NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Advance Mass Transfer**	Subject Code	**CL41111 (CL)**
Semester	M. Tech. ï 1st Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit I

Ternary and multicomponeut system, fractionation. Theories and design, No. of plates, Lewis Sorelôs method, minimum reflux ratio, Underwoodôs equation, Coburnôs equation.

Unit-II

Unsteady state mass transfer, multicomponent Gas-Phase systems, effective diffusivity, Maxwellôs law, Regular and Random surface renewal, Harriot Model, Danck werts model.

Unit-III

Mass Transfer across a phase boundary ï the film-penetration theory, other theories of mass transfer. Interfacial turbulence, Mass Transfer coefficient, Applications of theories of interphase transfer. Mass Transfer and chemical reaction ï steady state and unsteady state

Unit-IV

Momentum, heat and mass transfer, molecular diffusion, Eddy transfer, mixing length and eddy kinematics viscosity, overview of all separation processes including adsorption

Unit-V

Universal velocity profile ï The laminar sub-layer, the buffer layer, Reynolds analogy, Taylor ï Prandtl Modifications

Name of Text Books:

1. Chemical Engineering Principles by ï J.D. Seader, Ernest J. Henley.
2. Chemical Engineering by ï J.M. coulson & J.F. Richardson.

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR

CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Reactor Design & Stability**	Subject Code	**CL41112 (CL)**
Semester	M. Tech. ï 1st Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit-I

Industrial reactors: stirred tank reactors, tubular reactors, kilns and hearth furnaces, fixed and moving bed reactors, fluidized beds, multiphase reactors, special types of reactors.

Isothermal reactor design:

Design structure; scale up of liquid phase batch reactor to the design of CSTR, tubular reactors, pressure drop in reactors, reversible reactions, unsteady state operation of reactors, simultaneous reaction and separation.

Unit-II

Nonisothermal reactor design:

Energy balance, nonisothermal CSTR and PFR at steady state, equilibrium conversion, unsteady state operation, nonadiabatic reactor operation, multiple steady state.

Unit-III

Fluid particle reactions design: Performance equations for uniform gas composition - particles of single size + plug flow of solids, particles of different but unchanging size + plug flow of solids, particles of different but unchanging size + mixed flow of solids, particles of different size + mixed flow of solids, application to fluidized bed with entrainment of solid fines.

Unit-IV

Fluid - Fluid reactions design: Towers for fast reactions- mass transfer with and without reaction, Towers for slow reaction, mixer settlers, semibatch contacting patters, reactive and extractive reactions.

Unit-V

Solid catalyzed reaction design: Design of staged adiabatic packed bed reactors, Design of fluidized bed reactors.

Scaling up test results: method of scale up and blow up, chemical similitude

Name of Text Books:

1. Chemical Engineering Kinetics. J.M. Smith.
2. Reaction kinetics for chemical engineers. Sidney D. Kirkpatrick, McGraw Hill series.
3. Chemical Reaction Engineering. Octave Levenspiel.

Name of Reference Books:

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

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Advance Heat Transfer**	Subject Code	**CL41113 (CL)**
Semester	M. Tech. ï 1st Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit-I
General three dimensional differential equation of heat conduction, Steady state systems with out and with internal heat generation, systems with variable thermal conductivities.

Unit-II
Multi dimensional steady state heat conductions, mathematical and graphical analysis of 2-ñdò systems, electrical analog of 2-ñdò systems, Numerical relaxation method for 2-ñdò systems, three dimensional systems.

Unit-III
Transient heat conduction, lumped systems, systems with finite surface and internal resistance, systems with negligible surface resistance, chart solution, numerical procedure and graphical solution of Transient heat conduction.

Unit-IV
Forced convection heat transfer; Analytical and semi -analytical solution; Equations for velocity and temperature in vertical and horizontal planes for cylinders and spheres, Physical significance of dimensionless groups w.r.t. momentum and energy equations.

