New Scheme (CBCS) & Syllabus

of

Second, Third and Fourth Year (Semester-III, IV, V, VI, VII and VIII) Courses

in

B. Tech. (Chemical Engineering) Program

2020-21

CHEMICAL ENGINEERING DEPARTMENT

NATIONAL INSTITUTE OF TECHNOLOGY RAIPUR

RAIPUR – 492010, CHHATTISGARH

Department Academic Committee:

Chairperson:	Dr. A. K. Poonia, Associate Professor & Head, Chemical Engineering Department, NIT Raipur
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Semester-III

Scheme & Syllabus

National Institute of Technology Raipur

Course of Study and Scheme of Examination (CBCS Scheme) | B. Tech. III Semester | Branch: Chemical

S. No.	Subject Type	Subject Code	Subject Name	Periods per Week			TA	Examination Scheme				Total Marks	Credits
				L	T	P		MSE/MTR		ESE/ESVE			
								Theory	Practical	Theory	Practical		
1	Program Core	CH103101CH	Industrial Process Calculations	3	1	0	20	30		50		100	4
2		CH103102CH	Heat Transfer	3	1	0	20	30		50		100	4
3		CH103103CH	Fluid Particle Operations	3	1	0	20	30		50		100	4
4		CH103104CH	Fluid Mechanics	3	1	0	20	30		50		100	4
5		CH103105CH	Numerical Methods	3	1	0	20	30		50		100	4
6	EPR	CH103001MA	Mathematics-III	3	1	0	20	30		50		100	4
7	Laboratory	CH103401CH	Fluid Particle & Mechanics Lab	0	0	2	40		20		40	100	1
8		CH103402CH	Heat Transfer Lab	0	0	2	40		20		40	100	1
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Industrial Process Calculations

[IIIrd Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH103101CH

[Pre-requisites: Chemistry, Basic Mathematics]

Course Objectives

1. To learn about units & conversions involved in chemical processes.
2. To understand and apply the fundamentals of material and energy balances in unit operation and processes.
3. To understand the concepts of humidity, condensation and crystallization.
4. To provide variety of information such as the composition of flue gas which result from the combustion of fuels in the plant.

Course Content

Unit-1:

Unit and its conversion, Stoichiometric principles and compositions, PVT behaviors, Gas laws, Partial pressure and pure component volume, Concepts of degree of freedom, Mole concept and mole fraction, Weight fraction, Concentration, Molarity, Molality and Normality

Unit 2:

Vapor-liquid equilibrium, Concept of Humidity and Saturation, Psychometric chart, Calculations of processes involving Condensation, Crystallization and Vaporization.

Unit 3:

Material balance for systems with and without chemical reactions, Analysis of systems with by-pass, Recycle and Purge operations, Material balance problem involving simultaneous equations, Degree of conversion, Selectivity, Percentage yield.

Unit 4:

Hess's law of constant heat summation, heat of formation, Calculation of heat of reactions, Dissolution and mixing, Combustion, Energy balance with and without chemical reaction, Calculation of enthalpy change, Fuel combustion and analysis of products.

Course Materials

Required Text: Text books

1. O. A. Hougen, K. M. Watson and R. A. Ragatz, Chemical Process Principles, Part – I, Material and Energy Balance, John Wiley & Sons, Inc., New York, 2nd Edition.
2. Himmelblaue, Basic Principles and Calculations in Chemical Engineering, Pearson Education Pvt. Ltd.

Optional Materials: Reference Books

1. Narayanan K.V. and Lakshmikutty B. "Stoichiometry & process calculations, Prentice hall of India.
2. S. Ghoshal, S. Sanyal, S. Dutta, Introduction to Chemical McGraw-Hill Inc., US.
3. B. I. Bhatt and S. M. Vora, 'Stoichiometry', McGraw-Hill Publications.

Heat Transfer

[IIIrd Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH103102CH

[Pre-requisites: Mathematics I & II]

Course Objectives

1. To teach the students about various modes of heat transfer.
2. To encourage the creativity in problem solving related to heat transfer.
3. To introduce the heat transfer equipments.

Course Content

Unit 1:

Introduction to heat transfer; conduction, convection and radiation heat transfer.

Conduction: Steady-state conduction – One dimension, plane wall, cylindrical and spherical, overall heat transfer coefficient, composite layers etc. insulating materials, critical and optimum thickness of insulation. Extended surfaces, fins and their practical application. Introduction to unsteady state heat transfer – Lumped heat capacity system.

Unit 2:

Convection: Basic concept, natural and forced convection, hydrodynamic and thermal boundary layers, laminar and turbulent boundary layer heat transfer, Dimensional analysis, Buckingham pi-theorem, determination of individual and overall heat transfer coefficient, fouling factors.

Unit 3:

Boiling, Condensation, Radiation: Boiling heat transfer, film wise and drop wise condensation. Radiation heat transfer, radiation between surfaces, radiation shields, radiation shape factor.

Unit 4:

Heat exchangers: Types of heat exchanger, Mean temperature difference, Log mean temperature difference, LMTD correction factor for multiple pass exchangers, effectiveness-NTU method. **Evaporators:** Elementary principle, types of evaporators, single and multiple effect operation, material and energy balance in evaporators.

Course Materials

Required Text: Text books

4. J.P. Holman, S. Bhattacharyya, Heat Transfer, 10th Edition, McGraw Hill Education.
5. W.L. McCabe, J.C. Smith, P. Harriott, Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill Education.

Optional Materials: Reference Books

1. D.Q. Kern, Process Heat Transfer, 1st Edition, McGraw-Hill Education.
2. M. Necati Ozisik, Heat Transfer: A Basic Approach, McGraw Hill Inc.
3. A.S. Foust, L.A. Wenzel, C.W. Clump, Louis Maus, L.B. Andersen, Principles of Unit Operations, 2nd Edition, Wiley.
4. Y.A. Cengel, A.J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, 5th Edition, McGraw-Hill Education.
5. Welty, Wicks, Wilson, Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 5th Edition, Wiley.
6. Walter. L. Badger, Julius T. Banchero, Introduction to Chemical Engineering, McGraw Hill Education, 1st Edition.
7. Binay K Dutta, Heat Transfer: Principle and Applications, Prentice Hall India Learning Private Limited, 1st Edition.

Fluid Particle Operations

[IIIrd Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH103103CH

[Pre-requisites: None]

Course Objectives

1. To impart different concepts of mechanical operations with the help of practical and industrial examples in a lucid and reader friendly manner.
2. To impart knowledge of important industrial equipments relating to mechanical operations such as screening, size reduction, mixing, separation and conveying.

Course Content

Unit-1 :

Particle size and shape: measurement and analysis; Screening and screen analysis, Screen effectiveness, Industrial screening equipments – Grizzly screens, Gyrating screens and Trommels, Size reduction, Crushing efficiency, Energy and power requirement, Rittinger's Law, Kick's law and Bond's law.

Unit 2:

Size reduction equipments – Jaw crusher, Gyratory crusher, Roll crusher, Ball mill & Rod mill, Hammer mill, Attrition mill, Classifying hammer mill, Fluid energy mill, open circuit and closed circuit operation, Mixing – liquids with liquids, liquids with solids and solids with solids, Power requirements, Mixing equipments - Kneaders, dispersers and masticators, Banbury mixer, Muller mixer, Pug mills, Ribbon blenders, Tumbling mixers.

Unit 3:

Separation processes - Magnetic and electrostatic separation, Classification, Filtration, Sedimentation, Centrifugation, Separation equipments –Thickeners, Centrifuges, Electrostatic precipitator, Cyclone separator, Pressure filters, Leaf filters, Bag filters, Continuous rotary filters, Filter media and Filter aids.

Unit 4 :

Nature and characteristics of bulk solids, Conveying and handling of solids - Belt conveyors, Screw conveyor, Chain and Flight conveyors, Bucket elevators, Pneumatic conveyors, Storage bins, Silos and hoppers.

Course Materials

Required Text: Text books

1. W.L. McCabe, J.C. Smith & Peter Harriott, Unit Operations of Chemical Engineering, 5th Ed. McGraw Hill Publication.
2. R. S. Hiremath, A. P. Kulkarni, Mechanical Operations - Unit Operations of Chemical Engineering, Everest Publishing House, Pune.

Optional Materials: Reference Books

1. M. Coulson and J.F. Richardson, Chemical Engineering, Vol. II, 4th Ed., Butterworth – Heinemann.
2. Walter L. Badger and Julius T. Banchero, Introduction to Chemical Engineering, McGraw Hill book company, Inc., New York.
3. G.G. Brown, Unit Operation, John Wiley & Sons.
4. C.M. Narayan and B.C. Bhattacharya: Mechanical Operation for Chemical Engineers.
5.

Fluid Mechanics

[III[rd] Semester, Second Year]

Course Description			
Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH103104CH

[Pre-requisites: Mathematics-I & Mathematics-II]

Course Objectives

To impart the

1. fundamental concepts of fluid statics, pressure distribution and dimensional analysis
2. knowledge to solve fluid dynamics problems using Newton's laws of motion.
3. ability to compute pipe size, flow rate, head loss and power requirements in pipes and fittings under laminar and turbulent flow conditions.
4. knowledge of metering and transportation of fluids and fluid moving machinery performance.

Course Content

Unit 1:

Properties of fluids, Types of fluids: Newtonian and non-Newtonian fluids, Fluid statics: Pressure and its measurement, Dimensional analysis and Similitude.

Unit 2:

Kinematics of fluid flow, Bernoulli's equation and Energy balance, Correction for fluid friction, Correction for pump work, Laminar and turbulent flow of incompressible fluids through closed conduits, Friction factor, Head loss due to friction in pipes and fittings, Boundary layer theory.

Unit 3:

Flow past immersed bodies, Drag and Drag co-efficient, Flow around solids and packed beds, Ergun's Equation, Fluidisation: Mechanism and applications.

Unit 4:

Measurement of fluid flow: Orifice meter, Venturi meter, Pitot tube, Rotameter, Weirs and Notches, Advance flow meters, Fluid moving machinery: performance, selection and application, Positive displacement pumps: Rotary and Reciprocating pumps, Centrifugal pumps, Compressors.

Course Materials

Required Text: Text books

1. Noel. D. Nevers, "Fluid Mechanics for Chemical Engineers", McGraw Hill, 3rd International Edition.
2. W. L. McCabe, J.C. Smith and P. Harriott, "Unit operations of Chemical Engineering", 7[th] Ed., McGraw Hill, International Ed.
3. J. M. Coulson and J. F. Richardson, "Chemical Engineering", Vol. 1, 6th Edn. Butterworth- Heinemann

Optional Materials: Reference Books

1. Messey, B., Fluid Mechanics, Chapman Publication, London.
2. Walter L. Badger and Julius T. Banchero, Introduction to Chemical Engineering, McGraw Hill book company, Inc., New York.

Numerical Methods

[IIIrd Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH103105CH

[Pre-requisites: Mathematics I and Mathematics II, Computer language]

Course Objectives

1. To learn solution of algebraic equations, differential equations, partial differential equations etc and apply algorithms in solving engineering problems.
2. To learn stepwise solution of various simple and complex problems.
3. To learn optimization, fitting, differentiation and integration of experimental data.
4. To learn usage of numerical algorithms in making programs for chemical engineering models.

Course Content

Unit 1:

Solution of simultaneous linear algebraic equations, Iterative solution of a set of simultaneous linear algebraic equations, Solution of nonlinear algebraic equations, Determination of roots of a polynomial, Solution of simultaneous nonlinear algebraic equations.

Unit 2:

Method of least squares, Calculation of the sum of the squares of the residuals, Cubic spline problems, Newton's divided difference formulae, Lagrange interpolation, Finite difference methods, First and higher order differences of a polynomial.

Unit 3:

Numerical differentiation based on interpolation formulae, Numerical integration, Solution of ordinary differential equations - Initial value problem (IVP).

Unit 4:

Elliptic, Hyperbolic and Parabolic PDEs, Nonlinear PDEs, Solution of Laplace's equation and Poisson's equation, Application of finite difference method for solution of parabolic and elliptic partial differential equations, Applications of numerical methods to chemical engineering problems.

Course Materials

Required Text: Text books

1. E. Balagurusamy, Numerical Methods, McGraw Hill Education (India) Private Limited.
2. Grewal. B.S, Numerical Methods in Engineering and Science, Khanna Publishers, 42nd edition.

Optional Materials: Reference Books

1. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering computation.
2. P. Ahuja, Introduction to Numerical Methods in Chemical Engineering, PHI Learning, New Delhi.
3. Kenneth J. Beers, Numerical Methods for Chemical Engineering, Cambridge University Press.
4. Mark E. Davis, Numerical Methods and Modeling for Chemical Engineers, John Wiley & Sons, Inc.

Fluid Particle & Mechanics Lab

[IIIrd Semester, Second Year]

Course Description Offered by Department	Credits	Status	Code
Chemical Engineering [Pre-requisites: None]	0-0-2, (1)	Laboratory	CH103401CH

Course Objectives

1. To gain knowledge through conduction of experiments on characterization of particulate solids.
2. To perform screen analysis, filtration, mixing, sedimentation and elutriation.
3. To visualize and distinguish laminar and turbulent flow.
4. To learn characteristics of different flow meters.
5. To demonstrate and calculate pressure drop across pipe, valves and fittings.

Course Content

List of Experiments:

Experiments to be performed:

Total twelve experiments; six experiments from each section.

Section (A): Fluid Particle Operation

1. Determination of Rittinger's & Kick's constant in respect of the laboratory Jaw Crusher, Ball Mill, Hammer Mill/Roll Crusher
2. Determination of arithmetic mean, surface mean, volume surface mean diameter and volumetric mean diameter, and specific surface area of given sample.
3. Determination of effectiveness of screen
4. Batch settling study for given slurry and determination of thickener area.
5. Determination of the efficiency of the Crusher for crushing a material of known working index
6. Determination of the efficiency of a Ball Mill/Rod Mill for grinding a material of known work index.
7. Study of the effect of RPM on the power consumption of a Ball Mill/ Rod Mill.
8. Determination of the velocity of water for the separation of equal sized particles of different densities.
9. Determination of the velocity of water for separating the given solid mixture of the same density on the basis of size.
10. Study of the operation of a Hammer Mill/Filter press in the laboratory.
11. Evaluation of the specific cake resistance and medium resistance in Filter press.
12. Study of the working of Screw Conveyor/ Sigma mixer.
13. Study of the performance of a given Cyclone Separator.
14. Study of the effect of inlet gas velocity on overall efficiency in a Cyclone separator.

