Rashtrasant Tukadoji Maharaj Nagpur University

Faculty of Science & Technology

Syllabus for

Seventh Semester B.Tech. Chemical Engineering

Subject: CE-PCC-701T (BCE) **Transport Phenomena (Theory)**

Lecture	: 3 Hours	Tutorial: 1 Hour	No. of Credits	: 4
University	: 70 Marks		College Assessment	: 30 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To introduce fundamentals of heat, mass and momentum transfer.
- To analyze and model a particular system for heat, mass and momentum transfer.
- To understand and apply different governing correlations/ analogies for transport of heat, mass and momentum.

Course Outcomes:

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

CO1: Understand different coordinate systems & evaluate the overall heat, mass and momentum balance over a system.

CO2: Understand, derive and apply, the equation of continuity, equation of motion and Navier stokes of equation to evaluate the velocity profile.

CO3: Analyse various system & develop differential heat balance equations for temperature distribution.

CO4: Analyse various system & develop differential mass balance equations.

CO5: Analyse the analogies of heat mass and momentum transfer, concept of drag, and application of transport phenomena to biological systems.

Unit 1: Introduction to transport phenomena. Different coordinate systems, Basics of momentum transfer. Newtonian & Non-Newtonian fluids. Overall momentum, heat and mass balance. Substantial derivative, curvilinear coordinates.

Unit 2: Differential equation of continuity, Shell momentum balances for momentum flux & velocity distribution for flow of Newtonian fluids for various situations. Navier-Stokes equation and its applications.

Unit 3: Shell energy balances for heat flux & temperature distribution in solids by conduction with and without heat generation. Temperature distribution in laminar flow. General equation of heat transfer and its applications.

Unit 4: Shell mass balance for concentration distribution in solids & in laminar flow conditions, General equation for Mass transfer and its applications. Diffusion with chemical reaction. Theories of mass transfer.

Unit 5: Momentum, Heat and Mass transfer in boundary layers. Analogies of momentum, heat & mass transfer. Introduction to turbulent transport phenomena. Concept of Drag Introduction to transport phenomena in Bio-systems.

Books Recommended:

1. R. B. Bird, W.E. Stewart, E.W. Lighfoot, Transport Phenomena, 2nd Edition, John Wiley, 2002
2. C. J. Geankoplis, Transport Processes and Separation Process Principles, Prentice- Hall Inc., 4th Edition 2003.
3. C. O. Bennett, J. O. Myers, Momentum, Heat and Mass Transfer, 2nd International Student Edition Mc-Graw Hill, 1983.
4. W.J. Thomson, Introduction to Transport Phenomena, Pearson Education Asia, Singapore, 2000.

Subject: CE-PCC-702T (BCE) **Process Modelling and Simulation (Theory)**

Lecture	: 3 Hours	Tutorial: 1 Hour	No. of Credits	: 4
University	: 70 Marks		College Assessment	: 30 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To develop the theory and practice for modeling and simulation related to chemical processes
- To understand the methods and develop the algorithms for linear, non-linear and ordinary & partial differential equations
- To introduce computational techniques in obtaining solutions related to chemical engineering problems.

Course Outcomes:

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

CO1: Analyse physical and chemical phenomena and predict process parameters using mathematical model based on fundamental laws for various chemical processes

CO2: Develop mathematical model for various types of chemical processes involving heat transfer, mass transfer operations and chemical reactions

CO3: Understand and analyse the system and its behaviour.

CO4: Develop empirical model using suitable method based on statistical analysis

CO5: Apply appropriate analytical and/or numerical methods to solve mathematical models developed for chemicalsystems.

Unit 1: Introduction to process modeling, Applications of models, classification of models, Principles of Formulation, fundamental laws, general modeling procedure, industrial usage of process modelling and simulation; Macroscopic and microscopic mass, energy and momentum balances

Unit 2: Modeling of various mass and heat transfer equipment: distillation, absorption, extraction columns; evaporators; furnaces; heat exchangers; flash vessels etc. Modeling of Chemical Reactors: single phase and multiphase reactors.

Unit 3: Classification of systems, system's abstraction and modeling, types of systems and examples, system variables, input-output system description, system response, analysis of system behaviour, linear system, superposition principle, linearization, non-linear system analysis, system performance and performance targets.

Unit 4: Development of grey box models, empirical models, Statistical analysis and validation. Population balance models.

Unit 5: Numerical Methods for chemical engineering applications. Introduction and use of different softwares for modeling and simulation.

Books Recommended:

1. W. L. Luyben, Process Modeling Simulation and Control for Chemical Engineers, McGraw Hill, 1990.
2. R.E.G. Franks, Modeling and Simulation in Chemical Engineering, Wiley Interscience, NY, 1972.
3. J. Ingam, I. J. Dunn, Chemical Engineering Dynamic Modeling with PC simulation, VCH Publishers, 2008.
4. Ashok Kumar Verma, Process Modeling and Simulation in Chemical, Biochemical and Environmental Engineering, CRC Press, 2014.
5. Amiya K. Jana, Chemical Process Modeling and Computer Simulation, Prentice Hall, 2nd Edition, 2011.
6. Jim Caldwell, Douglas K. S. Ng, Mathematical Modeling: Case Studies, Kluwer Academic Publishers, 2004.
7. K. M. Hangos and I. T. Cameron, Process Modelling and Model Analysis, Academic Press, 2001.
8. Sandip Benerjee, Mathematical Modeling: Models, Analysis and Applications, CRC Press, 2014.
9. D. Himmelblau, K.B. Bischoff, Process Analysis and Simulation, John Wiley & Sons, 1968.
10. S.C. Chapra, R.P. Canale, Numerical Methods for Engineers, 6th Edition, Tata-McGraw Hill Publications, 2012.
11. S.K. Gupta, Numerical Methods for Engineers, 2nd Edition, New Age International, 2010.
12. B. A. Finlayson, Introduction to Chemical Engineering Computing, Wiley Interscience, New Jersey, 2006.

Subject: CE-CEL-703T (BCE)

Core Elective- III: Interfacial Science and Engineering (Theory)

Lecture	: 3 Hours	No. of Credits	: 3
University	: 70 Marks	College Assessment	: 30 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To understand the fundamentals of colloidal and interfacial science, microphases, rheological aspects and its application in chemical engineering.

Course Outcomes:

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

CO1: Understand the chemical and physical properties of interfaces and various definition involved in colloidal and interfacial science.

CO2: Understand the fundamentals of microphases and experimental techniques of measurement of chemical and physical properties.

