Chhattisgarh Swami Vivekanand Technical University, Bhilai

Name of the Program: **BTech** in **Chemical Engineering** **Semester: V**
Subject: Chemical Engineering Thermodynamics **Code: C019511(019)**
Period per week (L-T-P): (3 - 1 - 0) / Week **Credit: 04**
No. of Class Test to be conducted: 2 (Minimum) **No. of assignments to be submitted: 05**
Scheme of Examination (Theory): **Total Marks-150 [ESE-100**, **CT-20**, **TA- 30]**

PREREQUISITES: Knowledge of 10+2 standard of Physics, Chemistry, Mathematics, Engineering Chemistry and Fundamentals of Thermodynamics.

COURSE OBJECTIVES:

1. Conceptual ideas on laws of thermodynamics and applications.
2. Illustrative concept on process thermodynamics.
3. Knowledge of thermodynamic relationships on compression and refrigeration.
4. Explanatory understanding on solution thermodynamics and properties.

COURSE DETAILS:

Unit I: Laws of Thermodynamics and their Application (10 Hrs)
First Law of Thermodynamics and its Application to a Closed System (Non-flow Processes): Isothermal Process, Isobaric Process, Isochoric Process, Adiabatic Process, and Polytropic Process, Ideal Gas Equation, Introduction to Cubic Equations of State: van der Waal's Equation, Law of Corresponding State, Second Law of Thermodynamics and its Application.

Unit II:Entropy and General Thermodynamic Relations (10 Hrs)
Entropy of Various Processes, Pressure Volume and Temperature Relation, Helmholtz Free Energy, Gibbs Free Energy, Coefficient of Volume Expansion, Isothermal Compressibility, Maxwell's Relation, Joule Thompson Effect., Third Law of Thermodynamics.

Unit III: Compression (05 Hrs)
Reciprocating Air Compressors, Single stage compression, Clearance and Clearance Volume, Volumetric Efficiency, Multistage Reciprocating Air Compressor: Arrangement for Multistage with Intercooler, Power Requirement and Efficiency.

Unit IV: Refrigeration (05 Hrs)
Carnot and Reversed Carnot Cycle, Air cycle for Refrigeration: Bell Coleman air cycle, Reversed Brayton cycle, Vapour compression refrigeration cycle, cascade and Multistage refrigeration, Vapour Absorption cycle, Choice of Refrigerant.

Unit V:Solution Thermodynamics (10 Hrs)
Partial Molal Properties; Chemical Potential; Gibbs-Duhem Equation; Fugacity and Fugacity Coefficient; Activity and Activity Coefficient; Excess Properties of Mixtures, Chemical Equilibria, Chemical Equilibrium Constants; Homogeneous Reactions; Standard Gibbs Free-Energy Change; Equilibrium Conversion in Single and Multiple Reactions.

On completion of each unit, students have to submit one assignment from every unit.

COURSE OUTCOMES (CO):

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

CO1. Illustrate the use of thermodynamics laws, different flow processes and gas equations.
CO2. Demonstrate the implications of different process parameters with their application and thermodynamics energy equations.
CO3. Explain the thermodynamic principles on compression and efficiency calculations.
CO4. Define and elaborate the principles of Carnot cycle, reversed Carnot cycle and refrigeration.
CO5. Describe and deduce the principles and useful solution of complex problems of solution thermodynamics.
CO6. Explicate the complicated calculations of chemical engineering using thermodynamics principles.

TEXT BOOKS:

1. J. M. Smith and H.C Van Ness, Introduction to Chemical Engineering Thermodynamics, McGraw-Hill International Editions.
2. Y. V. C. Rao, "Chemical Engineering Thermodynamics" Universities Press.

REFERENCE BOOKS:

1. Dr. R. Yadav, Fundamentals of Engineering Thermodynamics, Central Publishing House.
2. P. L. Ballaney, Thermal Engineering, Khanna Publishers.

OPEN SOURCE LEARNING:

http://nptel.ac.in/
http://ocw.mit.edu/courses/chemical-engineering/

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Name of the Program: BTech in Chemical Engineering **Semester: V**
Subject: Chemical Reaction Engineering **Code: C019512(019)**
Period per week (L-T-P): (3-1-0) / Week **Credits: 04**
No. of Class Test to be conducted: 2 (Minimum) **No. of assignments to be submitted: 05**
Scheme of Examination (Theory): Total Marks-150 [ESE-100, CT-20, TA-30]

PREREQUISITES: Knowledge of 10+2 standard of Chemistry, Mathematics and Engineering Chemistry.