Section (B): Fluid Mechanics

1. Determination of the discharge coefficient of given Venturi meter.
2. Determination of discharge coefficient of given Orifice meter.
3. Determination of friction factor and head loss in given pipe assembly.
4. Determination of the discharge coefficient of given rectangular notch.
5. Determination of the discharge coefficient of given V- notch.
6. Verification of Bernoulli's theorem experimentally.
7. Determination of the pressure drop across packed column.
8. Determination of the friction factor/ pressure drop across contraction in a given pipe assembly.
9. Determination of the equivalent length of double pipe assembly.
10. Determination of the time required to empty an open hemispherical tank and coefficient
11. Calibration of the given Rotameter.

Heat Transfer Lab

[IIIrd Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	0-0-2, (1)	Laboratory	CH103402CH

[Pre-requisites: Heat Transfer Theory]

Course Objectives

1. To demonstrate the concept taught in heat transfer course.
2. To understand the use of various heat exchanger
3. Experimentally determine the thermal conductivities and heat transfer coefficient

Course Content

List of Experiments:

1. Heat transfer in double pipe heat exchanger
2. Heat transfer in shell and tube heat exchanger
3. Heat transfer in plate heat exchanger.
4. Heat transfer in agitated tank with coil/ jacket
5. Heat transfer in forced convection.
6. Heat transfer in natural convection
7. Heat transfer in fins
8. Heat transfer in unsteady condition
9. Drop wise and film wise condensation
10. Thermal conductivity measurement of metallic rod.
11. Thermal conductivity measurement of liquid.
12. Thermal conductivity measurement of insulating powder.
13. Thermal conductivity measurement of solids in composite slabs.
14. Heat transfer in single and double effect evaporators
15. Stefan Boltzmann apparatus.
16. Emissivity measurement.
17. Heat transfer in boiling

Semester-IV

Scheme & Syllabus

National Institute of Technology Raipur

Course of Study and Scheme of Examination (CBCS Scheme)								B. Tech. IV Semester					Branch: Chemical
S. No.	Subject Type	Subject Code	Subject Name	Periods per Week			TA	Examination Scheme				Total Marks	Credits
				L	T	P		MSE/MTR		ESE/ESVE			
								Theory	Practical	Theory	Practical		
1	Program Core	CH104101CH	Chemical Engineering Thermodynamics	3	1	0	20	30		50		100	4
2		CH104102CH	Mass Transfer-I	3	1	0	20	30		50		100	4
3		CH104103CH	Chemical Technology	3	1	0	20	30		50		100	4
4		CH104104CH	Chemical Reaction Engineering-I	3	1	0	20	30		50		100	4
5		CH104105CH	Fuel Technology	3	1	0	20	30		50		100	4
6	EPR	CH104001MA	Mathematics-IV	3	1	0	20	30		50		100	4
7	Laboratory	CH104401CH	Analytical Lab	0	0	2	40		20		40	100	1
8		CH104402CH	Fuel Technology Lab	0	0	2	40		20		40	100	1
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Chemical Engineering Thermodynamics

[IVth Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH104101CH

[Pre-requisites: Mathematics-I & Mathematics-II]

Course Objectives

1. To understand and appreciate the basic concepts & laws of thermodynamics as applied to various chemical engineering processes.
2. To compute the thermodynamic properties of pure substance & mixtures.
3. To estimate heat and work requirements for industrial processes.
4. To evaluate the efficiency of expansion and compression flow processes.

Course Content

Unit 1:

Basic concepts of Thermodynamics, First law, PVT behavior of pure fluids, Heat effects accompanying chemical reactions, Second law and Entropy, Clausius Inequality, Third law of Thermodynamics. Applications of first law to close and open systems.

Unit 2:

Thermodynamic properties of pure substances, Equation of state and residual properties. Work function and Gibb's Free energy, Fundamental property relations, Maxwell's equations, Entropy-Heat capacity relationship, Effect of pressure and volume on Cp and Cv, Gibb's-Helmholtz equation.

Unit 3:

Thermodynamic properties of solutions, Fugacity and Activity, Activity coefficients, Partial molar properties, Chemical potential, Lewis-Randall rule, Roults law and Henry's law, Excess properties, Gibbs-Duhem equation.

Unit 4:

Phase equilibria in single and multiple component systems, Duhem's theorem, VLE of systems, Chemical reaction equilibrium & Equilibrium constants, Effect of temperature, pressure, volume and other factors.

Course Materials

Required Text: Text books

1. J.M. Smith, Hendrick Van Ness, Michael M. Abbott, Introduction to Engineering Thermodynamics, McGraw Hill, New York.
2. Moran, Shapiro , Boettner and Bailey ,Principles of Engineering Thermodynamics, SI Version, 8 Ed. (Willey Student Edition).

Optional Materials: Reference Books

1. K.V. Narayanan, A Textbook of Chemical Engineering Thermodynamics, PHI Learning.
2. Y. V. C. Rao,Theory and Problems of Thermodynamics, Wiley Eastern Ltd., New Delhi.
3. B.F. Dogde, Chemical Engineering Thermodynamics, McGraw Hill, New York.
4. P. K. Nag, Engineering Thermodynamics, Tata McGraw-Hill publication, New Delhi.
5. R.Yadav, Fundamentals of Engineering Thermodynamics, Central Publishing House, Allahabad.

Mass Transfer -I

[IVth Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH104102CH

[Pre-requisites: Chemical Process Calculations, Heat transfer, Fluid Mechanics & Thermodynamics]

Course Objectives

1. To learn mechanism of mass transfer, mass transfer coefficient and its analogy to the heat- transfer coefficient; use Chilton and Colburn analogy to calculate rates of mass transfer in turbulent flow.
2. To understand common dimensionless groups (Sherwood, Schmidt and Peclet No.)
3. To design distillation column using different methods and calculation of plate efficiency.
4. To design gas absorption column – packed height, column diameter and pressure drop across the packing.
5. To study different types of industrial equipment for absorption and distillation and explain which are most popular.

Course Content

Unit 1:

Diffusion- Molecular & Eddy diffusion in fluids, Ficks 1st law of diffusion, EMD&UMD, Diffusivity - Measurement & calculation, Ficks 2nd law of diffusion, Molecular diffusion in Falling liquid Film, Mass Transfer coefficient, Schmidt number, Peclet number, Mass Transfer in Turbulent flow – Reynolds analogy, Chilton-Colburn Analogy, Film Theory, Penetration theory, Surface renewal Theory, Two- film theory and Overall mass transfer coefficient.

Unit 2:

Distillation: Boiling point diagram, Azeotropes-types, Partial vaporization and condensation and Relative volatility, flash distillation and differential distillation, Steam distillation, Azeotropic distillation and Extractive distillation.

Unit 3:

Distillation: Continuous distillation with rectification, Sieve plate column, Bubble cap column:Packed column; calculation of number of plates, Lewis sorel Method, McCabe Thiele Method, Economic reflux ratio, Minimum reflux Ratio, Fenske Underwood Equation. Plate efficiency, Ponchon Savarit method, Packed Column; HETP – method, Transfer unit and Batch distillation.

Unit 4:

Absorption: Design of packed tower, Principles of absorption and rate of absorption, Flooding point, Loading point. Mass transfer – Liquid phase & Gas phase, Overall MTC, H.T.U. method- absorption with chemical reaction, **Adsorption**- types and applications.

Course Materials

Required Text: Text books

1. W.L. McCabe, J.C. Smith & Peter Harriott, Unit Operations of Chemical Engineering, 5th Ed. McGraw Hill Publication

Optional Materials: Reference Books

1. J. M. Coulson and J. F. Richardson, Chemical Engineering, Vol. I, II & III, Pergamon press, NY.
2. Walter L. Badger and Julius T. Banchero, Introduction to Chemical Engineering, McGraw Hill book company, Inc., New York.
3. J. D. Seader, E.J. Henley and D. Keith Roper, Separation Process Principles, Wiley.
4. R.E.Trebal, Mass Transfer Operations, McGraw Hill Books.

Chemical Technology

[IVth Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH104103CH

[Pre-requisites: None]

Course Objectives

1. To apply fundamentals of unit operations and unit processes in chemical industries.
2. To learn manufacturing processes of Organic and Inorganic chemicals and their applications.
3. To understand about the advancement in chemical process industries.

Course Content

Unit 1:

Chlor-alkali industries-Soda ash, Sodium chloride, Chlorine and Caustic soda, Sulfur and Sulfuric acid industries, Industrial gases - Oxygen and Nitrogen, Nitrogen industries- Ammonia, Nitric acid.

Unit 2:

Hydrochloric acid, Phosphorus and Phosphoric acid, Fertilizer industry - Urea, Ammonium phosphates, Glass, Cement, Petroleum: Origin, Occurrence and characteristics of crude oil, Crude oil distillation and secondary processing.

Unit 3:

Paints and pigments, Soap and Detergent, Glycerin, Oils and Fats, Sugar, Starch and Cellulose, Industrial alcohol.

Unit 4:

Paper and pulp, Synthetic fibers - Viscose rayon and Cellulose acetate, Plastics- Thermosetting and thermo plastics - Rubber, Polyester, PVC, Polypropylene etc. Nitration, Halogenations, Condensation, Hydrolysis and Hydration.

(Industries mentioned in all the units are to be studied with reference to raw materials, manufacturing process and process flow diagrams, unit operations and unit processes involved, economic aspects and general engineering problems, and present industrial scenario.)

Course Materials

Required Text: Text Books

1. Shreve R.N., Austin G.T., Chemical Process Industries, McGraw Hills.
2. M Gopala Rao, Dryden's Outlines of Chemical Technology, East-west press.

Optional Materials: Reference Books

1. F.H.Henglein, Chemical Technology, Pergamon Press.
2. J.A.Moulijn, M. Makkee, A.E.Van Diepen, Chemical Process Technology, Wiley.
3. Peter Wasserscheid, Chemical Technology: An Integral Textbook Andreas Jess, (Willey).
4. Ronald W. Rousseau Richard M. Felder, Elementary Principles Of Chemical Processes, (Willey).
5. Philip Groggins, Unit Processes In Organic Synthesis, Tata Mcgraw Hills.

Chemical Reaction Engineering-I

[IVth Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH104104CH

[Pre-requisites: Basic knowledge of material and energy balances in chemical engineering applications, laws of thermodynamics, Mathematics and basics of chemistry]

Course Objectives

1. To enable undergraduate students to analyze and design chemical reactors.
2. To impart the knowledge of reaction rate theories and reaction mechanisms to derive expressions for rate equations.
3. To provide a core foundation for the analysis and design of chemical reactors.
4. To perform derivations of design equations and calculations in batch, continuous CSTR and PFR reactors.

Course Content

Unit 1:

Reaction order, Molecularity, Kinetics of homogeneous reactions: Chemical kinetics; Rate theories; Rate expressions from mechanism and experiments. Classification of reactors: Isothermal, Ideal batch, CSTR, PFR, Fixed beds, Moving beds, Non-ideal reactors, Fluidized beds, Special types of reactors.

Unit 2:

Constant-volume batch reactor –Irreversible reaction, Reversible reaction; Analysis of rate of reaction; Deferential method; Integral method; Least square method; Half life method; Initial value; Total pressure method; Liquid phase reaction; Analysis of complex reaction: Series, parallel, auto catalytic. Varying-volume batch reactor.

Unit 3:

Design for single batch or single flow reactor, Chain of reactors, Selection of reactor system, Size comparison of single reactors, Multiple-reactor systems, Recycle reactor, Autocatalytic reactions.

Unit 4:

Design for single, parallel and series reactors, Irreversible reactions in parallel-Qualitative and quantitative discussion about product distribution, Irreversible reactions in series-Qualitative and quantitative discussion about product distribution, Optimum temperature progression, Equilibrium conversion and Van't Hoff Isober equation.

Course Materials

Required Text: Text Books

1. J.M. Smith, Chemical Engineering Kinetics, McGraw-Hill Inc., US.
2. Octave Levenspiel, Chemical Reaction Engineering, Willey.

Optional Materials: Reference Books

1. H.Scott Fogler, Elements Of Chemical Reaction Engineering, Prentice Hall International.
2. S.D. Dawande, Principles of Reaction Engineering, Central Techno Publications.
3. Coulson and Richardson's Chemical Engineering, Pergamon Press, Oxford, UK.

Fuel Technology

[IVth Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH104105CH

[Pre-requisites: None]

Course Objectives

1. To impart knowledge about solid, liquid and gaseous fuels, their origin, classification.
2. To impart the knowledge of physico-chemical characterization and application of different fuels.

Course Content

Unit 1

Classification of fuel, various terms related to the study of fuels and combustion, Nuclear fuels- Fusion and Fission, Nuclear reactor types, Nuclear fuel cycle, Coal: Origin, Composition, Analysis and Properties of coal, Classification of coal, Coal preparation and storage.

Unit 2

Coal washing and efficiency calculations, Coal carbonization-LTC, HTC, Physical and Chemical properties of coke, Liquefaction of coal, Gasification of coal- Gasifier types, Efficiency calculations, Recovery of coal gas, Solid fuel firing system.

Unit 3

Liquid fuels: Origin and exploration of crude oil, Atmospheric and vacuum distillation, Petroleum cracking, Reforming, Hydro treatment and dewaxing, Petroleum products and properties, Burners for liquid and gaseous fuel, Furnace-Stoker furnace.

Unit 4

Gaseous fuels: LPG, Water gas, Producer gas, Carbureted water gas, Natural gas, Hydrogen, Acetylene, Gases from biomass, Combustion: Combustion calculations, Flame properties, Adiabatic flame temperature.

Course Materials

Required Text: Text Books

1. Samir Sarkar, Fuels and Combustion, University Press, 3rd Edition.
2. Om Prakash Gupta, Elements of Fuels, Furnaces & Refractories, Khanna Publishers.

