meter, Orifice Meter, Pitot Tube), Rotameter, Notches & Weirs.
Problems Based on All the Topics in a Unit. (10)

UNIT III

Flow Through Pipeline System: Loss of Energy in Pipes, Laws of Friction, Major Losses & Minor Losses, Loss of Head Due to Friction in Pipes (Darcy-Weisbach Formula), Chezy's Formula, Water Hammer in Pipes, Hydraulic & Total Energy Line.
Viscous Flow: Flow of Viscous Fluid through Circular Pipe (Hagen Poiseuille Formula), Between Two Parallel Plates, Methods of Determination of Coefficient of Viscosity, Kinetic Energy & Momentum Correction Factor.
Turbulent flow: Reynolds Experiment, Velocity Distribution in Turbulent Flow in Pipes, Hydrodynamically Smooth & Rough Boundaries, Velocity Distribution for Turbulent Flow in Smooth & Rough Pipes, Velocity Distribution for Turbulent Flow in Terms of Average Velocity, Variation of Friction Factor.
Problems Based on All the Topics in a Unit. (10)

UNIT IV

Dimensional Analysis: Fundamental Dimensions, Methods of Dimensional Analysis, Rayleigh's Method, Buckingham's π Theorem, Types of Similarities, Types of Forces Acting on Moving Fluid, Dimensionless Numbers, Classification of Models.

Boundary Layer Theory: Laminar & Turbulent Boundary Layer, Boundary Layer Thickness, Displacement Thickness, Momentum Thickness, Energy Thickness, Drag Force on a Flat Plate Due to Boundary Layer, Separation of Boundary Layer, Methods of Preventing Separation of Boundary Layer.
Problems Based on All the Topics in a Unit. (10)

UNIT V

Pumping of Liquids: Classification of Pumps, Principle, Construction, Working, Design, Discharge, Work Done & Power Requirement by Centrifugal Pump, Reciprocating Pump (Single & Double Acting), Pumps in Series, Pumps in Parallel, All Curves for Centrifugal Pump, Pump Efficiencies, Selection of Pumps, Priming, NPSH, Cavitation.
Pumping of Gases: Classification of Compressors, Principle, Construction, Working, Design, Discharge, Work Done & Power Requirement by Centrifugal & Reciprocating Compressor, Blowers, Vacuum Pump.
Problems Based on All the Topics in a Unit. (10)

Text/Reference Books

1. M. White, Fluid Mechanics, 8th Edition, Tata-McGraw Hill, 2016.
2. V. Gupta and S. K. Gupta, Fundamentals of Fluid Mechanics, 2nd Edition, New Age International 2011.
3. W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, McGraw-Hill International Edition 2005.
4. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall of India, 2005.
5. R. W. Fox, P. J. Pritchard and A. T. McDonald, Introduction to Fluid Mechanics, 7th Edition, Wiley-India 2010.
6. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th Ed.,Wiley (2007).
7. B. R. Munson, D. F. Young, T. H. Okiishi and W. W. Huebsch, 6th Edition, Wiley-India 2010.
8. R. B. Bird, W. E. Stewart and E. N. Lightfoot, Transport Phenomena, 2nd Edition, Wiley India 2002.

Course Outcome

- The students will have thorough knowledge of fluid properties, behaviour of fluid under different conditions, hydrostatics & pressure measurement.
- The students will get well acquainted with basic principles in kinematics & dynamics of fluid flow with its application.
- It will clear the basic concepts about various types of flows, complexities in flow through pipeline systems with detail study of laminar, turbulent flow.
- Students will get well acquainted with phenomena of boundary layer formation and separation. Students will be able to understand dimensional analysis and its application to solve the complex problems in heat & momentum transfer.
- Student will have thorough knowledge of handling of fluids by various pumps, compressors, blowers and will be able to design the fluid handling system with calculation of power requirement in it. It will enhance the ability of students to identify and solve various engineering problems.

Fluid Mechanics Lab

Course Code: CHC-204 (PR)

Practical: 03 Hours/ week **Total Credits: 1.5**

Course Objectives:

To impart practical knowledge of fluid mechanics to students.

Course Contents:

1. To Study Reynold's Experiment.
2. To Study different types of Manometers.
3. To Verify Bernoulli's Theorem
4. To Determine Coefficient of Discharge for Venturimeter.
5. To Determine Coefficient of Discharge for Orificemeter.
6. To Determine Coefficient of Discharge for Rectangular, Triangular & Trapezoidal Notch or Weirs.
7. To Determine the Viscosity of Oil Using Ostwald's Viscometer.
8. To Determine the Viscosity of Oil Using Stoke's Law.
9. To Determine Loss of Head Across Various Pipe Fittings.
10. To Study Different Types of Pumps & Compressors.