COURSE OBJECTIVES:

1. Fundamental and conceptual understandings on chemical kinetics and reaction engineering.
2. Demonstrative concept on reactor data analysis, reactor design and characterization.
3. Illustrative knowledge on reactor design analysis.
4. Comprehensive understanding and elaborative capacity on various types of heterogeneous, catalytic and non-catalytic heterogeneous and other types of reactors design.

COURSE DETAILS:

Unit I: Introduction to Chemical Kinetics and Reaction Engineering (08 Hrs)

Chemical Equilibrium, Effect of Temperature and Pressure on Chemical Equilibrium, Rate and Equilibrium Constant, Molecularity and Order, Arrhenius equation and Energy of Activation, Transition State Theory, Collision Theory, Development of Rate equation for Zero, First and Second order Reactions. Types and classification of reaction, Theory of Reaction Rates.

Unit II: Fundamentals of Reactor Data Analysis (07 Hrs)

Classification of Reactions, Reaction Mechanism, Methods and Analysis of Kinetic Rate Data, Differential, Integral and other methods of Kinetic Data Analysis, Total Pressure Method, Variable Volume Reactions.

Unit III: Elements of Reactor Design and Characteristics of Chemical Reactors (10 Hrs)

Reactor Design Fundamentals, Classification of Reactors based on mode of operation, Batch, PFR, CSTR and Semi Batch Isothermal and Non Isothermal Reactors, Batch Reactor Design. Multiphase Reactors, Deviations from Ideal – Reactor Performance.

Unit IV: Reactor Design Analysis (10 Hrs)

Design of Plug Flow Reactor, Space Velocity and Residence Time. Residence Time Distribution, Design of CSTR in Single and Multistage Battery Operation. Analytical and Graphical Methods of Design for Multistage CSTR, Product Distribution and Design for Multiple Reactions, Design for Isothermal and Non-Isothermal Reactors.

Unit V: Heterogeneous, Catalytic and Non-Catalytic Heterogeneous Reactors Design (10 Hrs)

Heterogeneous Catalytic Reactions, Catalysis and Adsorption Isotherms, Mechanism of Catalytic Reactions, Concept of Rate Controlling Step. Catalysis, Determination of Catalyst Surface Area, Pore Volume and Solid Density, Catalyst Preparation, Promoters and Inhibitors, Catalyst Poisoning and Deactivation, Heterogeneous Catalytic Reactors, Introduction to Non-Ideal Reactors, other types of Reactors and Biochemical Reactors.

On completion of each unit, students have to submit one assignment from every unit.

COURSE OUTCOMES (CO):
On completion of the course, students will be able to:

CO1 .Interpret and establish the fundamentals and comprehensive knowledge of chemical kinetics and reaction engineering.
CO2. Demonstrate .and explain the reactor data analysis competently.
CO3.Describe and elucidate the characteristics and detailed design parameters and elements of reactors.
CO4. Illustrate and solve the intricate problems of reactor design and analyze efficiently.
CO5. Exemplify and make useful solution of the various types of heterogeneous, catalytic and non-catalytic heterogeneous and other types of reactors design capably.
CO6. Demonstrate and proficiently explicate the complicated calculations of chemical kinetics and chemical reaction engineering.

TEXT BOOKS:

1. Octave Levenspiel, “Chemical Reaction Engineering”.
2. J.M. Smith, “Chemical Engineering Kinetics”, McGraw Hill International Edition, 3rd Edition.

REFERENCE BOOKS:

1. H.Scott Fogler, “Chemical Reaction Engineering”.
2. Coulsion and Richardson, “Chemical Engineering”, Vol V.
3. S.M. Walas, “Reaction Kinetics for Chemical Engineering”, McGraw Hill Book Co.
4. Houghen and Watson, “Chemical Process Principles, Part III, Kinetics and Catalysis”.

OPEN SOURCE LEARNING:

http://nptel.ac.in/
http://ocw.mit.edu/courses/chemical-engineering/

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Name of the Program: B.Tech in Chemical Engineering **Semester: V**
Subject: Process Equipment Design-I **Code: C019513(019)**
Periods per week (L-T-P): (3-1-0) / Week **Credits: 04**
Number of class Test to be conducted: 2 (Minimum) **No. of assignment to be submitted: 03**
Scheme of Examination (Theory): Total Marks- 150 [ESE-100, CT-20, TA-30]

PREREQUISITES: Knowledge of Engineering Mathematics and Chemistry, Material Science.