Optional Materials: Reference Books

1. Wilfrid Francis, Martin C. Peters, Fuels and Fuel Technology, 2nd Edition, Pergamon Press.
2. J. S. S. Brame and J. G. King., Fuel: Solid, Liquid, and Gaseous. 4th Edition, Edward Arnold, London.
3. A.V. K. Suryanarayana, Fuels Furnaces Refractories and Pyrometry, BS Publication.
4. S.N. Saha, Elements of Fuel Combustion and Energy Engineering, Dhanpat Rai Publishing Company.

Analytical Lab

[IVth Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	0-0-2, (1)	Laboratory	CH104401CH

[Pre-requisites: Organic and inorganic chemistry]

Course Objectives

1. To provide solid foundation of organic and inorganic chemistry.

Course Content

List of Experiments:

1. Analysis of cement - Moisture loss, combustion loss, calcium and silica
2. Analysis of water - Hardness, chloride, dissolved oxygen
3. Analysis of bleaching powder
4. Analysis of acid neutralizing capacity of antacids
5. Analysis of fertilizer
6. Soil analysis- pH, calcium carbonate
7. Double indicator titrations
8. Estimation of TFM of soap
9. Estimation of vitamin C in citrus fruit
10. Preparation of dyes and pigments
11. Vegetable oil analysis- Acid value, iodine value, moisture content
12. Sugar analysis- Glucose estimation
13. Analysis of milk

Course Materials

Required Text: Text Books

Fuel Technology Lab

[IVth Semester, Second Year]

Course Description			
Offered by Department	Credits	Status	Code
Chemical Engineering	0-0-2, (1)	Laboratory	CH104402CH

[Pre-requisites: Fuel Technology]

Course Objectives

1. To develop and idea of fuel properties and their variation with temperature.
2. To determine kinematic viscosity and calorific values of fuels.
3. To demonstrate and obtain hands on training on different fuel testing methods.

Course Content

List of Experiments:

1. Proximate analysis of solid fuel.
2. Calorific value determination using Bomb Calorimeter.
3. Viscosity determination using Redwood I & Redwood II.
4. Aniline point and Smoke point determination.
5. Flash and fire point determination using Pensky Marten's apparatus.
6. Flash and fire point determination using Abel's apparatus.
7. Cloud & pour point determination Cloud & Pour point apparatus.
8. Orsat analysis of flue gas to determine its composition.
9. Carbon residue determination Conradson apparatus.

Course Materials

Required Text: Text Books

Semester-V

Scheme & Syllabus

National Institute of Technology Raipur

Course of Study and Scheme of Examination (CBCS Scheme) — **B. Tech. V Semester** — **Branch: Chemical**

S. No.	Subject Type	Subject Code	Subject Name	Periods per Week			TA	Examination Scheme				Total Marks	Credits
				L	T	P		MSE/MTR		ESE/ESVE			
								Theory	Practical	Theory	Practical		
1	Program Core	CH105101CH	Process Equipment Design -I	3	1	0	20	30		50		100	4
2		CH105102CH	Chemical Reaction Engineering-II	3	1	0	20	30		50		100	4
3		CH105103CH	Mass Transfer -II	3	1	0	20	30		50		100	4
4	Program Elective-I	CH105201CH	Material Technology	3	0	0	20	30		50		100	3
		CH105202CH	Fertilizer Technology										
		CH105203CH	Polymer Technology										
5	Open Elective-I	CH105301CH	Industrial Economics and Management	3	0	0	20	30		50		100	3
6	Laboratory	CH105401CH	Chemical Reaction Engineering Lab	0	0	2	40		20		40	100	1
7		CH105402CH	Mass Transfer Lab	0	0	2	40		20		40	100	1
8	Summer Internship-I	CH105701CH	Summer Training I	0	0	2	-					-	1
													21

Process Equipment Design-I

[Vth Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH105101CH

[Pre-requisites: Material Technology, Engineering Mechanics]

Course Objectives

1. To understand the basics of process and instrumentation diagram.
2. To apply the knowledge of codes and standard of vessel design
3. To design the mechanical aspect of vessels and support

Course Content

Unit-1: Introduction

General design considerations, load, theories of failure, process equipment and utilities symbol, PFD & P&ID, Line Sizing.

Unit 2: Pressure Vessel Design

Mechanical aspect design of internal and external pressure vessel, head and closures, Designing of Flanges and Gasket.

Unit 3: Support and Flanges

Design of skirt, saddle and bracket support. Designing of Flanges and Gasket.

Unit 4: Tall Vessel

Design of tall vessel.

Course Materials

Required Text: Text books

1. S D Dawande, Process Design of Equipment, Central Techno Pub., Nagpur, 2000.
2. IS Code-2825 for Unfired Pressure Vessel & IS Code-803 for storage vessel

Optional Materials: Reference Books

1. SJoshi, M. V. and Mahajani, V. V., “Process Equipment Design,” 3rd ed., Macmillan, Delhi, 1996.
2. Bhattacharya, B. C., “Introduction to Chemical Equipment Design: Mechanical Aspects,” 5th ed., CBS Pub., Delhi., 1991

Chemical Reaction Engineering-II

[VthSemester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH105102CH

[Pre-requisites: Mathematics I and Mathematics II, Chemical Reaction Engineering-I, Heat transfer, Mass Transfer, Fluid mechanics]

Course Objectives

1. To formulate a residence time distribution from tracer experiment results and use it to predict conversion in an ideal reactor
2. To identify the mechanisms involved in a heterogeneous reaction and formulate an effective rate equation
3. To calculate the impact of changing solid (or fluid) properties on the conversion of a heterogeneous reaction
4. To specify/design the configuration of a reactor to achieve optima fluid flow, mixing, heat transfer and mass transfer for a given reaction
5. To calculate the conversion for an ideal isothermal reactor starting from a general mass balance

Course Content

Unit 1:

Basics of Non-Ideal Flow: Exit age distribution of fluid, RTD, Mixing of fluids and degree of segregation, Conversion in non-ideal flow reactors, models for non-ideal flow- dispersion model, Chemical reaction and dispersion, tanks in series model.

Unit 2:

Fluid particle reactions: Unreacted core model: diffusion through gas film control, diffusion through ash layer control, chemical reaction control. Rate of reaction for shrinking spherical particles, determination of rate controlling step.

Unit 3:

Fluid – Fluid reactions: Kinetic regimes for mass transfer and reaction, rate equations for various regimes, film conversion parameter, application to design, reactive and extractive reactions.

Unit 4:

Solid catalyzed reactions: film resistance, surface phenomenon and pore diffusion controls, heat effects, combination of resistances, experimental method for finding rate, determining controlling resistances and rate equations, application to design. Catalyst deactivation: mechanism, rate equation and design.

Course Materials

Required Text: Text books

1. J.M. Smith, Chemical Engineering Kinetics. McGraw-Hill, Inc., New York.
2. Octave Levenspiel, Chemical Reaction Engineering, John Wiley & Sons Inc

Optional Materials: Reference Books

1. H.ScottFogler, Chemical Reaction Engineering, Pearson.
2. S.D. Dawande, Principles of Reaction Engineering, Central Techno Publications.
3. Coulson and Richardson, Chemical Engineering, Volume IV.

Mass Transfer-II

[Vth Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH105103CH

[Pre-requisites: Mass Transfer-I, Heat Transfer, Thermodynamics, Industrial Process Calculation]

Course Objectives

1. To give a brief idea about the new separation technologies
2. To provide an understanding of liquid-liquid and solid-liquid equilibrium
3. To provide ability to carry out the mass and energy balance for mass transfer operations
4. To develop skill and ability to the basic design of the mass transfer units

Course Content

Unit-1 :Crystallization & Membrane separation

Equilibrium relationships, Mass balance and yield calculation, Equipment for crystallization, Crystal growth theories and design. Introduction to modern membrane separation techniques, theory and principle, and limitations.

Unit 2: Humidification and drying

Equilibrium, Humidity chart and its use, wet bulb temperature- theory and it's use in measurement of humidity, Calculations in humidification operations, Adiabatic humidification, Equipment design.
Drying: Equilibrium, Batch and continuous drying, Equipment for drying, Drying time calculations.

Unit 3: Leaching

Liquid-solid equilibrium, Single-stage and multi-stage leaching, Equipment for leaching, Calculation of number of stages.

Unit 4 :Liquid-Liquid Extraction

Liquid–liquid equilibrium, Principles of extraction, Single-stage and multi-stage extraction- cocurrent, cross-current and counter current modes, Calculation of number of stages, Equipment for extraction.

Course Materials

Required Text: Text books

1. Mass transfer operations by R. Treybal, McGraw hill, 1980.
2. Mass Transfer Operations for the Practicing Engineer by Louis Teodore, Francesco Ricci, Wiley, 2011.
3. Unit operations in chemical Engineering, Warren McCabe, Julian Smith, Peter Harriott, McGraw Hill Publications, 7th edition.
4. Mass Transfer in Chemical Engineering Processes, Hemming Lindberg, Scitus Academics LLC, 2016.
5. Transport Processes and Separation Process Principles by Christie Geankoplis, Prentice Hall Professional Technical Reference, 2003

Optional Materials: Reference Books

1. Separation Process Engineering Includes Mass Transfer Analysis By Phillip C. Wankat, Prentice Hall, 2012.
2. Principles of mass transfer and separation processes by B.K. Dutta, PHI learning, 2007.
3. Mass Transfer Operations by AlapatiSuryanarayana, New Age International Publishers, 2002.
4. Transport Processes and Unit Operations by Christie J. Geankoplis, PTR Prentice Hall, 1993.
5. Coulson and Richardson's Chemical Engineering, 7th Edition, Volume 1B: Heat and Mass Transfer: Fundamentals and Applications, Butterworth-Heinemann

Material Technology

[VthSemester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-I	CH105201CH

[Pre-requisites: None]

Course Objectives

1. To provide essential concepts of material science and technology
2. To learn fundamentals of material characteristics and its applications in chemical engineering.
3. To select suitable materials used in chemical industry

Course Content

Unit 1:

Properties and behavior of materials useful in structure, machines and equipment, atomic arrangements and imperfections elasticity, micro elasticity and phase transformation. Theories of corrosion and methods of corrosion control.

Unit 2:

Theory of alloying, constitutional diagrams, their construction and applications. Cast iron as material of construction with reference to its application in chemical Engineering, selection of material, general criterion of selection of material of construction in process industries.

Unit 3:

Materials of construction and their technology with reference to application in chemical industry: mild steel, high carbon steel, stainless steel, high silicon steel, molybdenum and tungsten steel. Heat treatment of plain steel, Nonferrous metals – copper, aluminum, lead, chromium, tin, brass, bronze and monel.

Unit 4:

Non-metals – Glass, Enamels, graphite, wood, plastics, rubber, ebonite, lining materials. Composite materials: fiber reinforced plastic composite material, concrete, asphalt and asphalt mixture, ceramic mixture and silicates, structure and properties of polymeric materials high energy materials.

Course Materials

Required Text: Text books

1. Russel E Gackenbach, Materials selection for process plants. Literary Licensing, LLC, ISBN: 1258668920
2. Frank Ramford, Chemical Engineering materials. Nabu Press, ISBN: 1174906812
3. Lee Z.Z., Materials of construction for Chemical Process Industries. MC GRAW HILL

Optional Materials: Reference Books

1. Agrawal B.K., Introduction to Engineering Materials. McGraw Hill. ISBN: 0074515055
2. Khurmi R.S., Materials Science. S. Chand.
3. Gupta K.M., Material Science & Engineering. Umesh Publication. ISBN: 9789380117249

Fertilizer Technology

[Vth Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-I	CH105202CH

[Pre-requisites: None]

Course Objectives

1. To classify the fertilizers on the basis of its properties.
2. To explain manufacturing processes involved in production of fertilizers.
3. To identify the effect of fertilizers on the health, safety, and environment.
4. To Select appropriate fertilizer.

Course Content

Unit1:Introduction

Elements required for plants growth, Classification of fertilizers, Nutrient contents of fertilizer, Uses of fertilizers, Complex and blended fertilizers. N-P-K values and calculations.

Unit2:Nitrogenous Fertilizer

Manufacturing of nitrogenous fertilizer, Physical and chemical properties, application, storage and transportation.

Unit3:Phosphatic and Potassium Fertilizer

Availability and grinding of rock phosphate, Manufacturing of Phosphatic and Potassium fertilizer, Physical and chemical properties, application, Storage and transportation.

Unit4:Bio Fertilizer

Biofertilizers and its types, Nitrogen fixing biofertilizers, Phosphate-solubilizing biofertilizers, Preparation of biofertilizers.

Course Materials

Required Text: Text books

1. Austin G T., Shreve's Chemical Process Industries, McGraw Hill Book Company, New Delhi, 5th Edition, 1986.
2. Sittig M., Gopala Rao M., Dryden's Outlines of Chemical Technology, 21st Century, 3rd Edition, WEP East West Press, 2010

Optional Materials: Reference Books

1. Shukla S.D. and Pandey G.N, Textbook of Chemical Technology, Vol I & II, Vikas Publishing House Pvt. Ltd., New Delhi, 2000.
2. Slack,A.V., Chemistry and Technology of Fertilizers, Interscience, New York, 1966

Polymer Technology

[Vth Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-I	CH105203CH

[Pre-requisites: None]

Course Objectives

1. To understand the basics of polymers
2. To understand the different reactions of polymers
3. To study various characterization methods and properties of the polymers
4. To gain the knowledge about various polymeric additive, blends and composites

Course Content

Unit 1:
Basic concepts and definitions, classification of polymers, polymer structure, molecular forces and chemical bonding in polymer, molecular weight and its distribution, chemical structure and thermal transition.

Unit 2:

Step-reaction (condensation) polymerization, radical chain (addition) polymerization, ionic and coordination chain (addition) polymerization, copolymerization, polymerization conditions and polymer reactions. Various polymeric processing methods.

Unit 3:

Characterization - Molecular weight and molecular size determination; Thermo-analytical methods: TGA, DTA, and DSC; Spectroscopy: IR, NMR, UV-visible; Properties: solution and mechanical properties, Viscoelasticity.