Unit-V
Radiation heat transfer concepts; Angle factor calculations; Network and Gebhast method of analysis of radiation exchange; Radiation calculation through gas and vapors; Design of compact heat exchangers; Heat transfer due to boiling, Liquid metal heat transfer Selected topic on heat transfer.

Name of Text books:
1. Fundamentals of Engineering Heat & Mass Transfer ï R.C.Sachdeva
2. Fundamentals of Engineering Heat & Mass Transfer ï Frank P.Incropera

Name of Reference books:
1. Process Heat Transfer- Donald D.Kern

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Optimization Techniques in Chemical Engineering**	Subject Code	**CL41131 (CL)**
Semester	M. Tech. ï 1st Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit-I
Introduction to optimization and its scope in chemical process design, Developing Models for Optimization, Formulation of the Objective Function.

Unit-II
Optimization Theory and Methods: Basic Concept of Optimization of Unconstrained Functions: One-Dimensional Search, Unconstrained Multivariable Optimization

Unit-III
Linear Programming (LP) and Applications, Nonlinear Programming with Constraints, Global Optimization for Problems with Continuous and Discrete Variables. Constrained multivariable optimization.

Unit-IV
Mixed-Integer Programming, Optimization in Large-Scale Plant Design and Operations, Integrated Planning, Scheduling, and Control in the Process Industries, Process integration examples.

Unit-V
Application of Optimization: Heat Transfer and Energy Conservation, Separation Processes, Fluid Flow Systems, Chemical Reactor Design and Operation.

Text Books:

1. Edgar, T.F. and Himmelblau, D.M., Optimization of Chemical Process, McGraw Hill, 1989.
2. Urbanier, K. and McDermott, C., Optimal Design of Process Equipment John, Wiley, 1986.
3. Reklaitis, G.V., Ravindran, A., Regsdell, K.M., Engineering Optimisation, John Wiley, New York, 1980.

Reference Books:

1. Biles, W.E. and Swain, J.J., Optimization and Industrial Experimentation, Inter Science, New York, 1980.
2. Seinfield, J.H., Lapidus, L., Process Modelling, Estimation and Identification, Prentice Hall, Englewood Cliffs, new Jersey, 1974.
3. Numerical Methods by B.S. Grewal, 2005

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Process Intensification in Chemical Engineering**	Subject Code	**CL41132 (CL)**
Semester	M. Tech. ï 1st Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit-I

History, philosophy and principles of process intensification (PI):- Introduction, philosophy and opportunities of PI, Types of PI equipments - Equipments and methods.

Unit-II

High gravity in chemical processing:- Historical development, Fundamentals, mechanical design, applications, scale-up and commercial use, future, The spinning disc reactor

Unit-III

Multifunctional heat exchanger- Introduction, Compact heat exchanger technology, Single phase flow, Heat transfer and mass transfer, applications.

Unit-IV

Microreaction technology:- Microtechnology, effect of miniaturization, microfabrication, implementation

Unit-V

Structured catalysis and reactors:- Introduction, overview of structured reactors, Gas phase reactions, multiphase reactions

Text Books:

1. Reengineering the chemical processing plant, Andrej stankiewiez, Jacob A., Moulin, Marcel Dekker Inc. New York, Basel.

Reference Books:

1. Compact brazed plate heat exchanger. J.M., Navarro, A., Bailly, Elsvier, Paris. 1994.
2. Compact heat exchanger for the process industry. R.K., Shah, Begell House, 1997.
3. Microreactors, Ehrfeld W., Hessel V., Lowe, H., Weinheim: Willey-VCH, 2000.
4. Conceptual design of chemical processes. J.M., Douglas, McGraw-Hill, New York, 1988.

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Fluidization Engineering**	Subject Code	**CL41133 (CL)**
Semester	M. Tech. ï 1st Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

UNIT – I
Introduction, Mechanism of Fluidization, Liquid-Solid Fluidization, Gas ï Solid Fluidization Types of Fluidization operation.

UNIT – II
Fluidized Bed ï Liquid like behavior of a fluidized bed, Comparison with other contacting methods. Pressure drop.