CO3: Understand and analyse the rheological aspects of two phase flow. Understand the theories in emulsification and demulsification process.

CO4: Understand thermodynamics aspects of solubilization and related theories.

CO5: Apply the fundamentals of colloidal and interfacial science in various chemical engineering processes.

Unit 1: Definitions: Chemical and physical properties of interfaces, Introduction to surface mechanisms and thermodynamics, capillarity, meniscus shapes, contact angle, surface tension and its measurement, Laplace Equation, Young's equation, Kelvin Equation, Gibbs equation, equilibrium criteria, dividing surface, monolayers and films, mobile and fixed interfaces Interfacial areas and degrees of wetting, aerosols, liquid-liquid and particulate dispersions, Bubbles, and drops aphrons.

Unit 2: Microphases: Definitions and dynamics, Micelle formation surfactants CMC, structures of micelles, swollen micelle and microemulsions models, phase diagrams, Macroemulsions, Mechanical vs thermodynamic stability, HLB, Bancroft rule and other systems, Foams Colloids, Film elasticity, drainage, association, Langmuir-Blodgets film production. **Experimental techniques of measurement of relevant properties**: surface tension, solubilization, thermodynamic properties, spectroscopic techniques

Unit 3: **Rheological aspects** of two phase (involving microphases) flow and transport, visco-elasticity of surfactant solutions.

Emulsification and Demulsification, foam breakage, theories of coalescence, and agglomeration, Brownian motion, shear and other models.

Unit 4: **Solubilization and catalysis by microphases:** Models, theories and data, surface potential and equations of state, double layer theory, Layer Debye-Huckel theory, EDL thickness – Surface potential, Zeta potential, pH effects, Thermodynamics of solubilization, Hydrology

Unit 5: **Applications**: Adsorption, foam fractionation, froth floatation Enhanced oil recovery, Novel separation processes, Coagulation, Flocculation, Microelectronics, surface vapour deposition, other applications with techniques

Books Recommended:

1. Drew Myers, Surfaces, Interfaces, and Colloids: Principles and Applications. 2nd Ed., Wiley-VCH, 1999
2. D. J. Shaw, Colloid & Surface Chemistry, 4th Edition, Butterworth-Hienemann, 2003,
3. T. Cosgrove, Colloid Science: Principles, Methods and Applications, Wiley-Blackwell, 2005.
4. A.W. Adamson and A.P. Gast, Physical Chemistry of Surfaces, 6th Ed., Wiley-Interscience, 1997.
5. P.C. Hiemenz and R. Rajagopalan (Editors), Principles of Colloid and Surface Chemistry, 3rd Ed., Academic Press, New York, 1997.
6. J.N. Israelachvili, Intermolecular and Surface Forces, 2nd Ed., Academic Press, New York, 1992.
7. D.F. Evans and H. Wennerström, The Colloidal Domain: Where Physics, Chemistry, Biology, and Technology Meet, 2nd Ed., Wiley-VCH, 1999.
8. I.D. Morrison and S. Ross, Colloidal Dispersions: Suspensions, Emulsions, and Foams, Wiley, 2002.
9. M.J. Rosen, Surfactants and Interfacial Phenomena, 3rd Ed., Wiley-Interscience, 2004.
10. Jacob N. Israelachvili, Intermolecular and Surface Forces, Academic Press, 1992

Subject: CE-CEL-703T (BCE)

Core Elective- III: Advanced Catalysis (Theory)

Lecture	: 3 Hours	No. of Credits	: 3
University	: 70 Marks	College Assessment	: 30 Marks
Duration of Examination: 3 Hours			

Course Objectives:

- To understand the role, application, opportunities & challenges in the catalysis involving various chemical reactions.
- To empower with skills in problem solving related to homogeneous, heterogeneous catalytic, and biocatalytic processes.
- To analyse, interpret, formulate & solve the problems related to synthesis and characterization of the catalyst in estimation of design parameters in catalytic reactor.
- To understand the role of enzymes in biocatalytic processes and to design the bioreactor.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Understand the basic concepts of catalysis and type of catalyst.

CO2: Understand the methods of preparation and characterization of catalysts.

CO3: Understand the mechanism and kinetics of homogeneous catalysis and apply in the design of reactor.

CO4: Understand the mechanism and kinetics of heterogeneous catalysis and apply in the design of multiphase reactor.

CO5: Understand the mechanism and kinetics of biocatalyst and apply in the design of bioreactor.

Unit 1: Introduction to Catalysis: General concepts of catalysis, Perspectives in Catalysis: Past, Present and Future, Basics of thermodynamics and kinetics for chemical reactions, Types of Catalysis, Importance of Catalysis, Acid–base-catalysed reactions, Phase transfer and tri-phase catalysis, Modern Catalysts (Zeolite catalysts, nanocatalysts, photocatalysts, carbon nanotubes, non-metal and metal oxide catalysts), New and Future Developments in Catalysis.

Unit 2: Preparation and Characterization of catalysts: Catalyst types and preparation, precipitation and co-precipitation, solgel method, supported catalysts, drying, calcinations and formulation. Introduction, fundamentals of solid-state chemistry, structure of solids, structure-property

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relationship and analysis, surface area analysis, pore analysis, XRD analysis, thermal analysis, FTIR analysis, catalyst tests.

Unit 3: Homogeneous Catalysis: Features of Homogeneous Catalysts, Elementary Steps in Homogeneous Catalysis, Catalytic Cycle, mechanism and kinetics, industrial homogeneous processes, homogeneous Catalysis for Fine and Specialty Chemicals, Homogeneous hydrogenations, Scale-Up and Practical Considerations, Recent developments in catalytic processes

Unit 4: Heterogeneous catalysis: Mechanism and kinetics of heterogeneous reactions, Optimal distribution of catalyst in a pellet. Surface reactivity and kinetics of reaction on surfaces, poisoning and regeneration. Calculations of effective diffusivity and thermal conductivity of porous catalysts. Recent developments in catalytic processes.

Unit 5: Bio-catalysis: Enzymes, Kinetics of Enzyme-catalysed Reactions, Mechanism of participation of enzymes in a few typical reaction, Biochemical Conversion Processes, Inhibition, mass transfer considerations, Industrial applications and new trends.