COURSE OBJECTIVES:

1. Technical knowledge of key concepts and techniques with relevant codes and standard procedures applicable to design of storage vessels.
2. Understand the design parameters like load, stress, factor of safety, temperature and pressure considerations which are important in design of pressure vessels.
3. Competency about the designing of the vessel supports and ability to apply standard codes for design of tall vessels.

COURSE DETAILS:

Unit I: **(14 hrs)**

Material Specifications-types of materials and their basic characteristics, Indian standards on materials. Materials for specific environments like high temperature, low temperature, corrosive services. Storage Vessels: Study of various types of storage vessels and applications, vessels for storing volatile and non-volatile liquids, storage of gases, Losses in storage vessels, various types of roofs used for storage vessels, manholes, nozzles and mountings. Design of cylindrical storage vessels as including base plates, shell plates, roof plates, wind girders, curb angles for self-supported and column supported roofs as per IS: 803, Design of columns, girders and rafters.

Unit II: **(13 hrs)**

Basic Principles of design: Design Factors, Design procedure, Codes and Standards, Optimization, Design Loads, Types of Stress and Strain Curves for Ductile and Brittle Materials, Factor of Safety, Young's Modulus Fatigue, Creep, Section Modulus. Pressure Vessels - Types of pressure vessels, Proportioning of pressure vessels, selection of L/D ratio, Optimization, Design of unfired pressure vessels as per Code for unfired pressure vessels (IS: 2825; 1969). Pressure vessels subjected to internal pressure: Complete design involving -

1) Shells: cylindrical, spherical
2) Various closures (heads): Torispherical, Elliptical, Hemispherical, Conical.

Pressure vessels subjected to external pressure: Design of shell, heads & stiffening rings.
Classification of flanges, types of flanges, Design of flanges, Gasket - types, selection, and design, Compensation for opening in vessel design.

Unit III: **(13 hrs)**

Design of Tall Vessels-Stresses in the shell of a tall vertical vessel, Calculation of shell thickness. Vessel Supports-Introduction and classification of supports, design of skirt supports considering stresses due to dead weight, wind load, design of base plate, skirt bearing plate, anchor bolts, bolting chairs and skirt shell plates, Design of saddle supports. Equipment Fabrication, Welding and Post weld heat treatments, Inspection and testing of equipment e.g. Pressure tests, Radiography tests, Dye penetration tests, Ultrasonic test.

On completion of each unit, students have to submit one assignment from every unit.

COURSE OUTCOMES (CO):

After completing the course, students will be able to:

CO1: Identify and apply the standard procedures for the design of storage vessel.
CO2: Understand and congregate the required data from the standard code book and design the pressure vessel.
CO3: Design and evaluate tall vertical vessel and its components.
CO4: Illustrate the various design procedures of the chemical process equipments.
CO5: Demonstrate the basic chemical engineering principles to design the various chemical process equipments.

TEXT BOOKS:

1. "Process Equipment Design" by L.E. Brownell and E. Young, John Wiley, New York, 1963.
2. "Introduction to Chemical Equipment Design" by B.C. Bhattacharya, C.B.S. Publications, New Delhi, 2009.

REFERENCE BOOKS:

1. "Process Equipment Design" by M.V. Joshi, McMillan India.
2. IS Code – 803 for material specification and storage vessels.
3. IS Code – 2825 for unfired pressure vessels.

OPEN SOURCE LEARNING:

http://nptel.ac.in/
http://ocw.mit.edu/courses/chemicaenginering/

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Name of the Program: BTech in Chemical Engineering **Semester: V**
Subject: Mechanical Operation **Code: C019514(019)**
Periods per week (L-T-P): (2-1-0) / Week **Credits: 03**
Number of class Test to be conducted: 2 (Minimum) **No. of assignments to be submitted: 05**
Scheme of Examination (Theory): Total Marks-150 [ESE-100, CT-20, TA-30]

PREREQUISITES: Knowledge of Engineering Mathematics, Physics and Chemistry, fundamentals of electrical calculations.