Unit 4:

Additives – plasticizers, fillers, reinforcements and other important additives. Polymer blends and interpenetrating networks - polymer blends, toughened plastics and phase-separated blends, interpenetrating network. Introduction to polymer composites – Mechanical properties, composite fabrication. Manufacturing of polymers and recent scenarios in polymer industries.

Course Materials

Required Text: Text books

1. Joel R. Fried, “Polymer science and technology”, 3rd Edition, Pearson Publisher, 2014.
2. R. R. Ebewele, “Polymer science and technology”, CRC Press, Boca Raton, New York 2000.
3. F. W. Billmeyer, “Textbook of polymer science”, 3rd Edition, A Wiley-lnterscience Publication 1984

Optional Materials: Reference Books

1. T. Meyer and J. Keurentjes, “Handbook of polymer reaction engineering”, A Wiley-VCH Publication 2008.
2. Rodriguez, F., Cohen. C., Oberic.K and Arches, L.A., Principles of Polymer Systems, 5th edition, Taylor and Francis.
3. S. Palsule, “Polymer composites”, New Age International 2008.
4. P. M.Ajayan, L. S Schadler., P. V Braun., “Nanocomposite science & technology”, Wiley VCH 2003.
5. Seymour. R.B., and Carraher.C.E., Jr., Polymer Chemistry, 2nd Ed., Marcel Dekker, 1988.
6. Gowariker.V.T., Viswanathan.N.V., and Sreedar.J., Polymer Science, Wiley Eastern Ltd., 1988

Industrial Economics and Management

[Vth Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Open Elective-I	CH105301CH

[Pre-requisites: None]

Course Objectives

1. To provide the fundamentals of industrial economics
2. To provide information of various industrial Acts.

Course Content

Unit 1:

Various Terms in Economics, Time Value of Money, Taxation Concept, Tools of Engineering Economics. Investment Analysis.

Unit 2:

Forms of Business Organization, Functions of Management, Organization Structure. Relationship & Scientific Management, Manpower Planning Techniques.

Unit 3:

Work Study, Networking Techniques in Project Management: Gantt Charts, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT).

Unit 4:

Indian Factory Act, Indian electricity Act, Industrial Dispute Act, Boiler Act, Workmen's Compensation Act, ESI Act, Gratuity Act, Minimum Wages Act, Payment of wages Act, Trade Union Act, Payment of Gratuity Act.

Course Materials

Required Text: Text books

1. T. R. Banga, S.C. Sharma, Industrial organization & Engineering Economics, Khanna Publishers, 2006.
2. T. Chand, Engineering Economics, Nem Chand & Bros, 15th Edition, 2019R. M. Jones, Mechanics of Composite Materials, CRC Press

Optional Materials: Reference Books

1. H. Koontz, C. O'Donnell, Principles of Management: An Analysis of Managerial Functions, McGraw-Hill, 1972.
2. R. H. Lansburgh, W. R. Spriagel, Industrial management, John Wiley & Sons: New York, 4th Edition, 1947

Chemical Reaction Engineering Lab

[Vth Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	0-0-2, (1)	Laboratory	CH105401CH

[Pre-requisites: Mathematics I and Mathematics II, Heat transfer, Industrial Process Calculations, Chemical Reaction Engineering-I and II]

Course Objectives

1. To determine the kinetics and reaction rate constant of the essentially irreversible reaction
2. To study residence time distribution (RTD) in a CSTR
3. To determine the specific rate of dissolution
4. To study the catalytic and non-catalytic homogeneous reaction

Course Content

List of Experiments:

1. To study physical dissolution of benzoic acid on water in Batch Reactor
2. To Study a Non-Catalytic Homogeneous reaction in an Isothermal Batch Reactor
3. To study a non-catalytic homogeneous reaction in a Straight type plug flow reactor under ambient conditions.
4. To study Residence Time Distribution (RTD) in a CSTR.
5. To study a non catalytic homogeneous second order liquid phase reaction in a CSTR
6. To study a non catalytic homogeneous reaction in a packed bed reactor.
7. To study a non catalytic homogeneous reaction in a coil tube plug flow reactor under ambient conditions
8. To determine the first order rate constant for photo-catalytic oxidation of formic acid
9. To study a second order Saponification reaction in a semi-batch reactor under isothermal condition
10. To study a catalytic homogenous reaction in a batch reactor under adiabatic condition.

Course Materials

Required Text: Text books

1. J.M. Smith, Chemical Engineering Kinetics. McGraw-Hill, Inc., New York.
2. Octave Levenspiel, Chemical Reaction Engineering, John Wiley & Sons Inc

Optional Materials: Reference Books

1. H.ScottFogler, Chemical Reaction Engineering, Pearson.
2. S.D. Dawande, Principles of Reaction Engineering, Central Techno Publications.
3. Coulson and Richardson, Chemical Engineering, Volume IV.

Mass Transfer Lab

[Vth Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	0-0-2, (1)	Laboratory	CH105402CH

[Pre-requisites: Mass Transfer]

Course Objectives

1. To determine the time of drying
2. To determine the VLE curves
3. To determine crystallizer efficiency
4. To determine the distribution coefficient of liquid liquid extraction
5. To study a cooling tower and leaching setups

Course Content

List of Experiments:

1. To study the VLE of binary mixtures
2. Determination of the diffusion co-efficient of an organic vapour in air.
3. To study the performance of a Crystallizer and to determine the crystal yield and the efficiency of crystallizer.
4. To study the drying characteristics of a solid under forced draft condition and determine the critical moisture content.
5. To study the kinetics of dissolution of Benzoic acid in water.
6. To determine the liquid-liquid equilibrium for a system of three liquids with one pair only partially soluble
7. Extraction of a substance from solid mixture of sand and substance with water as solvent using simple single contact
8. To study the kinetics of homogeneous liquid-liquid mass transfer limited chemical reactions
9. To determine the gas film coefficient in a wetted wall column using air-water system.
10. Actual visualization of the cooling tower operation and to determine the mass transfer coefficientTo study the behavior of beams with respect to the support conditions and loadings.

Course Materials

Required Text: Text books

1. Robert E. Treybal, Mass Transfer Operations, McGraw Hill Education; 3rd edition.
2. Binay K. Dutta, Mass Transfer- Separation Proceses, Prentice Hall India Learning Private Limited

Optional Materials: Reference Books

1. Edward Cussler, Diffusion: Mass Transfer in Fluid Systems, Cambridge University Press; 3rd edition.
2. 2. Francesco Ricci and Louis Theodore, Mass Transfer Operations for the Practicing Engineer, Wiley-AIChE; 1st edition

Semester-VI

Scheme & Syllabus

National Institute of Technology Raipur													
Course of Study and Scheme of Examination(CBCS Scheme)								B. Tech. VI Semester				Branch: Chemical	
S. No.	Subject Type	Subject Code	Subject Name	Periods per Week			TA	Examination Scheme				Total Marks	Credits
				L	T	P		MSE/MTR		ESE/ESVE			
								Theory	Practical	Theory	Practical		
1	Program Core	CH106101CH	Environmental Engineering	3	1	0	20	30		50		100	4
2		CH106102CH	Process Dynamics and Control	3	1	0	20	30		50		100	4
3		CH106103CH	Transport Phenomena	3	1	0	20	30		50		100	4
4	Program Elective-I	CH106201CH	Process Equipment Design -II	3	0	0	20	30		50		100	3
		CH106202CH	Biochemical Engineering										
		CH106203CH	Electrochemical Engineering										
		CH106204CH	Process Instrumentation										
5	Open Elective-I	CH106301CH	Non-Conventional Energy Sources	3	0	0	20	30		50		100	3
6	Laboratory	CH106401CH	Process Dynamics and Control Lab	0	0	2	40		20		40	100	1
7		CH106402CH	Environmental Engineering Lab	0	0	2	40		20		40	100	1
													20

Environmental Engineering

[VIth Semester, Third Year]

Course Description Offered by Department	Credits	Status	Code
Chemical Engineering [Pre-requisites: None]	3-1-0, (4)	Program Core	CH106101CH

Course Objectives

1. To understand the importance of environment, pollutant, and its law.
2. To describe the causes and prevention of air pollution.
3. To describe the causes and prevention of water pollution.
4. To understand the management of solid waste

Course Content

Unit 1:Overview

Pollution control Acts and laws, Standards of pollution discharge, Effect of pollution on environment and human health, Various emission sources.

Unit 2:Air Pollution

Introduction, Discharge standards, Classification of the pollutant, Meteorological aspects of air pollution, Control equipments, Methods of measurements and sampling of gaseous and particulate pollutants in ambient air and industrial emissions.

Unit 3:Water Pollution

Introduction, Discharge standards, Source and Classification of wastewater from chemical industries, Selection of control equipment, Method of wastewater sampling and treatment methods.

Unit 4:Solid Waste Management

Sources and Classification, Collection and Disposal methods, Land filling, Incineration, Composting, Solid waste as resource material.

Course Materials

Required Text: Text books

1. Peavy H.S. Rowe D.R., and George Tchobanoglous, Environmental Engineering, McGraw Hill Book Company, Ny, 1985.
2. Rao, C.S Environmental Pollution Control Engineering, Wiley- Eastern Ltd. 1991

Optional Materials: Reference Books

1. Gilbert M. Masters, Introduction to Environmental Engineering and Science, Prentice – Hall of India, New Delhi, 1994.
2. “Pollution Control Acts, Rules, Notification issued there under” CPCB, Ministry of Environment and Forest G.O.I. 3rd Ed. 2006

Process Dynamics & Control

[VIth Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH106102CH

[Pre-requisites: Mathematics I and Mathematics II, Heat Transfer, Mass Transfer, Reaction Engineering. CH103102CH,CH103101CH, CH104104CH]

Course Objectives

1. To understand the applications of different controllers used in chemical plant
2. To understand the safety and stability of the process
3. To design a control system for a process in chemical industry

Course Content

Unit 1:

Laplace transform, Linear open loop system, The first and second order systems and their transient response Interacting and non-interacting systems, Linearization, Transportation lag.

Unit 2:

Linear closed loop system-control system, block diagram, closed loop transfer function, Controllers, Transient response of closed loop systems.

Unit 3:

Pneumatic controller mechanism, baffle nozzle, proportional controller mechanism, Proportional integral control, Proportional derivative control value, PID control, Final control element, Control valve, Feed forward control, Controller tuning.

Unit 4:

Stability concept, Routh stability criterion, Nyquists stability criterion, Root locus technique, introduction to frequency response, Bode diagram, Bode stability criterion, Gain and phase margins, Fuzzy Logic Control.

Course Materials

Required Text: Text books

1. LeBlanc CoughanowrCoughanowr and Koppel, Process Systems Analysis and Control, McGraw Hill Education; Third edition
2. G. Stephanopoulos, Chemical Process Control, Pearson Education India, 1stEdition

Optional Materials: Reference Books

1. Donald P. Eckman, Automatic Process Control, Wiley India Pvt, Ltd.
2. Peter Harriot, Process Control, Krieger Publishing Company.
3. I.J. Nagrath and M. Gopal., Control Systems Engineering, New Age International Publishers.
4. Dale E. Seborg, Thomas F. Edgar and Dun can A. Mellichamp, Process Dynamics & Control, John Wiley& Sons Inc Pt. Ltd.

Transport Phenomena

[VIth Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH106103CH

[Pre-requisites: Heat Transfer, Mass Transfer, Chemical Reaction Engineering, Numerical Methods]

Course Objectives

1. To apply the knowledge of mathematics in solutions of transport equations
2. To apply mass, heat and momentum transfer process in design of flow processes
3. To learn the solution of real world problems using transport equations
4. To apply computer knowledge in solution of complex engineering problems

Course Content

Unit 1: Principles of Momentum Transport

Shell Momentum Balance and its Applications, Flow of Falling Film, Flow Through Circular Pipe, Flow Through annulus, Couetteflows, Flow in Viscometers.

Unit 2: Principles of Steady State Heat Transport

Shell Energy Balanceand its Applications Heat Conduction with Electrical Source, Heat Conduction with Chemical Heat Source, Natural Convention Heat Transfer Governing Equation, Analysis of Couette flow with heat transfer.

Unit 3: Principles of Mass Transport

Mass Transport, Molecular Diffusion in Gases, Diffusion of component through Non-Diffusing component, Mass and Molar Transport by Convection, Counter diffusion and Diffusion through a 'stagnant' media, Steady State Mass diffusion with heterogeneous catalytic surface reaction, Steady State Mass diffusion with homogeneous chemical reactions.

Unit 4: Equation of change

Derivation of Equation of continuity, Equation of Motion, Navier Stokes equation, Euler's equation for Cartesian coordinate system, nondimensional numbers, Application of equation of changes to solve flow problems.

Course Materials

Required Text: Text Books

1. R. B. Bird, W.E. Stewart, E.N. Lightfoot "Transport Phenomena", 2nd Edition, John Wiley & Sons (Asia) Pvt. Ltd.
2. C. J.Geankoplis, "Transport Processes and Separation Process Principles", 4th Edition, PHI Learning Private Limited., New Delhi
3. A. Keshav, B. Mazumdar, "Transport Phenomena", 1st edition, Wiley Indian Pvt. Ltd, New Delhi

Optional Materials: Reference Books

1. Frank P. Incropera, David P. DeWitt "Fundamentals of Heat and Mass Transfer", 6th Edition, John Wiley & Sons (Asia) pvt. Ltd.
2. W.J.Thomson, "Introduction to Transport Phenomena", Pearson Education Asia, New Delhi, 2001

Process Equipment Design-II

[VIth Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-I	CH106201CH

[Pre-requisites: Mass Transfer, Heat Transfer]

Course Objectives

1. To learn about the design procedures of process equipment used in chemical process plants.
2. To apply the knowledge of heat transfer for design heat transfer equipment.
3. To design mass transfer equipment

Course Content

Unit 1: Design of Heat Exchanger Equipment

General design procedure, Double pipe heat exchanger, Shell and tube heat exchanger, pressure drop calculation. Condensers for single vapor, Vertical and horizontal condenser, desuperheater cum condenser, condenser cum subcooler, pressure drop in condenser.