Books Recommended:

1. I. Chorkendorff, J.W. Niemantsverdriet, Concepts of Modern Catalysis and Kinetics, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2003.
2. Werner Bonrath, Jonathan Medlock, Marc-André Müller, Jan Schütz, Catalysis for Fine Chemicals, Walter de Gruyter GmbH, Berlin/Boston, 2021.
3. John Meurig Thomas, W. J. Thomas, Principles and Practice of Heterogeneous Catalysis, Wiley VCH; 2nd Edition, 2014.
4. James John Carberry, Chemical and Catalytic Reaction Engineering, Dover Publications, INC, 2001.
5. L. K. Doraiswamy, M. M. Sharma, Heterogeneous Reactions: Fluid-fluid-solid Reactions, Wiley, 1984.
5. H. S. Fogler, Elements of Chemical Reaction Engineering, 4th Edition, PHI, 2005.
6. J.M. Smith, Chemical Engineering Kinetics, 3rd Edition, McGraw Hill, 1981.
7. C. N. Satterfield, Heterogeneous Catalysis in Industrial Practices, 2nd Edition, McGraw-Hill International Editions, 1993.
8. J. Bailey, D. Ollis, Biochemical Engineering Fundamentals, 3rd Edition, McGraw Hill, 1986.
9. B. Viswanathan, S. Kannan, R.C. Deka, Catalysts and Surfaces: Characterization Techniques, Alpha Science International, 2010.

Subject: CE-CEL-703T (BCE)

Core Elective- III: Advanced Petroleum Refining (Theory)

Lecture	: 3 Hours	No. of Credits	: 3
University	: 70 Marks	College Assessment	: 30 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To understand various operations and processes in the petroleum refinery.
- To evaluate and analyse several important properties along with its significance for different petroleum fractions.
- To introduce different technologies in crude processing.

Course Outcomes:

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

CO1: Identify various hydrocarbons & non hydrocarbons present in crude oil and classify into various bases.

CO2: Understand and Analyse test methods and properties of the petroleum and petroleum products.

CO3: Analyse various petroleum refinery operations including primary, secondary and supporting processes.

CO4: Differentiate the treatment techniques involved in post processing of crude.

CO5: Understand finishing treatments used for petroleum processing.

Unit 1: Origin, formation and composition of petroleum: Origin and formation of petroleum, Reserves and deposits of world, Petro Glimpses and petroleum industry in India, Composition of petroleum and its classification.

Unit 2: Petroleum processing data: Evaluation of Petroleum, Thermal properties of petroleum fractions, important products-properties and test methods.

Unit 3: Fractionation of petroleum: Dehydration and desalting of crudes, Heating of crudes, Distillation of petroleum, Blending of gasoline.

Unit 4: Thermal and catalytic processes: Cracking, Catalytic cracking, Catalytic reforming-introduction and theory, Naptha cracking, Coking, Hydrogen processes, Alkylation, Isomerization processes, Polymer gasoline.

Unit 5: Treatment techniques: Fractions-Impurities, Gasoline treatment, Treatment of kerosene, Treatment of lubes, Wax and purification.

Books Recommended:

1. B.K. Bhaskara Rao, Modern Petroleum Refining Processes, 4th Edition, Oxford & IBH Publishing Co. Pvt. Ltd., 2008.
2. J.G. Speight, and B. Ozum, Petroleum Refining Processes, Marcel Dekker, 2002.
3. Mohamed A. Fahim, Taher A. Al-Sahhaf, Amal Elkilani, Fundamentals of Petroleum Refining, Elsevier Science, 2010
4. W.L. Nelson, Petroleum Refinery Engineering, McGraw Hill Publishing Company Limited, 1958.
5. G.D. Hobson, Modern petroleum Refining Technology, 4th Edition, Institute of Petroleum U.K, 1973.
6. J.H. Gary, G.E. Handwerk, M. J. Kaiser, Petroleum Refining: Technology and Economics, Fifth Edition, CRC Press, 2007.
7. R. A. Meyers, Hand Book of Petroleum Refining Processes, McGraw Hill, 3rd Edition, 2003.
8. Dr. Ram Prasad, Petroleum Refining Technology, Mercury Learning & Information Publisher, 2020.

Subject: CE-CEL-704T (BCE)

Core Elective- IV: Piping Engineering (Theory)

Lecture	: 3 Hours	No. of Credits	: 3
University	: 70 Marks	College Assessment	: 30 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To provide knowledge of various piping system designs, development skills and knowledge of current trends of plant layout.
- To provide a broad overview of piping engineering from designing to construction.

Course Outcomes:

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

CO1: Understand the piping fundamentals and understand the key steps in a pipeline's lifecycle: design, construction, installation and maintenance.

CO2: Apply fundamentals in the calculation of line size and understand the piping accessories.

CO3: understand and ally the fundamentals in developing unit plot plan, P&ID, equipment layout and utility layouts, isometrics etc.

CO4: Understand the codes and standards and apply those in the selection of piping accessories.

CO5: Understand the procedures for the design of piping systems for various applications

Unit 1: Introduction to piping, piping fundamentals, applications, codes and standards. Review of friction factor, pressure drop for Incompressible and Compressible fluid, pipe sizing, and economic velocity. Analysis of pipe line networks for flow in branches. Pipe line design on fluid dynamic parameter.

Unit 2: Line size calculation; details and types of pressure relief valve / safety valve; control valves, gaskets, Pipe fittings and pipe connectors. Desirable properties of Material of Construction (MOC) for pipe, valves, flanges, gaskets etc.

Unit 3: Unit plot plan, process P&ID, utility P&ID, equipment layout and utility layouts within battery limits. Isometrics (2D, 3D), material-take-off (MTO), piping spool drawings, Piping insulation (detail engineering), colour codes and hazardous area classification details.

Unit 4: Common ASME, ASTM and IS specifications for seamless/ ERW pipes, pipe fitting flanges and fasteners, gasket, and valve materials, types of gaskets and their selection etc. Applications of NFPA codes in piping system design.

Unit 5: Gas Pipe stress analysis (internal and external pressure). Selection & codes for pipe supports. Design of piping systems and accessories: Crude oil, natural gas, pressurised steam, condensate, hazardous chemicals etc.

Books Recommended:

1. McAllister E.W., Pipeline Rules of Thumb Handbook, 7th Edition, Gulf Publication, 2009
2. Kellogg, Design of piping System, 2nd Edition, M.W. Kellogg Co. 2009
3. Weaver R., Process Piping Design Vol. 1 and 2., Gulf Publication, 1989
4. Nayyar M. L.,Piping Handbook, McGraw Hill, 7th Edition, 2000.
5. G. A. Antaki, Piping and Pipeline Engineering: Design, Construction, Maintenance, Integrity, and Repair (Mechanical Engineering), 1st Edition, CRC Press, 2003.
6. Ed Bausbacher, Roger Hunt, Process Plant Layout and Piping Design, 1st Edition, Prentice Hall, 1993.
7. Robert A. Rhea, Roy A Parisher, Pipe Drafting and Design, 3rd Edition, Gulf Professional Publishing, 2011.
8. John McCketta, Piping Design Handbook, 1st Edition, CRC Press, 1992.
9. Crane Co. Staff, Flow of Fluids Through Valves, Fittings and Pipe, Crane Co.1985.
10. Peter Smith, Piping Materials Guide, Gulf Publishing, 2005.