UNIT – III
Hydrodynamic stability of fluid particle systems, Equation of motion, The Stability of an unbounded uniform suspension, the stability of Bubbles, magnetic and Electro stabillization.

UNIT – IV
Fluidization of Dissimilar materials, Incipient Fluidization and de fluidization Segregation patterns and Mixing Index, Mechanism of Mixing and segregation.

UNIT – V
Application of Fluidization to Heat transfer & Mass transfer (Drying, Particle growth, Coal Combustion)

Name of Text Books:

1. Kunii D. and Levenspiel O., ñFluidization Engineeringò, 2nd Ed., Butterworth-Heinemann.
2. Davidson D. and Harrison J. F., ñFluidization Engineeringò, 2nd Ed., Academic Press.
3. Yang W. C., ñHandbook of Fluidization and Fluid Particle Systemsò, 3rd Ed., CRC.

Name of Reference Books:

1. J.H. Perry, Chemical Engineering Hand Book, 3rd Edition.
2. McCabe & Smith, Unit operation of Chemical Engineering.

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Process Modeling & Simulation**	Subject Code	**CL41114 (CL)**
Semester	M. Tech. ï 1st Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit I
Numerical Techniques for Computer simulation: Linear algebraic equations, nonlinear algebraic equations, Ordinary differential equations, Partial differential equations. Transport phenomena based models. Modeling and simulation of fluid flow operations, Introduction to simulation software.

Unit II
Modeling and simulation of unsteady and steady state chemical reaction processes: Batch reactor, CSTR flow reactor, Plug flow reactor. Recycled reactor, Slurry reactor, Fluidized reactor, Population balance model.

Unit III
Modeling and simulation of unsteady and steady state heat transfer processes: Shell and tube heat exchanger, multiple effect evaporators, Condenser.

Unit IV
Modeling and simulation of unsteady and steady state Distillation, Flashing processes.

Unit V
Modeling and simulation of unsteady and steady state Drying, Extraction and Absorption processes.

Text Books:

1. Luyben W.L, Process Modeling, Simulation and Control for Chemical Engineers, McGraw-Hill Publishing Co.
2. Holland C. D., Fundamental and modeling of separation process, Prentice Hall, Inc., New Jersey
3. Babu B V, Process Plant Simulation, Oxford University Press India.
4. Ogunnaike B.A and .Ray W.H, Process Dynamics Modeling and Control, Oxford University Press.
5. Himmemblue D. M. and Bischof K.B., Process analysis and simulation, Deterministic system, John Willey and Sons, INC, New Delhi.

Reference Books:

1. Stephanopoulos G., ñChemical Process Control: An Introduction to Theory and Practiceò, Prentice-Hall INC.
2. Gupta S.K., ñNumerical Methods for Engineersò, New Age International Publishers Ltd., Wiley Eastern Ltd.
3. Gaikwad R.W., Process Modeling & Simulation, Central Techno Publication, Nagpur.

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Simulation Lab -I**	Subject Code	**CL41121 (CL)**
Semester	M. Tech. ï 1st Semester	Board of Studies	Chemical Engg.
Maximum Marks	20	Minimum marks	10
		Practical Periods/Week	Credits
		3	2

Details of Course:

List of Practical:

1. Eulerôs Method to solve differential Equation
2. Runga Kutta method to solve differential equation
3. Newton Raphson interpretation method
4. Gause elimination method to solve matrices
5. Simulation of CSTR in series
6. Simulation of batch reactor
7. Simulation of non-isothermal reactor
8. Simulation of fluidized bed reactor
9. Simulation of shell and tube heat exchanger
10. Simulation of multiple effect evaporator
11. Simulation of flash drum
12. Simulation of absorber
13. Simulation of distillation tower
14. Simulation of extractor

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Computational Fluid Dynamics**	Subject Code	**CL41211 (CL)**
Semester	M. Tech. ï 2nd Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit I

Introduction: Review of basic principles and equations of change in transport of momentum, heat and mass; Viscosity, thermal conductivity and diffusivity; Shell balance for simple situations to obtain shear stress, velocity, heat flux, temperature, mass flux and concentration distributions.