Unit 2: Design of Distillation Columns

Diameter and Height of tower, Plate efficiency, Tray spacing, downcomer, weir length, weeping and entrainment point, pressure drop calculations. Size and number of poles.

Unit 3: Design of Absorption Column

No. of overall transfer Unit, Height of column, Design of packing support, Design of liquid distributor, Liquid hold up, pressure drop and diameter calculations.

Unit 4: Design of Drier and Extraction Equipment

Designing of tunnel and tray drier. Design of plate and packed Extraction column.

Course Materials

Required Text: Text Books

1. Kern, D.Q., Process Heat Transfer, International Student Edition, McGraw Hill (2002).
2. Backhurst J. R., Harker J.H., Process Plant Design, Heinemann Educational Books, London.
3. Treybal R.E., Mass Transfer Operations, McGraw-Hill publication

Optional Materials: Reference Books

1. Perry, R.H. and Green, D, Chemical Engineer's Handbook, Mc Graw Hill, NewYork. (2008).
2. Ullman - Chemical Engineering and Plant Design, Wiley-vch, John Wiley & Sons
3. Ludwig E.E., Applied Process Design in Chemical and Petrochemical Plants Vol II, Gulf Publishing Co. (1995)

Biochemical Engineering

[VIth Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-I	CH106202CH

[Pre-requisites: CH106103CH, CH104104CH, CH105102CH]

Course Objectives

1. To apply the fundamentals of chemical engineering in biological system.
2. To understand the basics of bioreactor design and analysis.
3. To learn the enzyme kinetics and immobilization

Course Content

Unit 1

Basics of Biotechnology: Concepts of Biology & Biotechnology, Diversity in microbial cells, Cell constituents.

Bio-molecules: Carbohydrates, Proteins, Amino acids, Nucleic acids, Enzymes and its types, Enzyme immobilization

Unit 2

Microbial growth and regulation: Bioenergetics, Glucose metabolism, Krebs cycle, biosynthesis.

Unit 3

Kinetics of biochemical reaction: Enzyme and its kinetics, Kinetics of substrate utilization, product formation and biomass production, Michaelis-Menten equation and its modification, Monod growth kinetics, Thermal death rate kinetics.

Unit 4

Bioreactor Design: Bioreactor design and analysis, media formulation, Bio-product recovery and bio-separations.

Industrial application: SCP, High fructose corn syrup, Beer and wine manufacturing, Citric acid production, Penicillin production, Streptomycin production.

Course Materials

Required Text: Text Books

1. Shuler M., Kargi F., Bioprocess Engineering: Basic Concepts, PHI (2017)
2. Bailey, J.E. and Ollis, D.F, Biochemical Engineering Fundamentals, McGraw Hill, NewYork (2017)

Optional Materials: Reference Books

1. Doran, P.M Bioprocess Engineering Principles, Academic Press (2013)
2. Stanbury P. F., Whittaker, A. and Hall, S. J., Principles of Fermentation Technology,Butterworth-Heinemann (2016).

Electrochemical Engineering

[VIth Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-I	CH106203CH

[Pre-requisites: Basics knowledge in applied chemistry, corrosion and mass transfer]

Course Objectives

1. To understand the basic principles of electrochemistry and mechanism involved in electrochemical systems
2. To understand the mass transfer and mechanism of corrosion.
3. To understand the concepts of electro process and design of batteries, fuel cell and electrochemical reactors

Course Content

Unit 1:

Faraday's law - Nernst potential – Galvanic cells – Polarography, The electrical double layer and its role in electrochemical processes –Electrocapillary curve – Helmholtz layer – Guoy –Steven's layer – fields at the interface.

Unit 2:

Mass transfer in electrochemical systems: diffusion controlled electrochemical reaction – the importance of convention and the concept of limiting current. Over potential, primary-secondary current distribution – rotating disc electrode.

Unit 3:

Corrosion- theories and current relations; diffusion-controlled corrosion process; pH diagram and forms of corrosion; factors and control methods; boiler corrosion control; protective coatings and vapor phase inhibitors; Cathodic protection and sacrificial anodes.

Unit 4:

Electro deposition – electro refining – electroforming – electro polishing – anodizing – Selective solar coatings, Primary and secondary batteries – types of batteries, Fuel cells. Application of different electrodes: Metals-Graphite – Lead dioxide – Titanium substrate insoluble electrodes – Iron oxide – semi conducting type etc. Merits of different type of electrochemical reactors. Current electrochemical practices in industries.

Course Materials

Required Text: Text Books

1. Picket, "Electrochemical Engineering ", Prentice Hall. 1977.
2. Newman, J. S., "Electrochemical systems ", Prentice Hall, 1973

Optional Materials: Reference Books

1. Barak, M. and Stevenge, U.K., "Electrochemical Power Sources - Primary and Secondary Batteries" 1980
2. Mantell, C., "Electrochemical Engineering", McGraw Hill, 1972

Process Instrumentation

[VIth Semester, Third Year]

Course Description			
Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-I	CH106204CH

[Pre-requisites: None]

Course Objectives

1. To impart the knowledge about the principles and practices of measurement of important chemical process variables such as temperature, pressure, flow, level, concentration, etc.
2. To introduce the field of Instrumentation and covers process variables and the various instruments used to sense, measure, transmit and control these variables

Course Content

Unit 1:
General Concepts: Functional Elements of an Instrument, Error Analysis, Static and Dynamic Characteristics.

Temperature Measurement: Thermometers, Bimetallic Thermometer, Pressure-spring Thermometer, Resistance Temperature Devices, Thermistors, Thermocouples, Thermopile, Pyrometers.

Unit 2:
Pressure Measurement: Manometers, Diaphragms, Capsules, Bellows, Bourdon tubes, Barometers, Piezoelectric Pressure Gauge, Vacuum Instruments - Pirani Gauge, Ionization Gauge, McLeod Gauge

Unit 3:
Liquid Level Measurement: Direct Level Sensing - Sight Glass, Conductive Probes, Capacitive Probes, Ultrasonic Probes, Indirect Level Sensing - Resistive Tapes, Load Cells, Bubbler Device.

Other Measurement: Hygrometers, Psychrometers, Hydrometers, Thermohydrometer, Viscometer, pH meter, Refractometer.

Unit 4:

Manipulation, Transmission and Recording of Data: Bridge Circuits, Amplifiers, Filters, Analog-to-Digital Converters, Digital-to-Analog Converters, Fiber-Optic Data Transmission, Analog Voltmeters and Potentiometers, Digital Voltmeters and Multimeters, Active and Passive Transducers, Null and Deflection Methods, Magnetic Tape and Disk Recorders, Digital Printers and Plotters.

Course Materials

Required Text: Text Books

1. E. O. Doebelin, Measurement Systems: Application and Design, 4th Edition, McGraw-Hill Publishing Company, 1990.
2. Alan S. Morris, Measurement and Instrumentation Principles, Butterworth-Heinemann, 2001
3. B. C. Nakra and K. K. Chaudhry, Instrumentation Measurement and Analysis, 3rd Edition, Tata McGraw-Hill, 2009

Optional Materials: Reference Books

1. C.D. Johnson, Process Control Instrumentation Technology, 8th Edition, Pearson Education Limited, 2014.
2. W.G. Andrew, Applied Instrumentation in the Process Industries, Vol. I, II &III Ed. Gulf Publication. 1993.
3. K. Robards, P.R. Haddad and P.E. Jackson, Principles and Practice of Modern Chromatographic Methods, Elsevier, 1994.
4. William C. Dunn, Fundamentals of Industrial Instrumentation and Process Control, McGraw-Hill, 2005.
5. D. P. Eckman, Industrial Instrumentation, McGraw Hill Publications, 1975

Non-Conventional Energy Sources

[VIth Semester, Third Year]

Course Description			
Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Open Elective-I	CH106301CH

[Pre-requisites: None]

Course Objectives

1. To know about word energy scenario and non-conventional energy sources.
2. To appreciate the advantages of energy production from renewable energy resources.
3. To learn the technology involved in the extraction/conversion of renewable energy sources into useful energy.
4. To get updated with alternative and new sources of energy

Course Content

Unit 1:Overview

Indian & global energy scenario potential and advantages of non-conventional energy resources, energy conservation, renewable energy.

Unit 2: Solar Energy

Solar radiation and its measurement, Solar collectors – types, and constructional details. Solar water heating, applications of Solar Energy for heating, drying, space cooling, water desalination, solar concentrators, photovoltaic power generation using silicon cells.

Unit 3:

Wind Energy: Principle of energy from wind, windmill construction and operational details and electricity generation and mechanical power production.

Bio-Energy: Combustion, pyrolysis and other thermo-chemical conversion of biomass to energy, biogas

Unit 4:

Tidal Energy, Ocean thermal energy conversion (OTEC), Geothermal Energy, Hydrogen energy, other alternative & new sources of energy. Energy Storage and Distribution, Fuel cells.

Course Materials

Required Text: Text Books

1. Twiddle, J. Weir, T. "Renewable Energy Resources," Cambridge University Press, 1986.
2. Rai, G.D., "Non-Conventional Energy Sources," Khanna Publishers, New Delhi, 2001.
3. Sukhatme, S. P., "Solar Energy: Principles of Thermal Collection and Storage," 2nd ed., Tata McGraw-Hill, 2001

Optional Materials: Reference Books

1. Sorenson, B, "Renewable Energy", 3rd ed., Elsevier Science, 2004.
2. Kreith, F. and Kreider, J. F., "Principles of Solar Engineering," McGraw Hill, 1978.
3. Duffie, J. A., Beckman, W. A., "Solar Engineering of Thermal Processes," John Wiley, 1980.
4. Veziroglu, N., "Alternative Energy Sources," Volume 5 & 6, McGraw-Hill, 1978.
5. Garg, H.P. and Prakash, J., "Solar Energy: Fundamentals and Applications," Tata McGraw-Hill, 2001.
6. S. Rao and Dr. B.B. Parulekar, Energy Technology, Nonconvential, Renewable and Conventional, Khanna Publishers
7. G.N. Tiwari, Fundamentals of Renewable Energy Sources, Narosa Publishing House

Process Dynamics and Control Lab

[VIth Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	0-0-2, (1)	Laboratory	CH106401CH

[Pre-requisites: None]

Course Objectives

1. To determine the time constant & dynamics of I and II order system
2. To determine the control valve coefficient of control valve
3. To identify the suitable parameters needed for PID controllers

Course Content

List of Experiments:

1. Study of Control Valve – Valve Coefficient, Hysteresis, Inherent Characteristics, Installed Characteristics, Rangeability
2. Time Constant of First Order System – Temperature Measurement Devices – Glass Thermometer, Bimetallic Thermometer, RTD, Thermistor, Thermocouple
3. Dynamic Response of U-Tube Manometer – Mercury, Water
4. Dynamic Response of Interacting and Non-Interacting System
5. Study of Controller – P, PI, PD, PID
6. Study of Cascade Control Trainer (SCADA)
7. Study of DCS Trainer
8. Study of Flapper Nozzle System
9. Study of Non-linear Level Control
10. Study of I/P and P/I Converter

Course Materials

Required Text: Text Books

1. D.R. Coughanowr and S.E. Leblanc, Process Systems Analysis and Control, McGraw Hill Education, 3rd Edition, 2017.
2. G. Stephanopoulos, Chemical Process Control, Pearson Education India,1stEdition, 2015

Environmental Engineering Laboratory

[VIth Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	0-0-2, (1)	Laboratory	CH106402CH

[Pre-requisites: None]

Course Objectives

1. To understand the fundamentals of water as well as soil chemistry and their quality standards.
2. To learn various techniques and analytical methods available for wastewater treatment.
3. To understand different water, air, soil and noise quality parameters and their measurements

Course Content

List of Experiments(Any ten experiments):

1. Determination of pH and electrical conductivity of the given water sample.
2. Determination of the turbidity of the given water sample.
3. Determination of the optimum coagulant dosage of the given water sample.
4. Determination of the acidity and alkalinity of the given water sample.
5. Determination of the hardness of the given water sample.
6. Determination of various types of solids present in the given water sample.
7. Determination of sulphate and nitrate in the given water sample.
8. Determination of D.O in the given water sample.
9. Determination of B.O.D. in the given water sample.
10. Determination of C.O.D. in the given water sample.
11. Determination of chlorine in the given water sample.
12. Determination of coliforms using MPN Test in the given sample.
13. Determination of NOx, SOx and COx in the air sample
14. Determination of noise profile in a multiple noise source situation
15. Determination of particulate matter in air sample.
16. Determination of specific gravity, bulk density and moisture content of a given soil sample.
17. Determination of organic carbon, NPK and CEC of a given soil sample

Course Materials

Required Text: Text Books

1. K. R. Aneja (2007), Experiments in Microbiology, Plant Pathology and Biotechnology; New Age International, New Delhi.
2. APHA, Standard Methods for the Examination of Water and Wastewater, 22nd Edition. American Public Health Association, Washington, DC.
3. J. G. Cappuccino, N. Sherman (2014) Microbiology, a laboratory Manual. Benjamin-Cummings Publishing Company, SF, USA.
4. CPCB guidelines

Semester-VII

Scheme & Syllabus

National Institute of Technology Raipur														
Course of Study and Scheme of Examination(CBCS Scheme)								B. Tech. VII Semester					Branch: Chemical	
S. No.	Subject Type	Subject Code	Subject Name	Periods per Week			TA	Examination Scheme				Total Marks	Credits
								MSE/MTR		ESE/ESVE			
				L	T	P		Theory	Practical	Theory	Practical		
1	Program Core	CH107101CH	Process Modeling& Simulation	3	1	0	20	30		50		100	4
2	Program Elective-I	CH107201CH	Plant Design and Costing	3	0	0	20	30		50		100	3
		CH107202CH	Food Processing Technology										
		CH107203CH	Coal Processing Technology										
3	Program Elective-II	CH107251CH	Petroleum Refining Engineering	3	0	0	20	30		50		100	3
		CH107252CH	Heat Exchanger Network Design										
		CH107253CH	Membrane Science and Technology										
4	Open Elective-I	CH107301CH	Computational Fluid Dynamics	3	0	0	20	30		50		100	3
		CH107302CH	Introduction to Analytical Techniques										
5	Project Work	CH107501CH	Project Work	0	0	8	40		20		40	100	4
6	Laboratory	CH107401CH	Chemical Engineering Computational and Simulation Lab	0	0	2	40		20		40	100	1
7	Summer Internship	CH105801CH	Summer Internship -II				-					-	2
													20

Process Modeling & Simulation

[VIIthSemester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-1-0, (4)	Program Core	CH107101CH

[Pre-requisites: Heat transfer, Mass transfer & CRE]

Course Objectives

1. To understand the concept and importance of modeling and simulation.
2. To make aware with modeling of heat transfer and mass transfer processes etc.
3. To make aware about the use of computer programming/software in simulation of developed equations

Course Content

Unit 1:

Concept of modeling and simulation, Classification of models, uses of mathematical models, Principles of formulations. Introduction to C++, CFD, MATLAB and other computer languages & tools and their application in solving modeling problems.