Course Outcome

- To enhance the practical knowledge and clear the theoretical concepts in the subject by performing hands on experiments in the laboratory for detail understanding of the topic.

Text/ Reference Books

1. V. Gupta and S. K. Gupta, Fundamentals of Fluid Mechanics, 2nd Edition, New Age International 2011.
2. W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, McGraw-Hill International Edition 2005.
3. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall of India, 2005.
4. R. W. Fox, P. J. Pritchard and A. T. McDonald, Introduction to Fluid Mechanics, 7th Edition, Wiley-India 2010.

Course Title: Industrial Management and Economics

Course Code: HML-202

Theory: 03 Hours/week **Total Credits: 03**

Course Prerequisite: Basic Manufacturing Process, Principle of Economics

Course Objective

1. Identification and selection of management & administration with aspect towards the Production planning and management.
2. Understanding Micro and Macroeconomics Demand and Supply factors of market economy &institutional feature inside the organisation as well as outside the organisation.
3. Understanding GDP statement, Entrepreneurship Development

Course Content

Unit-I

Management: Introduction & meaning management & administration
Industrial management: Connotation of Industrial management
Organisation: Explication and Types of organisation
Manufacturing system: definition, class of manufacturing system
Plant layout: Classification of Plant layout (8)

Unit-II

Business organization: Forms of business organization
Productivity: Various techniques to increase Productivity
Sound wage program: Mechanics of sound wage program
Wages & Wage Administration: Introduction &meaning of Wages & Administration of remuneration
(8)

Unit-III

Marketing management: Introduction meaning and Concept of marketing management
Concept Sales management: Introduction meaning and Concept of Sales management significance of Sales management
Functions of Marketing management: prominence of marketing management
Functions of Sales management, role of Sales management (8)

Unit-IV

Economics: Introduction, meaning of Economics
Concept of GDP: Introduction meaning and Concept of GDP
Concept of ADP: influence of ADP
Introduction of Micro economics and Macro economics
Difference between Micro economics and Macroeconomics (8)

Unit-V

Entrepreneurship: Introduction, meaning and Concept of Entrepreneurship,
Types of Entrepreneurship: Order of Entrepreneurship
Entrepreneurship Development (8)

Text/ References Books:

1) John R. Hicks, "Value and Capital", 10th edition, Oxford, Clarendon Press, 2017
2) R. R. Barthwal, "Industrial Economics: An Introductory Text Book", 11th edition, New Age International, 2015
3) Martin Ricketts, "The Economics of Business Enterprise", 5th edition, ELGAR International, 2019
4) H. L. Ahuja, "Modern Economics" 9th edition, S. Chand Publishing, 2016
5) Alfred Marshal, "principle of Economics", 15th edition, Prometheus Books, 2016.

Course Outcomes:

Upon successful completion of this course the student will be able to:

1. Understanding of management and Productivity aspect towards the material management Production planning. Processes/operations according
2. Identification, selection and understanding the meaning and utility of Marketing management, consumer satisfaction, sales and advertising
3. Understand the importance of Entrepreneurship Development

Course Title: Chemical Process Technology

Course Code: CHL-205

Theory: 03 Hours/week **Total Credits: 03**

Pre-requisites: Basic Chemistry

Course Objective

To impart the thorough knowledge of industrial process technologies for the manufacturing of various organic and inorganic chemicals and to get the students well acquainted with various process industries.

Course Content

Unit I

Salient features of manufacturing commodity chemicals, status of chemical industry in India, classification & characterization of chemical industries, current trends in chemical industry. water treatment for industrial use, sources of impurities, methods of softening, treatment for boiler feed water. (8)

Unit II

Engineering aspects of manufacturing of basic inorganic chemicals such as sulphuric acid, caustic soda, soda ash, chlorine, ammonia, nitric acid and urea. (8)

Unit III

Introduction to petrochemicals, crude types and properties, concept of onshore and offshore drilling, desalting of crude and feed preparation. Physical & chemical properties of petrochemicals, classification of petrochemicals. (8)

Unit IV

Fluidized bed and catalytic cracking, thermal and hydrocracking, reforming, alkylation, isomerization, polymerization of petrochemicals, study of linear alkyl benzene, aromatic compounds, and separation techniques. (8)

Unit V

Engineering aspect of the manufacture with alternative routes for basic organic chemicals such as aldehydes, ethylene, other olefins, acetylene, butadiene, phenols, amines, alcohols, carboxylic acids, esters, ketones, and ethylene oxides. Classification, sampling, analysis and selection of coal, carbonization and complete gasification of coal. (8)

Course Outcome

- To enhance the ability of students to understand the manufacturing of various inorganic and organic chemicals.
- To get the students well acquainted with concept of onshore and offshore drilling, manufacturing and treatment processes of various petrochemicals.
- To enhance the ability of students to understand the process flow diagram and various process parameters.
- To enhance the ability of students to identify and solve engineering problems during production.
- The get the students well acquainted with water treatment processes.