Subject: CE-CEL-704T (BCE)

Core Elective- IV: Multiphase Reactor Design (Theory)

Lecture	: 3 Hours	No. of Credits	: 3
University	: 70 Marks	College Assessment	: 30 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To understand different (complex) models that can be used to design multiphase reactors. A systematic analysis of heterogeneous reactions and multiple phase reactors is made. Emphasis is on the optimal choice of reactor types and the final design of such reactors.
- To calculate operating regime for a given reaction.
- To calculate intrinsic kinetics from the data on model contactors.
- To calculate conversion / selectivity / size / temperature / pressure / power required for conducting a given multiphase reaction equipment.

Course Outcomes:

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

CO1: Understand the concept of multiphase reactor

CO2: Analyse the hydrodynamics of Bubble columns, packed bubble columns, Internal loop and external loop air-lift reactors, jet loop reactors and apply the concepts in scale-up, process design and performance of these reactors.

CO3: Analyse the hydrodynamics of fluid-fluid reactors such as spray columns, packed columns, plate columns, static mixers, rotating disc contactors and apply the concepts in scale-up, process design and performance of these reactors.

CO4: Analyse the hydrodynamics of fixed bed reactors, trickle bed reactors and apply the concepts in scale-up, process design and performance of these reactors.

CO5: Analyse the hydrodynamics of solid-liquid and gas-solid fluidised bed reactors, solid-gas transport reactors and apply the concepts in scale-up, process design and performance of these reactors.

Unit 1: Introduction to multiphase flows, Classification of multiphase reactors, qualitative description, examples of industrial importance. Hydrodynamics, scale-up, process design and performance of stirred tank reactors, case studies.

Unit 2: Hydrodynamics, scale-up, process design and performance of Bubble columns, packed bubble columns, Internal loop and external loop air-lift reactors, jet loop reactors, case studies.

Unit 3: Hydrodynamics, scale-up, process design and performance of Fluid-fluid reactors such as spray columns, packed columns, plate columns, static mixers, rotating disc contactors, case studies.

Unit 4: Hydrodynamics, scale-up, process design and performance of Fixed bed reactors, trickle bed reactors, case studies.

Unit 5: Hydrodynamics, scale-up, process design and performance of Solid-liquid and gas-solid fluidised bed reactors, solid-gas transport reactors, case studies.

Books Recommended:

1. L. K. Doraiswamy, M. M. Sharma Heterogeneous Reactions Vol 1 & 2: Analysis, Examples and Reactor Design, John Wiley and Sons, 1984
2. GB Tatterson, Fluid Mixing and Gas Dispersion in Agitated Tanks. McGraw-Hill, New York, 1991.
3. V. G. Pangarkar, Design of Multiphase Reactors, John Wiley & Sons, Inc. 2015.
4. W. D. Deckwer, Bubble Column Reactors, John Wiley & Sons Inc; 1st Ed, 1991.
5. D. Kunni and O. Levenspiel, Fluidization Engineering, Elsevier, 2nd Edition, 1991.
6. P. V. Danckwerts, Gas Liquid Reactions, McGraw-Hill Inc. US, 1970.
7. P. A. Ramachandran and R. V. Chaudhari, Three-Phase Catalytic Reactors, Gordon and Breach Sci. Publ., New York, 1992.
8. Y. Shah, Gas-Liquid-Solid Reactor Design, McGraw-Hill, New York, 1979.

Subject: CE-CEL-704T (BCE)

Core Elective- IV: Multiphase Flow (Theory)

Lecture	: 3 Hours	No. of Credits	: 3
University	: 70 Marks	College Assessment	: 30 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To understand the basic concept, terminologies of multiphase flow
- To analyze different systems of multiphase flow though various prescribed models
- To understand various techniques and applications of multiphase flow measurements

Course Outcomes:

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

CO1: understand the fundamentals of multiphase flow, principles and applications

CO2: Understand various flow patterns and regimes

CO3: Interpret simple analytical model and homogenous flow model for one dimensional steady state flow

CO4: Analyse drift flux model and separted flow model for multiphase flow

CO5: Understand and analyse different measurement techniques for multiphase flow

Unit 1: Introduction to multiphase flow, type of flow and applications: Basic fluid flow concepts: Flow field description, conservation laws, viscous flow, turbulent flow, pressure drop, Review of Single-Phase Flow; Scope and significance - applications

Unit 2: Flow pattern maps and Regime: Flow patterns for gas-liquid; gas-solid; liquid-liquid; liquid-solid system; Heated tubes, Vertical flow; horizontal flow; co-current; counter current systems; Gas-liquid-solid three phase flows.

Unit 3: One dimensional steady state flow: Definitions and common Terminologies - simple analytical model - homogenous flow model.

Unit 4: Drift flux model: Theory of drift flux model and its application, **Separated flow model:** Separated flow model for stratified and annular flow; Correction factor and analysis, **Two phase flow with phase change:** Boiling flow heat transfer - regimes - bubble growth.

Unit 5: Measurement techniques: Sampling Methods - Integral Methods – Local Measurement techniques - hold up studies – analysis.

Books Recommended:

1. G.B. Wallis, One-Dimensional Two-Phase Flow, McGraw Hill Book Co., New York, 1969.
2. G.C. John, R. T. John, Convective Boiling and Condensation, Oxford University Press, 3rd ed., UK, 2002.
3. K. S. Clement, Two Phase Flow – Theory and Applications, 1st ed., Taylor and Francis, USA, 2003
4. G.W. Govier, K. Aziz, The Flow of Complex Mixture in Pipes, 2nd ed., Society of Petroleum Engineers Publishers, USA, 2008.
5. R. Clift, M.E. Weber, J.R. Grace, Bubbles, Drops, and Particles, Academic Press, New York, 1978.
6. Y. T. Shah, Gas-Liquid-Solid reactors design, McGraw Hill Inc, 1979
7. L. S. Fan, C. Zhu, Principles of Gas-solid Flows, Cambridge University Press, 1998
8. C. T. Crowe, M. Sommerfeld, Y. Tsuji, Multiphase Flows with Droplets and Particles, CRC Press, 1998
9. C. Kleinstreuer, Two-phase Flow: Theory and Applications, Taylor & Francis, 2003
10. M. Rhodes, Introduction to Particle Technology, John Wiley & Sons, New York. 1998.
11. C.T. Crowe, Multiphase Flow Handbook, CRC Press, 2005.
12. C. E. Brennen, Fundamentals of multiphase flow, Cambridge University Press, 2005.
13. N.I. Kolev, Multiphase Flow Dynamics 1: Fundamentals, Springer, 2007.