Unit 2:

Mathematical Modeling of Chemical Reactors: CSTR, PFR, batch reactor, Non isothermal CSTR, Bioreactor, Trickle bed reactor, Moving bed reactor. Simulation, Program development and numerical solutions of above processes.

Unit 3:

Mathematical Modeling in Mass Transfer: distillation column, Liquid- liquid extraction, Reaction with mass transfer, Absorption, Adsorption. Simulation, program development and numerical solutions of above processes.

Unit 4:

Mathematical Modeling in Heat transfer: Two heated tanks, Single component vaporizer, Multi component flash drum, Cooling towers. Simulation, program development and numerical solutions of above processes.

Course Materials

Required Text: Text books

1. Luyben W. L., Process Modeling and Simulation Control for Chemical Engineers, Mc Graw Hill International Edition.
2. Fogler H.S., Elements of Chemical Reaction Engineering, Prentice Hall of India.
3. Holland C.D., Fundamental and Modelling of Seperation Process, Prentice Hall

Optional Materials: Reference Books

1. Edger T. F., Himmelblau D. M. and Lasdon L.S. Process Optimization in Chemical Process, McGraw Hill.
2. Gaikwad R.W. and Dhirendra, Process Modelling and Simulation, Denett and Co

Plant Design and Costing

[VIIthSemester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-I	CH107201CH

[Pre-requisites: CH104103CH, CH105301CH]

Course Objectives

1. To learn about the plant location and plant layout of a chemical industry.
2. To understand the basic concepts and design principles involved in piping, instrumentation, control, and power systems.
3. To study the procedures for the selection of process equipment and materials.
4. To understand the basic concepts and methods for calculation of depreciation, profitability analysis and estimation of different types of cost for a manufacturing unit

Course Content

Unit 1 :

Introduction to Plant Design, General Design Considerations, Process Design Development, Optimum Design and Design Strategy.

Unit 2:

Location of the Chemical Plant, Plant Layout, Selection of Process Equipment and Materials.

Unit 3:

Process Auxiliaries - Piping, Instrumentation, Control and Power Systems.

Unit 4:

Analysis of Cost Estimation, Time value of Money, Evaluation of Profitability, Alternatives investment and Replacements, Depreciation and methods of its calculation.

Course Materials

Required Text: Text books

1. Peters Max S., Timmerhaus Klaus. D., West Ronald E.: Plant Design and Economics for Chemical Engineers, Fifth edition McGraw Hill Co., New York, 1991.
2. Vilbrandt Frank C, Dryden Charles E: Chemical Engineering Plant Design, Fourth edition, McGraw Hill book Co., New York

Optional Materials: Reference Books

1. Towler G. and Sinnot R.K.: Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design". Butterworth-Heinemann. 2008
2. Mahajan M.S.: Industrial Engineering and Production Management, Dhanpat Rai Publication, First Edition 2000-01.
3. Kharbanda O.P.: Process Plant and Equipment Cost Estimation, Sevak Publication, Bombay

Food Processing Technology

[VIIth Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-I	CH107202CH

[Pre-requisites: Heat Transfer, Mass Transfer, Thermodynamics]

Course Objectives

1. To learn the basics of food processing and preservation
2. To understand the different food processing technologies
3. To understand the role of Nutraceuticals and functional food in health and disease
4. To familiarize with the current state of knowledge in food analysis.

Course Content

Unit 1: Basic considerations

Aims of preservation & processing of foods, Causes of quality deterioration and spoilage of perishable foods.

Unit 2: Thermal and non-thermal methods of food preservation

Basic concepts in thermal destruction of microorganism, Cooking, Blanching, Pasteurization and Sterilization of foods. Drying, Dehydration of fruits, vegetables, milk, animal products etc.; osmotic methods.

Unit 3: Methods of Food Analysis

Determination of Moisture in foods, ash content of foods, titratable acidity in foods, determination of dietary fiber and crude fiber, Spectroscopic and chromatographic techniques.

Unit 4: Analysis of phytochemicals and assessment of antioxidant activity

Qualitative and quantitative methods, In vitro and In vivo methods for the assessment of antioxidant activity, Variation of Antioxidant Activity during food processing.

Course Materials

Required Text: Text books

1. Karnal, Marcus and D.B. Lund “Physical Principles of Food Preservation”. Rutledge,2003.
2. Tegge, G., Green, J. H., and A. Kramer. “Food Processing Waste Management”. AVIPublishing, 1979.
3. VassoOreopoulou and Winfried Russ. “Utilization of by-products and Treatment ofWaste in the Food Industry”. Springer, 2007

Optional Materials: Reference Books

1. Herzka, A. and Booth, R.G. “Food Industry and Trade: Recycling Waste”. AppliedScience Publishers, 1981.
2. Gould, G.W. “New Methods in Food Preservation”. Springer,1995.
3. Adams, M.R and M.O. Moss. “Food Microbiology”. New Age International, 2002

Coal Processing Technology

[VIIth Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-I	CH107203CH

[Pre-requisites: None]

Course Objectives

1. To provide overall idea about coal processing and utilization
2. To provide in-depth understanding of the efficiencies of coal washing processes
3. To understand the various unit operations, equipments and beneficiation techniques for processing of coal
4. To learn the characteristics of coal relevant to its preparation.

Course Content

Unit 1: Coal preparation

Scope, objectives and applications, Types and properties of coals in general, industrial uses, characteristics of coals, coking and non-coking coals, Washability studies, sink and float analysis of coals, Standard washability curves, washability index, Efficiency of coal washing.

Unit 2: Crushing and Screening of Coal

Crushers for coal. Rotary breaker, Roll crushers, Impact group of crushers, Sizers, Pulveriser, Ball mill, Screening, Industrial Screens, Performance evaluation of crusher, mills and screens.

Unit 3: Carbonization and Gravity Separation Process

Theory, types and advantages carbonization, Gasification of coal, smelter gasifer and corex gas, Standard metallurgical coke making process, Properties of coke, by-products of a coke oven, Waste heat and flue gas recovery, Heavy media Separation: Types, application and operation, Heavy Media cyclones-operating principles, applications, performance, efficiency and design calculations.

Unit 4: Fine Coal Cleaning and Dewatering

Fine coal cleaning using Spirals, froth flotation, Dewatering - Centrifuges, thickeners, cyclones and filters, Typical flow-sheets for preparation of metallurgical (coking) and thermal (non-coking) coal, Coal washery equipments and its selection.

Course Materials

Required Text: Text books

1. Coal processing and utilization, D.V. Subba Rao, T. GouriCharan, CRC press, 2016.
2. Fuels and combustion by Samir Sarkar, 3rd edition, Universities Press, 2010.
3. Minerals and coal process calculations, D. V. Subba Rao, CRC Press, 2016

Optional Materials: Reference Books

1. Coal production and processing technology, M.R. Riazi, R. Gupta, CRC Press, 2015
2. The Science and Technology of Coal utilization, Bernard R Cooper and Willim A Ellingson,ist Edition, Springer, 1984

Petroleum Refining Engineering

[VIIth Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-II	CH107251CH

[Pre-requisites:Chemical Technology]

Course Objectives

1. To learn about crude reserves, consumption, composition, and evaluation.
2. To study various processes involved in petroleum refining.
3. To study sources of pollution in petroleum refining

Course Content

Unit 1:

Introduction to Petroleum Refinery, World reserves of petroleum crude, Production and consumption status of crude and its products in India, Composition, Classification and evaluation of crude oil, Common tests for petroleum crude and it's products

Unit 2:

Dehydration and desalting of crude, Distillation, temperature cuts and characteristics, Internals of distillation column, operation of distillation column. Various products: gasoline, kerosene, ATF, Diesel, lubricating oils and their characterization.

Unit 3:

Cracking, hydro cracking, Coking, Reforming, Hydro treating, Isomerization, Alkylation, Polymerization, Gas to liquid Technology (GTL), Gasification of heavy petroleum feed stock, Reformulated gasoline.

Unit 4:

Finishing operations (treatments of petroleum fractions), Pollution by refineries.

Course Materials

Required Text: Text books

1. W.L. Nelson, Petroleum Refining Engineering, McGraw-Hill Book Company, Inc., New York; International edition (January 1, 1941).
2. Hobson G.D, Modern petroleum Technology, 4th. Ed., Applied Science Publishers, Great Britain.
3. Bhaskara, Rao B.K., Modern Petroleum Refining Processes., 6th Ed., Oxford & IBH, New Delhi.

Optional Materials: Reference Books

1. James H. Gary, Glen E. Handwerk, Mark J .Kaiser , Petroleum refining: Technology & Economics, 5th Ed., CRC Press, Taylor & Francis Group
2. James G. Speight, G.J and Ozum, B (2002) Petroleum Refining Processes. Marcel Dekker Inc, New York

Heat Exchanger Network Design

[VIIthSemester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective -II	CH107252CH

[Pre-requisites:CH103102CH, CH104101CH]

Course Objectives

1. To introduce the concept of pinch technology for energy efficient heat exchanger network designs.
2. To understand the energy targets in design of processes.
3. To analyze and design heat exchanger networks

Course Content

Unit 1:Introduction to Pinch Technology:

Introduction, Basic concept, Role of thermodynamics in process design, Pinch technology applications**.**

Unit 2:

Key steps of Pinch Technology: Concept of ΔT_{min}, Data Extraction, Targeting, Designing, Optimization-Super targeting.

Basic Elements of Pinch Technology: Grid Diagram, Composite curve, ProblemTable Algorithm, Grand Composite Curve.

Unit 3:Targeting of Heat exchanger networks (HEN)

Energy targeting, Area targeting, Number of units targeting, Shell targeting and Cost targeting.

Unit 4:Designing of Heat exchanger networks

Pinch design methods, Heuristic rules, Stream splitting, Design of maximum energy recovery (MER), Design of multiple utilities and pinches, Design of threshold problem, Loops and Paths, Case study.

Course Materials

Required Text: Text books

1. U. V. Shenoy, Heat Exchanger Network Synthesis: Process Optimization by Energy and Resource Analysis, Gulf Publishing company, 1995.
2. M. M. El Halwagi, Process Integration, Academic Press, 7th Edition, 2006.
3. I. C. Kemp, Pinch Analysis and Process Integration: A User Guide on Process Integration for the Efficient Use of Energy, Butterworth-Heinemann; 2nd edition, 2006

Optional Materials: Reference Books

1. R. Smith, Chemical Process Design and Integration, John Wiley & Sons, 2nd edition, 2016
2. D.W. Linnhoff, User Guide on Process Integration for the Efficient Use of Energy,Institution of Chemical Engineers, 1994

Membrane Science and Technology

[VIIth Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-II	CH107253CH

[Pre-requisites:Mass Transfer, Fluid Mechanics]

Course Objectives

1. To understand the fundamentals of membrane separation process and its applications in various fields.
2. To understand the transport and fouling mechanisms of membranes
3. To gain the knowledge on membrane modules and flow patterns

Course Content

Unit 1:

Basics of membrane separation, Types of membranes, Membrane process classification, Synthesis and characterization of membranes.

Unit 2:

Transport theory in membranes – Porous membrane: bulk flow, liquid diffusion in pores, Gas Diffusion. Non-Porous Membranes: solution diffusion for liquid mixtures and gas mixtures.

Unit 3:

Membrane modules and applications, module flow patterns, control, polarization and fouling. Metal, ceramic and Liquid membranes.

Unit 4:

Different Membrane Processes and their applications: Microfiltration, Ultrafiltration, Nanofiltration, Reverse Osmosis, Dialysis and Electro dialysis, Gas permeation, Pervaporation, Hybrid membrane processes, Current scenario in Industries.

Course Materials

Required Text: Text books

1. K. Nath, “Membrane separation processes”, PHI Learning Pvt. Ltd, New Delhi, 3rd Edition, 2012.
2. M. Mulder, “Basic principles of membrane technology”, Kluwer Academic Publishers, Dordrecht, The Netherlands, 2nd Edition, 1996

Optional Materials: Reference Books

1. J.D. Seader, E. J. Henley, “Separation process principles”, John Wiley & Sons, Inc, 2 nd Edition.
2. R. W. Baker, “Member technology and applications”, John Wiley & Sons Ltd, 2 nd Edition.
3. K. Pabby., S.S. H. Rizvi., A. M. Sastre, “Hand book of membrane separations: Chemical, Pharmaceutical, Food, and Biotechnological Applications”, CRC press, Taylor & Francis Group, 2009.
4. K. Scott, “Handbook of industrial membranes”, Published by Elsevier Advanced Technology, I st Edition, 2006

Computational Fluid Dynamics

[VIIthSemester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Open Elective -I	CH107301CH

[Pre-requisites: None]

Course Objectives

1. To learn and apply the knowledge of mathematics in solutions of transport equations.
2. To apply numerical algorithms in making programs for solution of engineering modeling problems
3. To apply computer knowledge in solution of complex engineering problems
4. To engage in challenging problems of physical world

Course Content

Unit 1:Overview of CFD

Role, problem solving and components of CFD, Governing equations: Navier-Stokes Equations, Energy Equations, Mass conservation Equations. Structured and unstructured grids, Grid generation methods.

Unit 2: Approximation of Governing Equations

Discretization of equations – Finite difference / volume methods/finite element methods, Convection and diffusion problems, Solution methods of discretized equations.