Unit – II

Equations of Change: Equations of continuity, motion, mechanical energy, angular momentum, energy, and equation of continuity for multicomponent mixture. Use of the equations of change in solving problems of momentum, heat and mass transport, dimensional analysis of the equation of change, Philosophy of computational fluid dynamics CFD.

Unit – III

Grid Generation: Structured and unstructured grids, choice of suitable grid, grid transformation of equations, some modern developments in grid generation for solving engineering problems.

Unit – IV

Finite Difference Method (FDM) and Finite Volume Method (FVM): Discretization of ODE and PDE, approximation for first, second and mixed derivatives, approximations of surface integrals and volume integrals, implementation of boundary conditions, discretization errors, applications to engineering problems.

Unit – V

Special Topics: Modeling two dimensional flow over a flat plate for laminar and turbulent flow, steady two dimensional incompressible laminar flow between stationary plates, laminar flow past circular cylinder, steady state heat conduction across a infinite long solid slab, Discritization of continuity equation, steady state conduction process in large brick with uniform heat generation.

Text Books:

1. Bird R.B., Stewart W.E. and Lightfoot E.N., ñTransport Phenomenaò, 2nd Ed., Wiley, 1994
2. Anderson J.D., ñComputational Fluid Dynamicsò, McGraw Hill. 1995
3. Patankar S.V., ñNumerical Heat Transfer and Fluid Flowò, Taylor and Francis, 2004
4. Versteeg, H.K., Malalsekera, W. Introduction to computational fluid dynamics- the finite volume method, Longman scientific and technical, 1995.

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject		Subject Code	**CL41212 (CL)**
Semester	M. Tech. ï 2nd Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit I

Computer aided design of double pipe, shell and tube heat exchanger, condensers. Basic design procedure of heat transfer equipment, mean temperature, LMTD, Calorific temperature, Individual side heat transfer coefficient, Overall heat transfer coefficient, Dirt factors, Surface area for heat transfer, Construction details, Selection algorithm, Pressure drop, Design stability

Unit II

Computer aid design of multiple effect evaporator. Single and Multiple effect evaporators with and without BPR, Material and energy balance in each unit, Product and vapor rate in each evaporator, Area for evaporation, number of tubes

Unit III

Computer aided design of sieve tray, packed bed and valve tray distillation column: Material and energy balance, Tray hydraulics and design consideration for various trays, Evaluation of various design parameters, flooding and weeping check, plate efficiency. Design of distributor for packed tower, Number of stages, Diameter and height of towers.

Unit IV

Computer aided design of sieve tray and packed bed absorber, extraction unit *Sieve tray column for absorption:* Material balance, Minimum liquid to gas ratio, Absorption factor, No of ideal tray, Flow parameters, Capacity parameters, Tray design, Tower diameter, Flooding check, Calculation of entrainment, Plate efficiency, No of overall transfer unit, Height of column.

Packed column for absorption: Material balance, Design of packing support, Design of liquid distributor, Liquid hold up, Pressure drop, Height of one transfer unit, Height of tower.

Extraction unit: Design of dispersed gas distributor/ plate, Velocity of gas though distributor/orifice, calculation of droplet diameter, No of orifice, Tower diameter, Mass transfer coefficient, Height of one transfer unit, Height of extraction tower.

Unit V

Computer aided design of mixing .process, CSTR, Plug flow and fluidized bed reactors: Flow rate, conversion, rate constant, mass and energy balance, Intermediate time conversion and compositions.

Text Books

1. Kern D.Q.- Process Heat Transfer, McGraw Hill Publication
2. Backhaust, Process equipment design of mass transfer equipment
3. B. C. Bhattacharya, Computer aided design of process equipment

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Advance Process Dynamics &Control**	Subject Code	**CL41213 (CL)**
Semester	M. Tech. ï 2nd Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit I
Advanced control strategies, cascade control feed forward control, Ratio control, controller Turing ï Turing rules, Ziegler ï Nichols Rules Cohen & coon Rules.