Subject: CE-OEL-705T (BCE)

Open Elective- III: Nanoscience and Nanotechnology (Theory)

Lecture	: 3 Hours	No. of Credits	: 3
University	: 70 Marks	College Assessment	: 30 Marks
Duration of Examination: 3 Hours			

Course Objectives:

- To explore the basic concept of nanoscience and nanotechnology and its scope.
- To study various synthesis methods, analysis tools for nanomaterial's preparation and characterization.
- To understand the fundamental properties and emerging applications for nanomaterials

Course Outcomes:

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

CO1: Understand the concept of nano scale and nanotechnology, and classify various types of nanomaterial.

CO2: Learn the fundamentals and procedure of synthesis of nanomaterial and its method of synthesis according to application.

CO3: Identify the suitable type of characterization technique for Nano material.

CO4: Understand the synthesis and role carbon nanomaterials in various applications.

CO5: To identify the application of nanotechnology in chemical Engineering and evaluate the impact of nanotechnology on Environment and its safety aspects.

Unit 1: Introduction: Nano Scale, history and Scope of Nano Technology., Nanomaterials, Morphology. Enhanced properties at nano scale. Comparison with bulk materials. Applications of nanomaterials

Unit 2: Fabrication of Nanomaterials: Top-Down Approach: Grinding, Planetary milling and Comparison of particles, Bottom-Up Approach: Wet Chemical Synthesis Methods, Micro emulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods: Chemical Vapour Depositions. **Kinetics at Nanoscale:** Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface Charges, Zeta Potential and pH

Unit 3: Introduction to Instrumentation and characterization: Instrumentation Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential, SEM, TEM, AFM, STM, DLS, Spectroscopy. etc.

Unit 4: Carbon Nanomaterials: Synthesis of carbon buckyballs, List of stable carbon allotropes extended fullerenes, metallofullerenes solid C60, bucky onions nanotubes, nanocones Difference between Chemical Engineering processes and nanosynthesis processes.

Unit 5: Unit Applications, Safety and Environment: Waste water treatment, nanobiotechnology: drug delivery, nanoclay, nanocomposites, Surface coatings. self-cleaning materials, hydrophobic nanoparticles. Societal, health and environmental impacts. Commercial processes for nanotechnology and chemical engineering applications: nanohydrogel, photocatalytic reactors, nanoclay synthesis, polymer nanocomposite, introduction to industries which produces commercial nanomaterials.

Books Recommended:

1. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007.
2. Gabor L. Hornyak., H.F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2008.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4. K. K. Chattopadhyay, A.N. Banerjee, Introduction to Nanoscience and Nanotechnology, PHI Learning Private Limited.
5. B. A. Bhanvase, Vijay B. Pawade, Sanjay J. Dhoble, S. H. Sonawane, M. Ashokkumar, Nanomaterials for Green Energy, Elsevier, 2018.
6. B. A. Bhanvase, S. H. Sonawane, Vijay B. Pawade, A. B. Pandit, Handbook of Nanomaterials for Wastewater Treatment: Fundamentals and Scale up issues, Elsevier, 2021.
7. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
8. Poole C., and Owens F., Introduction to Nanotechnology, John Wiley, New Jersey, 2003.
9. Singh Nalwa, 10 Volume Enclypedia of Nanoscience and NanoTechnology, 2004.
10. Catherine Brechignac, Philippe Houdy, Marcel Lahmani (Editors) Nanomaterials and Nanochemistry, Springer-Verlag Berlin Heidelberg, 2007.

Subject: CE-OEL-705T (BCE)

Open Elective- III: Optimization of Chemical Processes (Theory)

Lecture	: 3 Hours	No. of Credits	: 3
University	: 70 Marks	College Assessment	: 30 Marks
Duration of Examination: 3 Hours			

Course Objectives:

- Provide an overview of state-of-the-art optimization algorithms
- Impart the theoretical knowledge of chemical engineering principles that underpin optimization techniques.
- Enhance the modelling skills to describe and formulate optimization problems and their use for solving several types of practically relevant optimization problems in Chemical engineering

Course Outcomes:

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

CO1: Understand the importance & relevance of optimization in chemical processes.

CO2: Formulate objective function for a given problem

CO3: Understand unconstrained single variable optimization and apply numerical methods for optimizing a function.

CO4: Understand multivariable optimization and linear programming techniques

CO5: Understand nonlinear programming techniques and use dynamic programming for optimization

Unit 1: The Nature and Organization of Optimization Problems: Scope and Hierarchy of Optimization, Examples of applications of Optimization, The Essential Features of Optimization Problems, General Procedure for Solving Optimization Problems, Obstacles to Optimization, Introduction to single and multi-objective optimization.

Unit 2: Basic Concepts of Optimization: Continuity of Functions, Unimodal vs. multimodal functions, convex and concave functions, convex region, Necessary and Sufficient Conditions for an Extremum of an Unconstrained Function, Interpretation of the Objective Function in terms of its Quadratic Approximation.

Unit 3: Optimization of Unconstrained Functions: One Dimensional search Numerical Methods for Optimizing a Function of One Variable, Scanning and Bracketing Procedures, Newton and Quasi-Newton Methods of Uni-dimensional Search, Polynomial approximation methods, How One-Dimensional Search is applied in a Multidimensional Problem, Evaluation of Uni-dimensional Search Methods.

Unit 4: **Multivariable Optimization**: Direct methods, Indirect methods – first order, Indirect methods – second order. **Linear Programming and Applications:** Basic concepts in linear programming, Degenerate LP's – Graphical Solution, Natural occurrence of Linear constraints, The Simplex methods of solving linear programming problems, standard LP form, Obtaining a first feasible solution, Sensitivity analysis, Duality in linear programming

Unit 5: Nonlinear programming with constraints The Lagrange multiplier method, Necessary and sufficient conditions for a local minimum, introduction to quadratic programming. **Optimization of Stage and Discrete Processes:** Dynamic programming, Introduction to integer and mixed integer programming. Applications to different processes.