COURSE OBJECTIVES:

1. Basic concepts of solid particle size, separation process and solid particle operations.
2. Ability to choose appropriate equipment for size reduction and estimate power requirements.
3. Familiarity about mixing, agitation and estimation of power requirements for agitation and mixing equipment.
4. Acquaintance to select suitable filtration equipments.
5. Demonstrative skills about the knowledge and application of conveyers.

COURSE DETAILS:

Unit I: Separation of Solids **(10 hrs)**

Properties of solids, particle size, Separation of solids from solids by screening, Types of screens, comparison in idea and actual screen, screen analysis, screening Equipment, surface area and particle population based on screen analysis, jigging, types of separators: cyclone separator, electrostatics, and magnetic separation processes.

Unit II: Size Reduction **(08 hrs)**

Size reduction equipments, Crushers, Grinders, Disintegration of coarse & intermediate & fine grinding, energy and power requirements, Rittinger's, Kick's and Bond's law, Work index.

Unit III: Mixing and Agitation **(08 hrs)**

Mixing and agitation: Axial and radial flow impellers, prevention of vortex, liquid-liquid, liquid-solid and solid- solid mixing operations and equipments, power consumption in agitated vessels mixing index.

Unit IV: Filtration and Sedimentation **(08 hrs)**

Sedimentation, settling velocity, flocculation, Thickener, Classifier. Filtration, filter media, filter aids, batch & continuous filtration, filtration equipment, filter press, leaf filter, cartridge, vacuum filter, rotary drum filters. Centrifugal filtration.

Unit V: Conveyers **(06 hrs)**

Conveyers: belt conveyer, bucket elevator, flight conveyer, apron conveyer, screw conveyer, pneumatic conveyer.

On completion of each unit, students have to submit one assignment from every unit.

COURSE OUTCOMES (COs):

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

CO1: Illustrate to characterize particles using size distribution techniques.
CO2: Show the competency to choose equipment and methods for size reduction, conveying, separation and mixing of particles.
CO3: Estimate the energy requirements for size reduction and mixing capably.
CO4: Proficiently select the suitable filtration equipments as per the necessary process requirements.
CO5: Exemplify the principles, construction and working of conveyers.
CO6: Demonstrate the detail knowledge of solid particles and their size reduction methods and equipments used.

TEXT BOOKS:

1. McCabe W. L.,Smith J. C. & HarriottPeter, Unit Operations of Chem. Engineering., 5th Edition, McGraw HillPublication.
2. Badger & Banchero, Introduction to Chemical Engineering, McGraw Hill Edition 1997.

REFERENCE BOOKS:

1. G.G.Brown ,Unit operations, CBC Publishers , 1995
2. Alan S Foust, Principles of unit operations, John Wiley and Sons, 2nd Edition.

OPEN SOURCE LEAENING:

http://nptel.ac.in/
http://ocw.mit.edu/courses/chemicalengineering/

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Name of the Program: BTech in Chemical Engineering **Semester: V**
Subject: Chemical Reaction Engineering Lab **Code: C019521(019)**
Period per week (L-T-P): (0-0-2) / Week **Credit: 01**
Scheme of Examination (Laboratory): Total Marks- 60 [ESE-40, TA- 20]

PREREQUISITES: Knowledge of 10+2 standard of Chemistry, Mathematics and Engineering Chemistry, Chemical Reaction Engineering.

COURSE OBJECTIVES:

1. Adequate knowledge and conceptual understandings on chemical kinetics and reaction engineering.
2. Demonstrative capacity to apply intangible ideas and correlate the relevant theories during experimentation.
3. Comprehensive understanding about the various types of reactors and kinetic data analysis.
4. Professional skills and proficiency on the usage of the various instruments.

PRACTICAL DETAILS:

***List of Experiments* (*At least ten experiments are to be performed by each student*)**

1. To study the Kinetics of Irreversible reaction in Batch Reactor.
2. To study the Kinetics of Reversible reaction in Batch Reactor.
3. Kinetics of Irreversible reaction in Isothermal Plug Flow Reactor.
4. Kinetics of Reversible reaction in Isothermal Plug Flow Reactor.
5. Kinetics of Irreversible reaction in Adiabatic Plug Flow Reactor.
6. Kinetics of Reversible reaction in Adiabatic Plug Flow Reactor.
7. Kinetics of Irreversible reaction in CSTR.
8. Kinetics of Reversible reaction in CSTR.
9. Performance of combined reactor (CSTR+PFR).
10. Performance of combined reactor (PFR+CSTR).
11. Kinetics of Irreversible reaction in Heterogeneous Catalytic reactor.
12. Kinetics of Irreversible reaction in Biochemical Reactor.
13. Study of Residence Time Distribution.
14. Kinetics of Irreversible reaction in Semi batch Reactor

COURSE OUTCOMES (CO):

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

CO1. Define and exemplify the problems of chemical kinetics and reaction engineering.
CO2. Demonstrate capably the intangible ideas and correlate the relevant theories during experimentation.
CO3. Illustrate efficiently the operating principles and working methodologies of various types of instruments usages in chemical reaction engineering.
CO4. Exhibit and deduce the suitable conclusions during the practical analysis of the kinetic data for various types of reactors.