Unit II
Control Valves, Theoretical analysis of complex process steam jacket wall, Dynamic response of a Gas absorber, Heat Exchanger.

Unit III
Sampled Data control systems ï Sampling and z ï transform, Analysis for Digital control. Stability, Modified z-transform.

Unit IV
Sampled data control of Physical systems ï first order process with Transport Lag, state-space representation of Physical systems, selection of state variables, Transfer function matrix.

Unit V
Multivariable control ï SISO models, MIMO models. Digital Process Control System. Relative gain array, decoupling, Robnet controller.

Text Books:

Process Systems Analysis and Control McGraw-Hill Publication By-Donald R. coughanowar.

Reference Books:

1. Process Dynamics and Control By ï Dale E. Seborg, Thomas F. Edgon. Dun Can A. Mellichamp ï WILEY Publication.
2. Process Control by Harriet.
3. Chemical Process Control by George Stephanopoulos.

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Industrial Pollution Control**	Subject Code	**CL41214 (CL)**
Semester	M. Tech. ï 2nd Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit I
Industrial Pollution, Socio-Political Aspects of Industrial Pollution, Environmental Impact Assessment (EIA), Planning and Methodology for EIA, Environmental Audit, Modern Methods of Pollution Control

Unit II
Air Pollution ï Sources and effects, Meteorological aspects of air pollution, Sampling Procedures, Control of Air Pollution by Equipment and Process Changes. Air pollution legislation and regulations

Unit III
Water Pollution ï types, sources and effects, Waste water characteristics-physical and chemical, Conventional and Advanced Wasted water treatment techniques. Water pollution legislation and regulations

Unit IV
Solid Waste Management-source and types, Processing Methods, Clean liquid and gaseous fuels from Organic Wastes, Metals recovery from solid waste, Nuclear pollution and radioactive wastes

Unit V
Noise Pollution-Characteristics, sources and health effects of Noise, Measuring instruments and Techniques, Noise standards and Limits, Nose control Techniques, Noise strategy-Future guidelines.

Text books:

1. M.N Rao and H.V.N Rao, Air Pollution, Tata McGraw Hill
2. S.C. Bhatia, Environmental Pollution and Control in Chemical Process Industries, Khanna Publishers, New Delhi.
3. S.P Singal, Noise Pollution and control, Narosa publishing House, New Delhi
4. G.N. Pandey and C.G. Carney Environmental engineering, Tata McGraw Hill.
5. C.S. Rao, Environmental Pollution control engineering, Wiley Eastern Ltd.

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Operation Research & Management Elective -II**	Subject Code	**CL41231 (CL)**
Semester	M. Tech. ï 2nd Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit I
Introduction to Operation Research-Definitions, Aims, Characteristics, limitation and phases of operation research, similarities and Differences between Manufacturing and service operations.

Unit II
Analysis for operations management ï Trade-off analysis, models in operation management, cost data for operation management investment analysis

Unit III
Inventory Control ï Models, Models with price breaks, with Restrictions.

Unit IV
Optimization ï Techniques, planning and control models (Network techniques) ï Development and construction. Difference between CPM and PERT, PERT and CPM analysis.

Unit V
Allocation Models ï Linear Programming, Graphical solution of L.P. Problem, Integer programming problem. Replacement Models ï items fail due to deteriorate and without deteriorate, Preventive inspection of equipment used in emergency.

Name of Text Books:

1. Operation Research - Hira & Gupta

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Advanced thermodynamics Elective -II**	Subject Code	**CL41232(CL)**
Semester	M. Tech. ï 2nd Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit I

An Introduction to Vapour-Liquid Equilibria: Qualitative behaviour of the vapour-liquid equilibria (VLE). Simple models for vapour- liquid equilibria:Raoultôs and Henry´s laws. Dewpoint and bubblepoint calculations. VLE by modified Raoult´s law and K-value correlations. Flash calculations.