Books Recommended:

1. Edger T.F., Himmelblau D.M., Lasdon L.S., Optimization of Chemical Processes, 2nd ed., McGraw-Hill, USA, 2015.
2. Hillier F.S., Lieberman G. J., Introduction to Operations Research, 7th ed., McGraw-Hill, USA, 2001.
3. Rao S.S., Engineering Optimization: Theory and Practice, 4th ed., John Wiley & Sons Ltd., USA, 2009.

Subject: CE-OEL-705T (BCE)

Open Elective- III: Biochemical Engineering (Theory)

Lecture	: 3 Hours	No. of Credits	: 3
University	: 70 Marks	College Assessment	: 30 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To impart the basic knowledge and overview of biotechnology covering the principles of cell and kinetics
- To develop general understanding on major metabolic pathways
- To evaluate different fermentation processes and to identify the bioreactor components and their application in design
- To recognize the role of biochemical engineering in pollution management.

Course Outcomes:

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

CO1: Understand the importance & relevance of bioprocessing.

CO2: Recognize the function of enzyme and develop the understanding about enzyme kinetics.

CO3: Develop general understanding on major metabolic pathways

CO4: Design bioreactor and analyze the performance of the bioreactor

CO5: Design and develop the wastewater treatment unit using principles of biochemical engineering

Unit 1: Introduction to bioprocessing fundamentals: Overview of microbiology, importance of microbiology, introduction to biochemistry, Classification and nomenclature of enzymes, industrial applications of enzymes, aerobic and anaerobic fermentation processes, solid state fermentation and submerged fermentation, Cell cultivation

Unit 2: Enzyme Kinetics: Models for simple and complex enzyme kinetics, modelling of effect of pH and temperature, models for insoluble substrate, models for immobilized enzyme systems, diffusional limitations, electrostatic and steric effects.

Unit 3: Major metabolic pathways: Introduction, Bioenergetics, Glucose metabolism, metabolism of nitrogenous compounds, respiration, metabolism of hydrocarbons, anaerobic metabolism, autotrophic metabolism.

Unit 4: Cell Kinetics and Bioreactor design: Growth Cycle for batch cultivation, Various types of Fermenters for cell growth, Sterilization techniques, Modifications of batch and continuous reactors, chemostat with recycle, multistage chemostat, fed-batch operation, perfusion system, active and passive immobilization of cells, diffusional limitations in the immobilized cell system, Agitation and aeration, cultivation and media optimization, product recovery by various unit operations, Scaleup and difficulties

Unit 5: **Biological waste water treatment:** Mixed Culture Introduction, Microbial participation in natural cycle of matter, activated sludge process, design and modeling of activated sludge process, nitrification, anaerobic digestion, mathematical modeling of anaerobic digester, anaerobic denitrification, phosphate removal

Books Recommended:

1. D.G. Rao, Introduction to Biochemical Engineering, Tata McGraw Hill Education, 2010.
2. M. L Shuler, F. Kargi, Bioprocess Engineering – Basic Concepts, 2nd Edition, Prentice Hall Publication, 2003.
3. J.E. Bailey, D.E. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, McGrawHill, Inc., 1986.
4. A. Whitekar, P. F. Stanbury, S. J. Hall, Principles of Fermentation Technology, 2nd Edition, Butterworth-Heinemann, 1999.
5. S. Aiba, A. E. Humphrey and N. F. Millis, Biochemical Engineering, 2nd Edition, Academic Press, New York, 1973.
6. B. Atkinson, Biochemical reactors, Pion Limited, London, 1974.

Subject: CE-OEL-706T (BCE)

Open Elective- IV: Fluidization Engineering (Theory)

Lecture	: 3 Hours	No. of Credits	: 3
University	: 70 Marks	College Assessment	: 30 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To enable the students to understand the fundamentals and applications of fluidization and to learn the design aspects of fluidized beds.

Course Outcomes:

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

CO1: Understand the basics of fluidization.

CO2: Analyse the various industrial applications of fluidization

CO3: Understand and analyse the various fluidization regimes, classification of particles.

CO4: Understand and apply the K-L bubbling model

CO5: Understand the staging of fluidized beds, and evaluate the exchange coefficient

Unit 1: Introduction: Phenomenon of fluidization, behavior of fluidized bed, contacting modes, advantages and disadvantages of fluidization, fluidization quality, selection of contacting mode

Unit 2: Industrial applications of fluidized beds: Coal gasification; gasoline from other petroleum fractions; Gasoline from natural and synthesis gases; Heat exchange; Coating of metal objects with plastics; Drying of solids; Synthesis of phthalic anhydride; Acrylonitrile; Polymerization of olefins; FCCU; Fluidized combustion of coal; incineration of solid waste; Activation of carbon; gasification of waste; bio-fluidization.

Unit 3: Mapping of fluidization regimes: Characterization of particles, minimum fluidization velocity, pressure drop versus velocity diagram, The Geldart classification of solids, fluidization with carryover of particles, terminal velocity of particles, distributor types, gas entry region of bed, pressure drop requirements, design of gas distributor, power consumption.

Unit 4: Bubbles in dense bed: Davidson model for gas flow, the wake region and movement of solids at bubbles, coalescence and splitting of bubbles, bubble formation above a distributor, slug flow. **Bubbling fluidized beds:** Emulsion movement, estimation of bed properties, bubble rise velocity, scale up aspects, flow models, two phase model, K-L model

Unit 5: Entrainment and elutriation: Freeboard behavior, gas outlet, entrainment from tall vessel, freeboard entrainment model, high velocity fluidization, pressure drop in turbulent and fast fluidization. **Solids movement:** Vertical and horizontal movement of solids, Dispersion model, large solids in beds of smaller particles, staging of fluidized beds. **Gas dispersion:** Gas dispersion in beds, gas interchange between bubble and emulsion, estimation of gas interchange coefficient

Books Recommended:

1. O. Levenspiel, D. Kunnii, Fluidization Engineering, John Wiley, 1972.
2. Liang-Shih Fan, Gas-Liquid-Solid Fluidization Engineering, Butterworths, 1989.

Subject: CE-OEL-706T (BCE)

Open Elective- IV: Advanced Materials (Theory)

Lecture	: 3 Hours	No. of Credits	: 3
University	: 70 Marks	College Assessment	: 30 Marks
Duration of Examination: 3 Hours			

Course Objectives:

- To enable the students to understand the fundamentals, fabrication, characterization, and applications of advanced materials.