Unit 3: Handling unknown pressure field

Pressure – velocity coupling, Staggered grid, SIMPLE, SIMPLEC and PISO, Unsteady flows- Explicit scheme, Crank Nicholson scheme, fully implicit scheme.

Unit 4: CFD Solution Procedure and case studies

Problem setup – creation of geometry, mesh generation, selection of physics and fluid properties, initialization, solution control and convergence monitoring, results reports and visualization, validation, Simulation of CFD problems by use of general CFD software.

Course Materials

Required Text: Text books

1. J. D. Anderson,Computational Fluid Dynamics, McGraw-Hill.
2. H. K. Versteeg, W. Malalasekera, An Introduction to Computational Fluid Dynamics - The finite volume method, Pearson Education Limited,2ndEdition, 2007.
3. S. V. Patankar. Numerical Heat Transfer and Fluid Flow, Taylor and Francis, 1978

Optional Materials: Reference Books

1. J.C. Tannehill, D.A.Anderson, R.H. Pletcher, Taylor and Francis. Computational Fluid Mechanics and Heat Transfer
2. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2nd Edition, 2010.
3. A. Keshav, B. Mazumdar, “Transport Phenomena”, 1st edition, Wiley Indian Pvt. Ltd, New Delhi

Introduction to Analytical Techniques

[VIIth Semester, Fourth Year]

Course Description			
Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Open Elective-I	CH107302CH

[Pre-requisites: None]

Course Objectives

1. To determine the concentration of the solutes in a mixture.
2. To interpret the thermal stability.
3. To identify the structure of the organic compound

Course Content

Unit 1:

Introduction to Spectroscopy, Lambert Beer's law, limitations of Beer's law, Instrumentation, Applications in Qualitative and Quantitative analysis, Theory of electronic spectroscopy, Double beam spectrophotometer, Atomic absorption Spectroscopy (AAS).

Unit 2:

Basic principles, Theory, Instrumentations, Vibrational frequency, - Number of fundamental vibrations, Hook's law Scanning of IR spectrum, Applications, difference between IR and Raman spectroscopy and its advantages, FTIR & NMR.

Unit 3:

Principle, Instrumentation, analytical applications of HPLC, GC and GC-MS etc.

Unit 4:

Thermogravimetry – TGA, DSC, BET and other advance analytical methods.

Course Materials

Required Text: Text books

1. Braun, R.D., Introduction to Instrumental Analysis, Pharma Med Press, 2016.
2. R.S. Khandpur, Handbook of Analytical Instruments, Tata McGraw Hill publishing Co. Ltd., 2nd edition, 2006.
3. Sharma B.K., Instrumental methods of chemical analysis, Eighteenth Edition, GOEL publishing House. 2002.
4. Donald L.P, Gary M.L., George A.K., James R.V., Introduction to Spectroscopy, Cengage Learning India Private Limited, 2015
5. Chatwal G.R., and Anand S.K., Instrumental Methods of Chemical Analysis, Seventh Edition, Himalaya Publishing House. 2005

Optional Materials: Reference Books

1. Skoog D.A., - Pinciples of Instrumental Analysis, Sixth Edition, Saunders College Publication, 2007.
2. Bela G. Liptak, Analytical Instrumentation, CRC Press, 1994
3. C.N. Banwell and EM McCash, Fundamentals of molecular spectroscopy, Tata McGraw Hill publishing Co. Ltd, 2017
4. Cazes J., Ewing's Analytical Instrumentation Handbook, 3rd Edition, Marcel Dekker, New York, 2005
5. Hand book for Instrumental Techniques for Analytical Chemistry, Ed. Frank Settle Prentice Hall, New Jersey, USA (1997).

Chemical Engineering Computational and Simulation Lab

[VIIth Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	0-0-2, (1)	Lab	CH107401CH

[Pre-requisites:Numerical Methods, Transport Phenomena]

Course Objectives

1. To study the simulation of flow over flat plates and pipe lines
2. To model and simulate laminar and turbulent flows
3. To employ computational software to solve flow in elbows, over cylinders and air foils.
4. To determine the influence of roughness and vibrations in pipe in flow simulations

Course Content

List of Experiments (Experiments will be conducted using Ansys/MATLAB/COMSOL/STAR CD/CCM etc.):

1. Flat plate boundary layer computational fluid dynamics
2. Laminar pipe flow computational fluid dynamics
3. Turbulent pipe flow computational fluid dynamics
4. Laminar convection computational fluid dynamics
5. Turbulent forced convection computational fluid dynamics
6. Computational fluid dynamics of flow over an Airfoil
7. Computational fluid dynamics steady flow past cylinder
8. Computational fluid dynamics of mixing elbow
9. Determination of effect of roughness on turbulent pipe flow using Computational fluid dynamics
10. Computational fluid dynamics for fluid flow through a vibrating pipe

Course Materials

Required Text: Text books

1. J.D. Anderson, Computational fluid dynamics: An introduction. 3rd Edition, Springer.
2. H.K. Versteeg and W. Malalasekera, An introduction to computational fluid dynamics: The finite volume method. 2nd Edition, Pearson

Optional Materials: Reference Books

1. Joel J. Ferziger, Computational methods for fluid dynamics, Springer.
2. Chaoqun Liu, Guan Heng Yeoh and Jiyuan Tu., Computational fluid dynamics: A practical approach. 3rd edition, Butterworth-Heinemann

Semester-VIII

Scheme & Syllabus

National Institute of Technology Raipur													
Course of Study and Scheme of Examination(CBCS Scheme)								B. Tech. VIII-A Semester				Branch: Chemical	
S. No.	Subject Type	Subject Code	Subject Name	Periods per Week			TA	Examination Scheme				Total Marks	Credits
								MSE/MTR		ESE/ESVE			
				L	T	P		Theory	Practical	Theory	Practical		
1	Program Elective-I	CH108201CH	Process Safety and Hazard Management	3	0	0	20	30		50		100	3
		CH108202CH	Disaster Management in Chemical Industries										
		CH108203CH	Petrochemical Technology										
		CH108204CH	Nanotechnology										
2	Program Elective-II	CH108251CH	Fluidization Engineering	3	0	0	20	30		50		100	3
		CH108252CH	Process Intensification										
		CH108253CH	Colloidal and Interfacial Science and Engineering										
3	Open Elective-I	CH108301CH	Project Planning Evaluation and Management	3	0	0	20	30		50		100	3
		CH108302CH	Environmental Impact Assessment										
4	Open Elective-II	CH108351CH	Solid Waste Management	3	0	0	20	30		50		100	3
													12

National Institute of Technology Raipur													
Course of Study and Scheme of Examination(CBCS Scheme)								B. Tech. VIII-B Semester				Branch: Chemical	
S. No.	Subject Type	Subject Code	Subject Name	Periods per Week			TA	Examination Scheme				Total Marks	Credits
				L	T	P		MSE/MTR		ESE/ESVE			
								Theory	Prac.	Theory	Prac.		
1	#Open Elective-I	CH108326CH	Online courses/MOOCs approved by the DAC	3	0	0	20	30		50		100	3
2	#Open Elective-II	CH108376CH		3	0	0	20	30		50		100	3
3	Major Internship	CH108701CH	Major Internship										6 (4^+2^^)
													12

Courses for Open Elective-I and II to be opted from online courses

^ Mid-Semester evaluation report and field evaluation report to be submitted by industry

^^ Report Submission and Presentation in the department

Process Safety and Hazard Management

[VIIIth Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-I	CH108201CH

[Pre-requisites: Chemical Technology, Environmental Engineering]

Course Objectives

1. To know about industrial safety programs and toxicology, industrial laws, regulations and source models
2. To understand about fire and explosion and preventive methods.
3. To study industrial hazards and its risk assessment.
4. To understand the methods of hazard identification and preventive measures

Course Content

Unit 1

Safety programs, engineering ethics, Accident and loss statistics, Acceptable risk, Public perceptions, Nature of accidents, disaster case studies. Toxicology: Effect of toxicants, Toxicological studies, Relative toxicity, Threshold limit values, Industrial hygiene: Government regulations, Identification, evaluation and control. Source models: Flow of liquids and vapors through pipes, flashing liquids, Liquid pool evaporation or boiling.

Unit 2

Fires and explosions, Flammability characteristics of liquids and vapors, Minimum Oxygen Concentration (MOC), Inerting and Ignition energy. Designs to prevent fires and explosions: controlling static electricity, explosion proof equipments and instruments; Reliefs and rupture disks.

Unit 3

Hazards identification, Process hazards checklists, Hazard surveys, Hazard and Operability studies (HAZOP), Safety reviews, Govt. Regulations for industrial safety – Indian and international scenario, MSDS.

Unit 4

Investigations and learning from accidents, Investigation process, Case studies: static electricity, Chemical reactivity, Safety of Critical Equipment, Risk Register, Project Health, Safety and Environment Review (PHSER).

Course Materials

Required Text: Text books

1. D.A.Crowl and J.F. Louvar, Chemical Process Safety: Fundamentals with Applications, Prentice Hall PTR.
2. R.E.Sanders, Chemical Process Safety: Learning from Case Histories, Butterworth Heinemann

Optional Materials: Reference Books

1. Ralph King and Ronald Hirst, King's Safety in the Process Industries, Wuerz Publishing Ltd., Canada

Disaster Management in Chemical Industries

[VIIIth Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-I	CH108202CH

[Pre-requisites: None]

Course objectives

1. To provide overall idea about disasters and their effects in chemical industries
2. To provide in-depth understanding of the chemical industry related disasters with some case studies
3. To educate about chemical industry related disaster management
4. To educate the legal aspects of the disasters in chemical industries

Course Content

Unit 1 Introduction

Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life-case study, General aspects of industrial disaster: Due to fire, explosion, toxicity and radiation; Chemical hazards. Natural and man-made disasters, Classification of chemical hazards, Chemical as cause of occupational diseases –dust, fumes, gases and vapours.

Unit 2 Hazard identification and assessment

Engineering control of chemical plant hazards, Hazard analysis techniques: Fault and Event tree analysis, General outline of DOW index, Risk estimation and management, Major hazard control.

Unit 3: Disaster management

Legal framework for chemical disaster management in India, disaster management in industry and sensitive land, community awareness and preparedness, few case studies. Guidelines for chemical installations, storage, transport and road accidents.

Unit 4: Planning for disaster management

Plant and companywide planning, Emergency shutdown procedures, building report form, implementation of guidelines, Institutional mechanisms and coordination at state and district levels.

Course Materials

Required Text: Text books

1. What Went Wrong? Case Histories of Process Plant Disasters and How They Could Have Been Avoided By Trevor Kletz , fifth edition, Elsevier, 2009
2. Resource book on chemical (industrial) disaster management, National institute of disaster management, India.
3. Safety and Accident Prevention in Chemical Operations, 2nd Edition, by Howard H. Fawcett (Editor), William S. Wood (Editor), Wiley International, 1982.
4. National disaster management guidelines- Chemical disasters (Industrial), National Disaster Management Authority -Government of India-2007

Optional Materials: Reference Books

1. Emergency and Disaster Planning for Chemical and Allied Industries, By United States. Business and Defense Services Administration, 1954
2. Disaster Management by Harsh K. Gupta, Universities Press Publications, 2003.
3. Safety & Health Guide for the Chemical Industry, OSHA-1986.
4. Safety in Process Plant Design by Wells John Wiley and Sons, 1981.
5. Less, P. Frank, Loss Prevention in Process Industries.
6. J. Lolb& S. Roy Sterm, Product Safety and Liability

Petrochemical Technology

[VIIIth Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-I	CH108203CH

[Pre-requisites: None]

Course Objectives

1. To learn about petrochemical industry
2. To study production methods of various petrochemicals

Course Content

Unit 1

Overview of Petrochemical Industry, Feedstock for Petrochemical Industries and their Preparation, Derivatives from Methane, Ethane, Propane and Butane.

Unit 2

Derivatives of Ethylene and Acetylene, Polyethylene, Ethylene Oxide, Ethyl Alcohol and Ethyl Benzene. Vinyl Chloride, Acrylonitrile, Neoprene and Vinyl Acetate.

Unit 3

Propylene and C4 Hydrocarbon Derivatives, Polypropylene, Isoprene, Propylene Oxide, Iso-Propyl Alcohol, Cumene. Butadiene by Oxidative Dehydrogenation, Chemicals from Synthesis Gas and Olefins.

Unit 4

Synthetic Rubber: Manufacture, General Characteristics, Raw Materials for Synthesis, PBR, SBR, NBR, Butyl Rubber. Field of Application of Surface-Active Agents.

Course Materials

Required Text: Text books

1. Dryden C. E., Outlines of Chemical Technology, East-West Press, 2008
2. Mall I. D; Petrochemical Process Technology. Macmillan India Ltd, 2007
3. Rao Bhaskar B.K.; A textbook on Petrochemicals, Khanna Publishers, New Delhi
4. Maiti Sukumar; Introduction to petrochemicals, Oxford & IBH Publishing CO. Pvt. Ltd.; New Delhi, Kolkata

Optional Materials: Reference Books

1. James G. Speight; Handbook of Petrochemical Processes; CRC Press, Taylor & Francis Group.
2. P. Belov; Fundamentals of Petroleum Chemicals Technology;Central Books Ltd.(1971)

Nanotechnology

[VIIIth Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-I	CH108204CH

[Pre-requisites: None]

Course Objectives

1. To provide an overview of nanostructures evincing their fascinating properties unseen otherwise.
2. To understand the hierarchical development from nano to macro length scale, and its adoption in nature.
3. To study the structural, phase, microstructural and mechanical characterization techniques in detail

Course Content

Unit 1

Introduction to Physics of the Solid State: Structure, Size Dependence of Properties, Crystal Structures, Energy Bands, Localized Particles.

Method of Measuring Properties: Structure, Atomic Structures, Crystallography, Particle Size Determination, Surface Structure, Transmission Electron Microscopy, Field Ion Microscopy, Scanning Microscopy, Infrared and Raman Spectroscopy, Photoemission and X-ray Spectroscopy, Magnetic Resonance Spectroscopy

Unit 2

Properties of Individual Nanoparticles: Metal Nanoclusters, Semiconducting Nanoparticles, Rare Gas and Molecular Clusters, Methods of Synthesis. Self-Assembly and Catalysis, plasmonic nanoparticles

Unit 3

Bulk Nanostructured Materials: Solid disordered nanostructures, nanostructured crystals.