TEXT BOOKS:

1. Octave Levenspiel, “Chemical Reaction Engineering”.
2. J.M. Smith, “Chemical Engineering Kinetics”, McGraw Hill International Edition, 3rd Edition.

REFERENCE BOOKS:

1. H.Scott Fogler, “Chemical Reaction Engineering”.
2. Coulsion and Richardson, “Chemical Engineering”, Vol V.
3. Houghen and Watson, “Chemical Process Principles, Part III, Kinetics and Catalysis”.

OPEN SOURCE LEARNING:

http://nptel.ac.in/
http://ocw.mit.edu/courses/chemical-engineering/

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Name of the Program: BTech in Chemical Engineering **Semester: V**
Subject: Process Equipment Design-I Lab **Code: C019522(019)**
Period per week (L-T-P): (0-0-2) / Week **Credit: 01**
Scheme of Examination (Laboratory): Total Marks- 60 [ESE-40, TA- 20]

PREREQUISITES: Knowledge of Engineering Mathematics, Material Science and Process Equipment Design-I.

COURSE OBJECTIVES:

1. Comprehensive understanding of the basic chemical engineering principles applicable to design of chemical engineering equipments.
2. Able to apply significantly the standard codes for design of chemical engineering equipments.
3. Technical competency to design the storage vessel, pressure vessel, tall vessel and to understand the various design parameters and vessel supports.

COURSE DETAILS:

1. Problems on various types of storage vesselsfor storing volatile and non-volatile liquids.
2. Problems on various types of roofs used for storage vessels, manholes, nozzles and mountings.
3. Problems ondesign of cylindrical storage vessels including columns, girders and rafters.
4. Problems on internal and external pressure vessels.
5. Problems on internal and external pressure vessels with various closures (heads): Torispherical, Elliptical, Hemispherical, Conical.
6. Problems on flanges.
7. Problems on gaskets.
8. Problems ondesign of tall vessel.
9. Problems on design of tall vessel including stresses in the shell of a tall vertical vessel and calculation of shell thickness.
10. Problems on design of tall vessel with various vessel supports.

COURSE OUTCOMES (CO):
On completion of the course, students will be able to:

CO1: Apply the key concepts and technical procedures for designing the various chemical process equipments.
CO2: Estimate the physical dimensions of each part of the process equipments and their accessories.
CO3: Demonstrate the standard codes for designing of chemical process equipments.

TEXT BOOKS:

3. "Process Equipment Design" by L.E. Brownell and E. Young, John Wiley, New York,1963.
4. "Introduction to Chemical Equipment Design" by B.C. Bhattacharya, C.B.S.Publications, New Delhi, 2009.

REFERENCE BOOKS:

4. "Process Equipment Design" by M.V. Joshi, McMillanIndia.
5. IS Code – 803 for material specification and storage vessels.
6. IS Code – 2825 for unfired pressure vessels.

OPEN SOURCE LEARNING:
http://nptel.ac.in/
http://ocw.mit.edu/courses/chemicaenginering/

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Name of the Program: **BTech** in **Chemical Engineering** Semester: **V**
Subject: **Mechanical Operation Lab** Code: **C019523(019)**
Period per week (L-T-P): **(0-0-2) / Week** Credit: **01**
Scheme of Examination (Laboratory): **Total Marks- 60 [ESE-40, TA- 20]**

PREREQUISITES: Knowledge of Engineering Mathematics, Physics and Chemistry, Mechanical Operation, fundamentals of electrical calculations.

COURSE OBJECTIVES:

1. Knowledge about the analysis of coarse, medium and fine sized particles.
2. Skilled knowledge about to choose the appropriate equipments for size reduction and estimate power requirements.
3. Demonstrative capacity to apply the principles of particle size analysis and unit operations to solve industrial screening problems.
4. Technical ability to classify size reduction equipments and evaluate their performance using laws of size reduction.