Course Outcomes:

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

CO1: Understand the synthesis and properties of nanomaterials.

CO2: Evaluate the usefulness of nanomaterials and composite materials in various applications.

CO3: Understand the fundamentals of optical materials and evaluate the usefulness of optical materials in various applications.

CO4: Differentiate superconducting materials

CO5: Understand the characteristics and uses of smart/functional materials

Unit 1: Nano Materials: Origin of nanotechnology, Classification of nanomaterials, Physical, chemical, electrical, mechanical properties of nanomaterials. Preparation of nanomaterials by plasma arcing, physical vapour deposition, chemical vapour deposition (CVD), Sol-Gel, electro deposition, ball milling, carbon nanotubes (CNT). Synthesis, preparation of nanotubes, nanosensors, Quantum dots, nanowires, nanobiology, nanomedicines.

Unit 2: Biomaterials: Overview of biomaterials. Biomaterials, bioceramics, biopolymers, tissue grafts, soft tissue applications, cardiovascular implants, biomaterials in ophthalmology, orthopedic implants, dental materials. **Composites:** General characteristics of composites, composites classes, PMCs, MMCs, CMCs, CCCs, IMCs, hybrid composites, fibers and matrices, different types of fibers, whiskers, different matrices materials, polymers, metal, ceramic matrices, toughening mechanism, interfaces, blending and adhesion.

Unit 3: Optical materials: Mechanisms of optical absorption in metals, semiconductors and insulators. Nonlinear optical materials, optical modulators, optical fibers. Display devices and materials photo-emissive, photovoltaic cells, charge coupled devices (CCD), laser materials.

Unit 4: Super conducting materials: Types of super conductors, an account of mechanism of superconductors, effects of magnetic field currents, thermal energy, energy gap, acoustic attenuation, penetration depth, BCS theory, DC and AC Josephson effects, high Tc superconductors, potential applications of superconductivity, electrical switching element, superconductor power transmission and transformers, magnetic mirror, bearings, superconductor motors, generators, SQUIDS etc.

Unit 5: Smart materials: An introduction, principles of smart materials, input – output decision ability, devices based on conductivity changes, devices based on changes in optical response, biological systems smart materials. Devices based on magnetization, artificial structures, surfaces, hetero structures, polycrystalline, amorphous, liquid crystalline materials.

Books Recommended:

1. T. Pradeep, Nano: The Essentials; TATA McGraw-Hill, 2008.
2. B.S. Murthy et al., Textbook of Nano science and Nanotechnology, University press, 2012.
3. B. A. Bhanvase, Vijay B. Pawade, Sanjay J. Dhoble, S. H. Sonawane, M. Ashokkumar, Nanomaterials for Green Energy, Elsevier, 2018.
4. B. A. Bhanvase, S. H. Sonawane, Vijay B. Pawade, A. B. Pandit, Handbook of Nanomaterials for Wastewater Treatment: Fundamentals and Scale up issues, Elsevier, 2021.
5. Krishan K Chawla, Composite Materials; 2nd Edition, Springer 2006.

Subject: CE-OEL-706T (BCE)

Open Elective- IV: Scale up Methods (Theory)

Lecture	: 3 Hours	No. of Credits	: 3
University	: 70 Marks	College Assessment	: 30 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To develop general understanding of different scale-up methods
- To develop the understanding about the scale-up of mixing, agitation, mass & heat transfer equipments and chemical reactors
- To enhance the problem-solving skills for solving scale-up problems in Chemical engineering
- To foresee the importance of the scale-up of in chemical Industry

Course Outcomes:

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

CO1: Understand scale up in chemical engineering plants & apply different analysis techniques for scale up problems

CO2: Understand the Scale-up of Mixing, agitation and apply principles in Mass Transfer Equipments scale-up

CO3: Understand and apply the Scale-up principles in Heat Transfer Equipment

CO4: Understand and apply the Scale-up principles in chemical reactors

CO5: Understand and apply the Scale-up principles in Industrial applications

Unit 1: Introduction to Scale-Up Methods: Important Aspects concerning Scale-up, Principals of Similarity, Pilot Plants and Models, Dimensional Analysis, Experimental Techniques for Scale-up

Unit 2: Scale-Up of Mixing, agitation and Mass Transfer Equipments: Determination of stirrer power, Typical problems in scale up of mixing equipment. Scale-up of mixers for mixing Solids, Absorption column and extraction process scaleup, Scale-up of distillation column.

Unit 3: Scale-Up of Heat Transfer Equipment: General aspects in scale up of heat transfer equipment. Optimization of stirrers for maximum removal of reaction heat, Process heat duty scaleup based on the laboratory data, Typical problems in scale up.

Unit 4: Scale-Up of Chemical Reactors: Kinetics, Reactor development and scale-up techniques for chemical reactors. Mass & heat transfer in catalysed reaction, Continuous Chemical Process in Tubular Reactor, Factors affecting choice of reactor, Runaway Reaction and Scaleup issues

Unit 5: Selected Examples of Industrial Applications: Mass transfer and reaction in G/L, G-L-S system, Scale-up of the dryers, Scale-up of the reactors for the catalytic processes in the petrochemical Industry, Scale up of the processes in speciality and pharmaceutical Industry, Scaleup of hydrogenation and nitration reaction, Scaleup of ammonia process.

Books Recommended:

1. Johnstone and Thring, Pilot Plants Models and Scale-up methods in Chemical Engg., McGraw Hill, New York, 1962.
2. W. Hoyle, Pilot Plants and Scale-Up, Royal Society of Chemistry, 1st Edition, 1999.
3. E. Bruce Nauman, Chemical Reactor Design, Optimization and Scale-up, McGraw Hill, New York, 2002.
4. M. Zlokarnik, Scale-up in Chemical Engineering, Wiley-VCH, VErlag GmbH & Co., 2002
5. Attilio Bisio, Robert L. Kabel, Scale up of Chemical Processes, John Wiley & Sons, 1985
6. D. G. Jordan, "Chemical Process Development" (Part 1 & 2), Interscience Publishers, 1988.