Unit II

Solution Thermodynamics: Theory

Fundamental property relation. The chemical potential and phase equilibria. Partial properties. Equations relating molar and partial molar properties. Partial properties in binary solutions. Relations among partial properties. Ideal gas mixtures. Fugacity and fugacity coefficient for pure species. VLE for pure species. Fugacity of a pure liquid. Fugacity and fugacity coefficient for species in solution. The fundamental residual property relation. Fugacity coefficients from the virial equation of state and generalized correlations. The ideal solution: the Lewis/Randall rule. Excess properties. The excess Gibbs energy and the activity coefficient. The nature of excess properties.

Unit III

Solution Thermodynamics: Applications: Liquid phase properties from VLE data. Fugacity. Activity coefficient. Excess Gibbs energy. Data reduction.Thermodynamic consistency. Models for the excess Gibbs energy. Local composition models. Property changes of mixing. Heat effects of mixing processes. Heats of solution. Enthalpy-Concentration diagrams.

Unit IV

Chemical Reaction Equilibria:

The reaction coordinate. Multireaction stoichiometry. Application of equlibrium criteria to chemical reactions. The standard Gibbs energy change and equilibrium constant. Effect of temperature on the equilibrium constant. Evaluation of equilibrium constants. Relation of equilibrium constants to composition. Gas-phase and liquid-phase reactions. Equilibrium conversions for single reactions. Single phase reactions. Reactions in heterogeneous systems. Multireaction equilibria. Fuel cells.

Unit V

Topics in Phase Equilibria: The gamma/phi formulation of VLE. VLE from cubic equations of state. Equilibrium and stability. Liquid-liquid equilibrium. Vapour-liquid-liquid equilibrium. Solid-liquid equilibrium. Osmotic equilibrium and osmotic pressure.

Text Books

1. Smith, J. M.; Introduction to chemical engineering thermodynamics . ISBN: 0-07-240296-2 Complementary Bibliography
2. Prausnitz, John M.; Molecular Thermodynamics of Fluid-Phase Equilibria . ISBN: 0-13- 977745-8

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Nanotechnology Elective -II**	Subject Code	**CL41233CL)**
Semester	M. Tech. ï 2nd Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit I

Introduction to nanotechnology: background, definition , basic ideas about atoms and molecules, physics of solid state, review of properties of matter and quantum mechanics

Unit II

Preparation of Nanostructured Materials : Lithography : nanoscale lithography, E-beam lithography, dip pen lithography, nanosphere lithography. Sol gel technique Molecular synthesis, Selfassembly, Polymerization

Unit III

Characterization of Nanostructured materials : Microscopy: TEM, SEM, SPM techniques, confocal scanning microscopy,, Raman microscopy-Basic principles, applicability and practice to colloidal, macromolecular and thin film systems. Sample preparation and artifacts. Polymer fractionation techniques: SEC, FFF, Gel electrophoresis.: Basic theory, principles and practice. Thermal analysis: Basic principles, theory and practice. Micro DSC in the study of phase behavior and conformational change.

Mass spectrometry of polymers: MALDI TOF MS ï Basic theory, principles and practice. Applicability to proteins, polyethers, controlled architecture systems

Unit IV

Cross-cutting Areas of Application of Nanotechnology : Energy storage, Production and Conversion. Agriculture productivity enhancement Water treatment and remediation. Disease diagnosis and screening. Drug delivery systems. Food processing and storage. Air pollution and remediation. Construction. Health monitoring..Vector and pest detection, and control. Biomedical applications. Molecular electronics. Nanophotonics. Emerging trends in applications of nanotechnology

Unit V

Industrial Implications of Nanotechnology : Development of carbon nanotube based composites. Nanocrystalline silver Antistatic conductive coatings. Nanometric powders. Sintered ceramics. Nanoparticle ZnO and TiO2 for sun barrier products. Quantum dots for biomarkers. Sensors. Molecular electronics. Other significant implications

References:

1. Guozhong Cao, ñNanostructures and Nanomaterialsò, Imperial College Press, London
2. Mark Ratner and Daniel Ratner, ñA Gentle Introduction to Next Big Thingò, Pearson Education 2005