PRACTICAL DETAILS:
***List of Experiments* (*At least ten experiments are to be performed by each student*)**

1. Determination of size distribution of a sample of particulate solid by sieve analysis and to evaluate the averageparticle diameter.
2. Determination of size distribution of a sample of particulate solid by sieve analysis and to evaluate the averageparticle diameter (by cumulative method).
3. Determination of size distribution of the product of laboratory rod mill.
4. Determination of size distribution of the product of laboratory ball mill.
5. To evaluate the overall effectiveness of given screen.
6. Determination of power required in size reduction and to evaluate the Rittinger's constant in respect oflaboratory rod mill and ball mill.
7. Determination of degree of mixing of a given binary solid system in Tumbler Mixer.
8. Determination of size distribution in a mass of fine solids by the method of decantation.
9. To study the settling characteristics of the given slurry.
10. Determination of power required for crushing in roll crusher.
11. Study of separation of two liquids in laboratory centrifuge.
12. Determination of filtration time required for a given slurry using filter press for constant rate filtration.
13. Determination of the size of a Thickener for given slurry.
14. Study of Conveyors.
15. Study the separation efficiency of a cyclone separator.

COURSE OUTCOMES (CO):
On completion of the course, students will be able to:

CO1: Demonstrate and characterize the particles using size reduction and distribution techniques.
CO2: Choose equipment and methods for size reduction, conveying, separation, separation and mixing of particles.
CO3: Estimate the settling velocity, energy requirements for size reduction, mixing size.
CO4: Describe the analysis of motion of particles through filtration characteristics and filtration equipment.

TEXT BOOKS:

1. W.L. McCabe and J.C. smith, "Unit Operations In Chemical Engineering",4thEdn., McGraw Hill publishing Co., 1985.
2. Badger and Bancharo, "Introduction to Chemical Engg." McGraw Hill.

REFERENCE BOOKS:

1. G.G.Brown ,Unit operations, CBC Publishers , 1995
2. Alan S Foust, Principles of unit operations, John Wiley and Sons, 2nd Edition.

OPEN SOURCE LEARNING:
http://nptel.ac.in/
http://ocw.mit.edu/courses/chemicaenginering/

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Name of the Program: B.Tech in Chemical Engineering **Semester: V**
Subject: Nanotechnology (Professional Elective – I) **Code: C019531(019)**
Periods per week (L-T-P): (2-0-0) / Week **Credits: 02**
Number of class Test to be conducted: 2 (Minimum) **No. of assignment to be submitted: 05**
Scheme of Examination (Theory): Total Marks-150 [ESE-100, CT-20, TA-30]

PREREQUISITES: Knowledge of Engineering Physics and Mathematics, Physical and Organic Chemistry.

COURSE OBJECTIVES:

1. Adequate comprehension of the nanotechnology processes along with emphasis on recent technological development.
2. Develop and assess the alternative system designs for nanotechnology engineering systems incorporating considerations such as feasibility, cost, safety, legal/regulatory issues and societal impacts.
3. Comprehensive knowledge on the process of nanotechnologies, availability of raw materials, production trends, and preparation of flow sheets.
4. Demonstrative skills on nanotechnology engineering and environmental problems of various chemical industries.

COURSE DETAILS:

Unit I: Introduction to Nanotechnology (06 hrs)

Introduction: Nanotechnology and nonmaterials, How it all began, Carbon nanostructures, Classification of nonmaterial: 3D, 2D, 1D, 0D materials, Surface and interface effect, van-der-Waals forces between colloidal particles.

Unit II: Nanomaterials (10 hrs)

Synthesis procedures of nonmaterials : Methods of synthesis. Top down approach, Bottom up approach, , Spontaneous growth, Template based synthesis, Production and use of nanotubes, nanorods, nanowires, Film growth, Physical Vapour Deposition (PVD), Chemical Vapor Deposition (CVD), Patterning, Itching.

Unit III: Assessment Techniques of Nanomaterials (08 hrs)

Nanostructures Fabricated by Physical Techniques: Lithography, Nanomanipulation and nanolithography, Soft lithography, Assembly of nanoparticles and nanowires.

Unit IV: Characterization of Nanomaterials (06 hrs)

Characterizations of nonomaterials : Structural characterization, Physical characterization, Physical properties of nonmaterial.