Subject: CE-OEL-706T (BCE)

Open Elective- IV: Sustainable Development and Governance (Theory)

Lecture	: 3 Hours	No. of Credits	: 3
University	: 70 Marks	College Assessment	: 30 Marks

Duration of Examination: 3 Hours

Course Objectives:

- To learn the concept of sustainable development idea, terminologies and reporting framework
- To understand Environmental Impact Assessment process in India
- To understand the implementation and role of Corporate social responsibility for sustainable development in India

Course Outcomes:

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

CO1: Understand concept of sustainable development- need, terminologies, challenges

CO2: Identify the national and international initiative, laws and treaty towards sustainable development

CO3: Analyse different sustainability reporting format

CO4: Understand process of Environmental impacts assessment particularly in the Indian context and interpret various case studies

CO5: Understand the corporate social responsibility framework for India

Unit 1: Concept of sustainable development, challenges of sustainable development, Sustainable development goals, Sustainability Terminologies, Environmental issues and crisis, Resource degradation, greenhouse gases, Triple Bottom Line, Other Sustainability Indices

Unit 2: Actions towards sustainable development - United Nations Initiatives, Brundtland Commission, Agenda 21, Rio Declaration, Kyoto Protocol, Millennium Development Goals, International Forest Carbon Initiative, Regulatory Framework of Environment India, Extended producers responsibility

Unit 3: Sustainability Reporting: GRI, Dow Jones Sustainability Index, BRSR, Climate Disclosure project etc. Investor interest in Sustainability, Materiality Assessment

Unit 4: Understanding Environmental Impact Assessment- History, Forms of impact assessment, Comparative review of EIA procedures and practice, EIA process In India, Case studies

Unit 5: Corporate Social Responsibility- Concept, definition, scope, CSR Reporting Framework, CSR through triple bottom line and Sustainable Business; relation between CSR and Corporate governance; environmental aspect of CSR; Chronological evolution of CSR in India; models of CSR in India, Carroll's model; drivers of CSR; major codes on CSR Initiatives in India

Books Recommended:

1. Jennifer A. Elliott, An Introduction to Sustainable Development Third edition, Routledge-m Taylor & Francis Group
2. Handbook on Corporate Social Responsibility in India, CII.
3. Kye Gbangbola , Nicole Lawler , Gold Standard Sustainability Reporting, Taylor and Francis, (2020)
4. Handbook of Corporate Sustainability: Frameworks, Strategies and Tools - M. A. Quaddus, Muhammed Abu B. Siddique
5. Growth, Sustainability, and India's Economic Reforms – Srinivasan
6. Corporate Social Responsibility: Concepts and Cases: The Indian - C. V. Baxi, Ajit Prasad
7. Ministry of Environment & Forests, Govt. of India 2006 EIA Notification
8. A K Srivastava, Environment impact Assessment, APH Publishing, 2014
9. John Glasson, Riki Therivel & S Andrew Chadwick "Introduction to EIA" University College London Press Limited, 2011
10. Larry W Canter, "Environmental Impact Assessment", McGraw Hill Inc., New York, 1995.

Subject: CE-PCC-707P (BCE) Process Modelling and Simulation Lab (Practical)

Practical	: 3 Hours	No. of Credits	: 1.5
University	: 25 Marks	College Assessment	: 25 Marks

Duration of Examination: 6 Hours

Course Objectives:

- To introduce various numerical methods that are important in the solution of a variety of process models.
- To perform experiments using modeling and simulation tools for chemical processes involving combinations of process parameters.
- Students will be made acquainted with theoretical aspects of mathematical softwares and commercial simulators.

Course Outcomes:

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

CO1: Understand and analyse physical and chemical phenomena involved in various process in development of mathematical model

CO2: Apply various simulation approaches like MS-Excel, MATLAB/Scilab, POLYMATH, Mathcad, etc. to estimate design parameters for linear and non-linear algebraic models

CO3: Apply various simulation approaches like MS-Excel, MATLAB/Scilab, POLYMATH, Mathcad, etc. to estimate design parameters for processes involving unsteady state conditions

CO4: Estimate process parameters using modern process simulators like ASPEN PLUS/HYSYS/ CHEMCAD etc.

LIST OF EXPERIMENTS:

Required to perform minimum 10 practicals from the list given below:

Before starting the practical sessions, students will be made acquainted with theoretical aspects of mathematical softwares and commercial simulators.

Students have to perform minimum eight to ten practicals using MS-Excel, MATLAB/Scilab, POLYMATH, Mathcad, ASPEN PLUS/HYSYS/ CHEMCAD software for design/simulation of chemical engineering problems.

Books Recommended:

1. S.C. Chapra, R.P. Canale, Numerical Methods for Engineers, 6th Edition, Tata-McGraw Hill Publications, 2012.
2. W. L. Luyben, Process Modeling Simulation and Control for Chemical Engineers, McGraw Hill, 1990.
3. B. V. Babu, Process Plant Simulation, Oxford University Press, 2004.

4. B. A. Finlayson, Introduction to Chemical Engineering Computing, Wiley Interscience, New Jersey, 2006.
5. S.K. Gupta, Numerical Methods for Engineers, 2nd Edition, New Age International, 2010.

Subject: CE-PCC-708P (BCE)

Seminar and Summer Internship Evaluation (Practical)

Practical	: 3 Hours	No. of Credits	: 1.5
		College Assessment	: 50 Marks

Course Objectives:

- To develop self-learning habit for understanding recent developments in the field of engineering.
- To develop report writing and presentation skills.

Course Outcomes:

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

CO1: Carry out literature survey on a topic of latest development / innovation in chemical engineering and technology.

CO2: Analyze topics related chemical engineering and technology for environment and sustainability issues.

CO3: Apply ethical principles and social responsibility in execution of the work (individually/team).

CO4: Apply knowledge to prepare a formatted report on selected topic after study / experimentation and present a work on selected topic using ICT tools.

The seminar work shall consist of preferably study of certain phenomenon, system, equipment, process design in depth, review of certain research work, compilation and analysis of certain engineering/ management activity including costing, safety, administration, market study, field study, etc. on any topic which may have importance in chemical engineering and technology.

Students are expected to work individually on the seminar and the report shall be a bound journal written in technical format with illustrations by graphs, charts, tables, photographs etc. about the specific work undertaken by the student. The number of copies of the report shall be such that the guide, departmental library and the concerned student shall have one copy each. Students will also be required to make an oral presentation for review using PowerPoint in presence of faculty and students of Programme.

Further, each student needs to submit a written report (3 copies) based on the work carried out during the Summer Internship (3-4 weeks) undergone at the end of 6^{th} semester in the given format. The report shall be countersigned by the Supervisor from Industry / Institute as the case may be.

Performance of the student will be assessed based on the written report and a presentation to a departmental committee of faculty members from the Chemical Engineering Department. Students will be evaluated and marks will be awarded based on the written report and a presentation; evaluated by a committee of faculty members.