Nanostructured Ferromagnetism: Basics of Ferromagnetism, Effect of Bulk Nanostructuring of Magnetic Properties, Dynamics of Nanomagnets, Nanopore Containment of Magnetic Particles, Nanocarbon, Ferromagnets, Giant and Colossal Magnetoresistance, Ferrofluids.

Unit 4

Optical and Vibrational Spectroscopy: Introduction, Infrared Frequency Range, Luminescence, Nanostructures in Zeolite Cages.

Quantum Wells, Wires and Dots: Introduction, Preparation of Quantum Nanostructures, Size and Dimensionality Effects, Applications.

Course Materials

Required Text: Text books

1. Introduction to Nanotechnology, Charles P. Poole, Jr. Frank J. Owens, A John Wiley & Sons, Inc., Publication, 2007.
2. Nanotechnology: Basic Calculations for Engineers and Scientists, Louis Theodore,Wiley, 2011

Optional Materials: Reference Books

1. Nanomaterials, Nanotechnologies and Design: An Introduction to Engineers and Architects, Michael F. Ashby, Paulo J. Ferreira, Daniel L. Schodek, Butterworth-Heinemann, 2009.
2. Introduction to Nanoscience and Nanotechnology, Chris Binns, Wiley-Blackwell, 2010

Fluidization Engineering

[VIIIth Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-II	CH108251CH

[Pre-requisites: None]

Course Objectives

1. To understand the importance and applications of fluidization process
2. To study the types and stages of fluidization
3. To learn about the application in chemical reaction, heat and mass transfer processes

Course Content

Unit 1: Introduction

Importance of fluidization in process industry, Comparison of fluidized beds with other modes of contacting, Advantages and disadvantages, Industrial applications.

Unit 2: Fluidization and Mapping of Regimes

Fixed bed of particles of one and mixed sizes, Fluidization with and without carryover of particles, Minimum fluidization, Terminal velocity of particles, Pneumatic transport of solids, Mapping of regimes, Classification of particles, Distributors for dense beds, types, and design.

Unit 3: Bubble Behavior and Bed Properties

Single rising bubble models, Wake region and solids within bubbles, Interaction and coalescence of bubbles, Bubble formation, Slug flow. Bubbling Fluidized Beds: Emulsion phase, gas flow, Bubble properties, Effect of temperature and pressure on bed, Physical models, Flow models. Entrainment and Elutriation of Fluidized Beds: Free boards behavior, Gas outlet location, Entrainment from tall and short vessels.

Unit 4: High Velocity Fluidization

Turbulent fluidized beds, Fast fluidization, Pressure drop in turbulent and fast fluidization. Solid movement: Vertical and horizontal movement of solids, Dispersion models. Gas dispersion and Gas Interchange in Bubble Bed: Dispersion of gas in beds, Gas interchange between bubble and emulsion, Estimation of gas interchange coefficients. Particle to Gas Heat and Mass Transfer: Interpretation of mass transfer coefficients and heat transfer coefficients and its determination.

Course Materials

Required Text: Text Books

1. Kunii D. and Levenspiel O., Fluidization Engineering, Butterworth-Heinemann.
2. Davidson D. and Harrison J.F., Fluidization Engineering, Academic Press

Optional Materials: Reference Books

1. Perry J.H., Chemical Engineering Hand Book.
2. Mc Cabe and Smith, Unit operation of Chemical Engineering.
3. Yang W. C., Handbook of Fluidization and Fluid Particle Systems, CRC

Process Intensification

[VIIIth Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-II	CH108252CH

[Pre-requisites: None]

Course Objectives

1. To understand the concept of process intensification.
2. To know the limitations of conventional chemical processes.
3. To apply the techniques of intensification to a range of chemical processes.
4. To develop and learn various process equipment used for intensifying the processes

Course Content

Unit 1:

Introduction to Process Intensification, History, Philosophy, principles; High Gravity Fields, Rotating Packed Bed, Spinning Disc Reactor, Compact multifunctional heat exchangers, Microreaction technology, Structured catalyst and reactors: monolithic reactors.

Unit 2:

Inline and high-intensity mixers, combined heat exchanger and reactors, Reactive and hybrid separations, reactive distillation, membrane-based reactive separation hybrid separations, membrane chromatographic separation.

Unit 3:

Multifunctional reactors, Process synthesis and integration, industrial studies.

Unit 4:

Process intensification for industrial safety, Industrial practice, methodology and applications, commercial examples of process intensification.

Course Materials

Required Text: Text Books

1. Andrzej Stankiewicz, Jacob A. Moulijn, Re-engineering the chemical processing plant. CRC Press

Optional Materials: Reference Books

1. Cornelis de Weerd, Process Intensification in Practice, John Wiley and Sons, 1 st edition,2005
2. David Reay, Colin Ramshaw and Adam Harvey, Butterworth Heinemann, Engineering for Efficiency, Sustainability and Flexibility- Process Intensification,Elsevier Ltd., 2008

Colloids and Interfacial Science and Engineering

[VIIIth Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Program Elective-II	CH108253CH

[Pre-requisites: None]

Course Objectives

1. To understand the basic nomenclature and concepts of colloid and interface science and engineering.
2. To understand the differences between the surface and bulk dominated regimes.
3. To study the concepts and tools, translate into a variety of applications from processes to materials

Course Content

Unit 1:

Nature of Colloidal Dispersions: Introduction, Classification of Colloids, Brownian Motion, Diffusion, Electric Charge and Colloid Stability, Effect of Polymers on Colloid Stability.

Thermodynamics of Surfaces: Surface Energy and its Consequences, Thermodynamic Behavior of Small Particles, Equilibrium shape of a Crystal, Behavior of Liquids in Capillaries, Homogeneous Nucleation, Limits of Applicability of the Kelvin and Young-Laplace Equations, Contact Angle and Wetting Behavior.

Unit 2:

Transport Properties of Suspensions: Mass Conservation Equation, Stress in a Moving Fluid, Stress and Velocity Field in a Fluid in Thermodynamic Equilibrium, Relationship Between the Stress Tensor and the Velocity Field, Navier-Stokes Equations, Methods for Measuring the Viscosity, Sedimentation of a Suspension, Flow Properties of Suspensions.

Unit 3 :

Particle Size and Shape: Direct Microscopic Observation, Particle Size Distribution, Theoretical Distribution Functions, Sedimentation Methods of Determining Particle Size, Electrical Pulse Counters, Light Scattering Methods, Hydrodynamic Methods, Acoustic Methods.

Unit 4 :

Electrified Interfaces: Electrical Double Layer, Electrostatic Potential of a Phase, Potential Distribution at a Flat Surface-Guoy-Chapman Model, Limitations of the Poisson-Boltzmann Equation, Mechanisms of Surface Charge Generation.

Electrokinetics and the Zeta Potential: Equilibrium Double Layer Theory of Electrokinetics, Measurement of Electrokinetic Properties, Standard Double Layer Model, Double Layer Dynamics.

Course Materials

Required Text: Text Books

1. Robert J. Hunter, Foundations of Colloid Science, Oxford, 2nd Edition, 2000.
2. Paul C. Hiemenz, R. Rajagopalan, Principles of Colloid and Surface Chemistry, CRC Press, 3rd Edition, 1997Andrzej Stankiewicz, Jacob A. Moulijn, Re-engineering the chemical processing plant. CRC Press

Optional Materials: Reference Books

1. Arthur W. Adamson, A. P. Gast, Physical Chemistry of Surfaces, Wiley India Pvt. Ltd, 6th Edition, 2011.
2. W.B. Russel, D.A. Saville, W.R. Schowalter, Colloidal Dispersions, Cambridge University Press, 1992.
3. Jacob N. Israelachvili, Intermolecular and Surface Forces, Academic Press, 3rd Edition, 2011.
4. Carel J. van Oss, Interfacial Forces in Aqueous Media, Taylor & Francis, 2nd Edition, 2006.

Project Planning Evaluation and Management

[VIIIth Semester, Fourth Year]

Course Description			
Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Open Elective-I	CH108301CH

[Pre-requisites: None]

Course Objectives

1. To formulate and present a viable project idea with a realistic economic plan
2. To study the models and methods to lead, carry out, document and evaluate project
3. To critically review and evaluate the project plans

Course Content

Unit 1:

Identification of projects: Generation and screening of idea, monitoring corporate appraisal, preparing project profiles and project rating index.

Unit 2:

Feasibility studies: Market and demand analysis, technical analysis, financial analysis and economic viability.

Unit 3:

Project appraisal: Criteria, net present value, internal rate of return, payback period and accounting rate of return method.

Unit 4:

Project management and implementation: Project planning, project control, prerequisites of Implementation. Network techniques of project management-Project evaluation and review technique (PERT) and critical path method (CPM), Project review and control: Initial review, performance evaluation, abandonment analysis and its behavioral issues.

Course Materials

Required Text: Text Books

1. Project planning, analysis, selection, implementation and review by Prasanna Chandra, TMH
2. Project management, Harold Kerzner, Wiley

Optional Materials: Reference Books

1. Total Project management, P K Joy, Macmillan.
2. Project Management: The Managerial Process, Erik Larson, Clifford Gray, McGraw Hill

Environmental Impact Assessment

[VIIIth Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Open Elective-I	CH108302CH

[Pre-requisites: None]

Course Objectives

1. To understand the basic principles and steps of EIA and formulate objectives of the EIA.
2. To gain the knowledge about various policies, environmental acts and clearance related to EIA.
3. To understand the environmental attributes and guidelines for EIA report preparation

Course Content

Unit 1

Introduction to EIA; National & global policies; EIA on development activities; Impact prediction, evaluation and mitigation. Preparation of environmental base map; Public hearing; Classification of environmental parameters.

Unit 2

Environmental Legislation Acts; Latest amendments; Rules; Regulations and notifications; Environmental standards; Criteria for standard setting. Environment audit: Audit legislations, Types of audit, Protocol, Data evaluation and Report preparation, Post audit activities.

Unit 3

Environmental Clearance: Forest clearance; Consent to Establish & Operate; Environmental conservation plan for endangered flora and fauna. Framework for EIA, Screening, Scoping, Baseline studies, EIA Methodologies and selection criteria.

Unit 4

Guidelines for preparation of project report and its evaluation, methods of clearance from the concerned authorities. Standards for Water, Air and Noise Quality - Environmental Management Plan-EIA- Case studies of EIA.

Course Materials

Required Text: Text Books

1. Larry W Canter, Environmental Impact Assessment, 2nd Ed, McGraw-Hill, 1997.
2. A Chadwick, Introduction to Environmental Impact Assessment, Taylor & Francis, 2007.
3. Ministry of Environment & Forests, Govt. of India 2006 EIA Notification, 2006
4. Barthwal, R. R. Environmental Impact Assessment, New Age International Publications

Optional Materials: Reference Books

1. John G. Rau and David C. Wooten (Ed), Environmental Impact Analysis Handbook, McGraw Hill Book, 1990.
2. APHA, Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, WPCF, Washington, D.C., 18th Ed, 1993.
3. R. Therirvel, E. Wilson, S. Thompson, D. Heaney, D. Pritchard, “Strategic Environmental Assessment”, Earthscan publications, London, 1992
4. Paul, A Erickson, “A Practical Guide to Environmental Impact Assessment”, Academic Press, 1994.
5. Wathern P, “Environmental Impact Assessment: Theory & Practice”, Publishers Rutledge, London, 1992.
6. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, “Environmental Engineering”, McGraw-Hill International Ed, 1985.
7. Richard K. Morgan., “Environmental Impact Assessment” Kluwer Academic Publications, London, 2002.
8. Judith Petts, “Handbook of Environmental Impact Assessment” Vol.I& II”, Blackwell Science, 1999

Solid Waste Management

[VIIIth Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Chemical Engineering	3-0-0, (3)	Open Elective-II	CH108351CH

[Pre-requisites: None]

Course Objectives

1. To learn solid waste disposal and management
2. To understand the characterization, segregation and disposal of wastes
3. To understand the nature of wastes and its management
4. To understand practical aspects of waste management through case studies

Course Content

Unit 1: Solid Waste Management Fundamental

Classification andsources of solid wastes, characteristics of solid wastes, problems associated with solid wastes, environmental and health impact of solid waste, solid waste reduction, recycling and reuse.

Unit 2: Municipal Solid Waste (MSW)

Collection, transport, organization and management of municipal solid waste, composition of MSW, storage and handling of solid waste, future changes in waste composition, collection of MSW.

Unit 3: Chemical and Biomedical wastes

Characterization and composition of chemical and biomedical solid wastes, evolution of chemical and biomedical waste, organization and management of chemical and biomedical waste, segregation, handling and storage of waste, treatment and disposal of chemical and biomedical waste.

Unit 4: Electronic waste (E-waste)

Type of electronic wastes, electronic waste component average life, E-waste classification, composition and characterization of E-waste, organization and management of E-waste, E-waste management technologies.

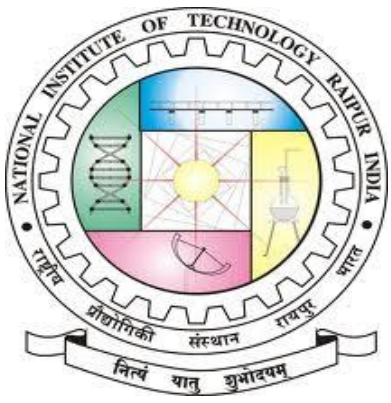
Course Materials

Required Text: Text Books

1. Vesilind P.A., Worrell W and Reinhart, Solid Waste Engineering, 2nd Edition (2011), C L Engineering.
2. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, Integrated Solid Waste Management, (1993)Mc-Graw Hill International edition, New York

Optional Materials: Reference Books

1. CPHEEO (2000), Manual on Municipal Solid waste management, Central Public Health and
2. Paul T Williams (2013), Waste Treatment and Disposal, 2nd Edition Wiley



CHEMICAL ENGINEERING DEPARTMENT

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