Unit V: Scope and Applications of Nanotechnology and Nanomaterials (10 hrs)

Applications and Safety: Nanotechnology and Chemical Engineering Applications: Environment, Waste Water Treatment, Photo catalytic reactors, .Photo electrochemical cells, Self cleaning Materials, Nanobiotechnology :Drug Delivery, Nanocomposites, Surface coatings, Biological nonmaterial. Nanoelectronics. nanomachines & nanodevices Safety aspects, Societal, Health and Environmental Impacts.

On completion of each unit, students have to submit one assignment from every unit.

COURSE OUTCOMES (CO):

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

CO1: Illustrate the applicable knowledge regarding various aspects of Nanotechnology industries.
CO2: To think, invent and develop novel nanotechnology operations and processes.
CO3: Describe the principles, and process technology of different nanotechnology process and its application to industries.
CO4: Explain about the manufacturing process and technical problems associated with Nanotechnology.
CO5: Understand the synthetic Nano-materials for preparing the desired product.
CO6: Elucidate the process and synthesis of Nanomaterials with an emphasis on the science and technology.

TEXT BOOKS:

1. Guozhong, Cao, "Nanostructures and Nanomaterials", Imperial College Press, 2004
2. Edelstein, C, "Nanomaterial: Synthesis, Properties and Applications", Institute of Physics Publication, 3 Philadelphia.

REFERENCE BOOKS:

1. Kulkarni S K, "Nanotehnology: Principles and Practices", Capital Publishing Company.
2. Poole, C P, Owens, F J Introduction to Nanotechnology", John Wiley & Sons publication.

OPEN SOURCE LEARNING:

http://nptel.ac.in/

http://ocw.mit.edu/courses/chemicalengineering

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Name of the Program: BTech in Chemical Engineering **Semester: V**
Subject: Optimization Techniques (Professional Elective–I) **Code: C019532(019)**
Period per week (L-T-P): (2-0-0)/Week **Credits: 02**
No. of class Tests to be conducted: 02 (Minimum) **No. of assignments to be submitted: 05**
Scheme of Examination (Theory): Total Marks-150 [ESE-100, CT-20, TA-30]

PREREQUISTIES: Knowledge of Engineering Mathematics.

COURSE OBJECTIVES:

1. Acquaintance with the various optimization techniques, i.e., classical, linear programming, transportation problem, simplex algorithm, dynamic programming.
2. Demonstrative knowledge of minimizing the effort required for design, construction and maintenance of any engineering system.
3. Comprehensive skills to maximize the desired benefit from any design.
4. Technical competency about the linear programming and its significant application to get the desired outcome.

COURSE DETAILS:

Unit I: Introduction to Optimization **(10 hrs)**

Introduction to optimization and its scope in chemical processes: Essential features of optimization problems, General procedure for solving optimization problems. Fitting models to data: Classification of models, How to select and build a model, Method of least squares.

Unit II: **Optimization Formulation and Functional Objectives** **(08 hrs)**

Formulation of objective functions: Investment costs and operating costs in Objective functions. Basic concepts of optimization: Continuity of functions, uni modal vs. .multi modal functions, Convex and concave functions, convex region.

Unit III: Mathematical Correlation in Optimization -I **(10 hrs)**

Unconstrained single variable optimization: Numerical methods for one dimensional search, Newton, Quasi-Newton and Secant methods, Region elimination methods, Polynomial approximation methods.

Unit IV: Mathematical Correlation in Optimization -II **(06 hrs)**

Linear programming: Basic concepts, Degenerate LP problems, linear constraints, Simplex method, Standard LP form, Duality in linear programming.

Unit V: Application of Optimization Techniques **(06 hrs)**

Optimization applications: Heat transfer and energy conservation, Separation processes, Fluid flow systems.

On completion of each unit, students have to submit one assignment from every unit.

COURSE OUTCOMES (CO):

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

CO1. Explain the need of optimization of engineering system.
CO2. Apply classical optimization techniques, linear programming, simplex algorithm, transportation problem
CO3. Demonstrate the simplex method for linear programming
CO4. Formulate optimization problems.
CO5. Recognize, formulate, and solve linear programming problems.

TEXT BOOKS:

1. F.Edgar and D.M.Himmelblau, "Optimization of Chemical Processes".
2. T, Peter Englezos, Nicolas Kalogerakis, "Applied Parameter Estimation for Chemical Engineers", McGraw-Hill BookCo.