Text Books

1. Shreve's Chemical Process Industries, George T. Austin, McGraw-Hill International Editions Series, 1984
2. Dryden's Outlines of Chemical Technology, M. Gopala Rao, Marshall Sittig, East West Press, 1997
3. Chemical Project Economics, Mahajani V. V. and Mokashi S M., MacMillan India Ltd. 2005
4. Plant Design and Economics for Chemical Engineers, Max Peters, Klaus Timmerhaus, Ronald West, McGraw Hill International Edition, 2013
5. Chemical Process Technology, Moulijn, M. and van Dippen, Wiley, 2013

Course Title: Material and Energy Balance Computations

Course Code: CHL-206

Theory: 04 Hours/ week (Teaching Hours: 03, Tutorial: 01) **Total Credits: 04**

Course Prerequisites: Physics, Chemistry-I, Mathematics-I, Thermodynamics-I

Course Objectives:

1. To teach students fundamental knowledge of chemical engineering and application of this knowledge in the solving of material and energy balances of chemical processes.
2. The course will cover concepts ranging from basics such as units and dimensions, stoichiometry to the simultaneous application of material and energy balances with and without occurrence of chemical reaction.

Course Contents:

UNIT- I

Units and Dimensions: Basic and derived units, different ways of expressing units of quantities and physical constants.

Calculations for mole, molecular weight, equivalent weight, etc., Composition of gaseous mixtures, liquid mixtures, solid mixtures, etc., Ideal gas law & other equations of state and their applications, Dalton law, Raoult's law, Hess's Law, Henry's law, Solutions and their properties. (10)

UNIT-II

Stoichiometry and unit operations:

Introduction to unit operation, development of block diagram and material balance for unit operations like blending, evaporation, crystallization, extraction and leaching, distillation, absorption & stripping, drying etc. (10)

UNIT-III

Material balance involving chemical reaction:

Introduction, definition and concept of terminologies like Excess Reactant, Conversion, Yield, Selectivity. Problems on material balance for chemical reactions for calculation of feed composition and product composition, Conversion, Yield, Selectivity etc. (10)

UNIT-IV

Humidity: Terminologies of Humidification like Humid Heat, Humid volume, % saturation, Molal Humidity, Molal saturation, absolute humidity etc.

Energy balance: Enthalpy calculation for systems (single component and multi components) without Chemical Reaction with Mean and Temperature Dependent Heat Capacity, Enthalpy calculation for systems with Chemical Reactions. Heat of Reaction from Heat of Formation and Heat of Combustion Data, Effect of Temperature and Pressure on Heat of Reaction. (10)

UNIT-V

Introduction to Recycle, Bypass and purge operations: Applications of Recycle, Bypass and purge operations in unit operations and processes for calculation of recycle ratio, purge ratio, combined feed ratio.

Fuels: Types of fuels, Calorific value of fuels, Problems on combustion of coal, liquid fuels, gaseous fuels, etc., Proximate and ultimate analysis, Combustion calculations, Air requirement and flue gases. (10)

Text/ Reference Books:

Author, name of Book, latest edition year, publication

1. Bhatt., B.I. and Vora S.M.“Stoichiometry*”* IInd edition, Tata McGraw Hill.
2. O.A. Hougen, K.M. Watson and R.A. Ragatz “Chemical Process Principles” Part-I,CBS Publishers & distributors ,New Delhi.
3. K.A.Gavhane “Introduction to process calculations” Nirali Publications.
4. Shekhar Pandharipande and Samir Musharaf “Process Calculations” Pune Vidyarthi Griha Prakashan, Pune.
5. Himmelblau, D.M. ″Basic Principles and Calculations in Chemical Engineering″, 6th edition. Prentice Hall.

Course Outcomes:

1. The capability to convert units and dimensions and modify equations from system to another.
2. The capability to apply the laws of physics and chemistry in solving process industry related applications.
3. The proficiency to integrate the data and formulate the mass and energy balance problems.
4. The capability to use mathematical knowledge for solving mass and energy balance problems with and without chemical reactions.