REFERENCE BOOKS:

1. Chapra & Canal, "Numerical methods for Engineers".
2. S. S. Rao, "Optimization"

OPEN SOURCE LEARNING:

http://nptel.ac.in/
http://ocw.mit.edu/courses/chemical-engineering/

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Name of the Program: BTech in Chemical Engineering **Semester: V**
Subject: Environmental Studies **Code: C000506(020)**
Period per week (L-T-P): (2-0-0) / Week **Non-Credit**
Total Contact Hours: 40 **No. of assignments to be submitted: 05**
PREREQUISITE: Knowledge of basic Chemistry, Physics and Mathematics.

COURSE OBJECTIVES:

1. Basic knowledge of environment, ecology, ecosystems, biodiversity and conservation.
2. Fundamentals of natural resources, control, uses and its impact on environment.
3. Human population, growth, growing needs and its impact on society and environment.
4. Types of environmental pollution, legislations, enactment and management.

COURSE DETAILS:

UNIT I: Introduction to environmental studies, ecology and ecosystems (06 hours)
Introduction to environment; Concept and structure of ecology and ecosystem, energy flow; Community ecology; Food chains and webs; Ecological succession; Characteristic features of forest, grassland, desert and aquatic ecosystem; Multidisciplinary nature of environmental studies, scope and importance; Concept of sustainability and sustainable development.

UNIT II: Biodiversity and conservation (06 hours)
Introduction to biological diversity and levels of genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots; Threats to biodiversity, habitat loss, conflicts and biological invasions; In-situ and Ex-situ conservation of biodiversity: Ecosystem and biodiversity services.

UNIT III: Natural resources and environment (08 hours)
Concept of Renewable and non-renewable resources; Land resources, land use change, land degradation, soil erosion; Desertification; Deforestation: causes, consequences and remedial measures; Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state); Energy resources: environmental impacts of energy generation, use of alternative and nonconventional energy sources, growing energy needs.

UNIT IV: Human communities, social issues and environment (08 hours)
Basic concept of human population, growth and communities; Impacts on environment, human health, welfare and human rights; Resettlement and rehabilitation; Environmental natural disaster: floods, earthquake, cyclones, tsunami and landslides; Manmade disaster; Environmental movements; Environmental ethics: role of gender and cultures in environmental conservation; Environmental education and public awareness; Human health risks and preventive measurements.

UNIT V: Environmental pollution, policies, legislations, assessment and practices (12 hours)
Environmental pollution: Causes, effects and controls of air, water, soil, noise and marine pollution; Concept of hazardous and non-hazardous wastes, biomedical and e-wastes; Solid waste management and control measures; Climate change, global warming, ozone layer depletion, acid rain and their societal impacts; Environment laws: Wildlife Protection Act, Forest Conservation Act, Water (Prevention and control of Pollution) Act, Air (Prevention & Control of Pollution) Act, Environment Protection Act, Biodiversity Act, International agreements negotiations, protocols and practices; EIA, EMP.

On completion of each unit, students have to submit one assignment from each unit.

COURSE OUTCOMES (CO):

On completion of the course, students will able to:

1. Interpret and demonstrate the concept of ecology and ecosystem for environmental sustainability.
2. Define and establish the diversified knowledge of biodiversity and its conservation.
3. Explain the uses of natural resources efficiently and its impact on environment.
4. Illustrate and solve the simple and complex social issues relating to human communities.
5. Exemplify and make useful solution to combat the environmental degradation with the aid of national and international legislations and protocols there under.
6. Demonstrate and elucidate the complicated issues and anthropological problems for societal development.

TEXT BOOKS:

1. De, A.K., (2006).*Environmental Chemistry*, 6th Edition, New Age International, New Delhi.
2. Bharucha, E. (2013). *Textbook of Environmental Studies for Undergraduate Courses*. Universities Press.
3. Asthana, D. K. (2006).*Text Book of Environmental Studies*. S. Chand Publishing.

REFERENCE BOOKS:

1. Odum, E. P., Odum, H. T., & Andrews, J. (1971).*Fundamentals of ecology*. Philadelphia: Saunders.
2. Basu, M., Xavier, S. (2016). Fundamentals of Environmental Studies, Cambridge University Press, India.
3. Sharma, P. D., & Sharma, P. D. (2005).*Ecology and Environment*. Rastogi Publications.

OPEN SOURSE LEARNING:

http://nptel.ac.in/