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**CAD Lab**	Subject Code	**CL41221 (CL)**
Semester	M. Tech. ï 2nd Semester	Board of Studies	Chemical Engg.
Maximum Marks	20	Minimum marks	10
		Practical Periods/Week	Credits
		3	2

Details of Course:

List of Practicals

1. 1.Computer aided design of Double Pipe heat exchanger
2. Computer aided design of, Shell and Tube heat exchanger
3. Computer aided design of condensers
4. Computer aided design of multiple effect evaporates
5. Computer aided design of sieve tray distillation column
6. Computer aided design of sieve packed bed distillation column
7. Computer aided design of valve tray distillation column
8. 8.Computer aided design of sieve tray absorber
9. Computer aided design of packed bed absorber
10. 10 Computer aided design of extraction unit
11. Computer aided design of mixing process
12. Computer aided design of CSTR
13. 13 Computer aided design of Plug flow reactor
14. Computer aided design of fluidized bed reactor

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**CFD Lab**	Subject Code	**CL41222 (CL)**
Semester	M. Tech. ï 2nd Semester	Board of Studies	Chemical Engg.
Maximum Marks	20	Minimum marks	10
		Practical Periods/Week	Credits
		3	2

Details of Course:

List of Practical

1. Fluid flow and heat transfer in mixing tee
2. Cooling with natural convection and radiation
3. External compressible flow
4. Temperature study in a control room of a chemical plant
5. Modeling turbulent flow in a CSTR
6. Modeling flow and heat transfer in packed bed
7. Modeling the effect of sedimentation concentration in a secondary clarifier
8. Fluid flow and heat transfer in mixing elbow
9. Modeling air cooling in a coil of an heat exchanger
10. Modeling time dependent flow through a nozzle
11. Flow and thermal modeling of a head lamp
12. Modeling film cooling problem using non conformal mesh
13. Modeling flow through porous media
14. Modeling a rotating disk
15. Modeling multiple rotating reference frames

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Membrane separation**	Subject Code	**CL41311(CL)**
Semester	M. Tech. ï 3rd Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit I
Principles of membrane separation, Types of membranes, membrane processes classification, characterization and preparation of membranes.

Unit II
Analysis and modelling of of membrane separation, membrane modules and applications. Transport Theory in membranes ï porous membrane, bulk flow, liquid diffusion in pores, Gas Diffusion.

Unit III
Non-Porous Membranes ï solution diffusion for liquid mixtures and gas mixtures, module flow patterns, control, polarization and fouling. Metal membranes and ceramic membranes.

Unit IV
Dialysis and Electro dialysis, Reverse osmosis ï membrane materials-sea water and brackish water Desalination membranes. Nanofillration, Gas permeation.

Unit V
Per Vaporation, ullrafiltration, Microfiltration, Constant-flux operation, constant pressure operation. Combined operation and Industrial application.

Textbooks

1. Separation Process by King. J McGraw ï Hill
2. Separation Process Principles by ï J.D. Seader / Ernest J. Henley.
3. Member Technology and Applications - Richard w. Baker.

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Advance Wastewater Treatment**	Subject Code	**CL41331(CL)**
Semester	M. Tech. ï 3rd Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit I

Introduction, Impact of regulation on the waste engineering, Health and environment concern in wastewater management. Water quality: Definitions, characteristics and perspectives. The hydraulic cycle, Water quality, Physical, chemical and biological water quality parameters.

Unit II

Measurement of organic concentration, BOD, COD and TOC Test, reaction between BOD,COD, & TOC, Most probable number (MPN), Measurement of biological characteristics, Toxicity Test.

Unit III

Reactor used for transient of wastewater mass balance analysis, Modeling of ideal flow in reactor, Modeling of treatment process, Kinetic of processes, Process selection.

Unit IV

Physical unit operation vis: Screening, mixing, Gravity separation, Particle seething theory, Primary sedimentation, Coagulation, Secondary treatment of waste water, adsorption.

Unit V

Biological waste water treatment, Micro-organism growth kinetics, modeling of suspended froth treatment process, Aerobic biological oxidation,Anaerobic process, heavy metal pollution remedies

Name of Text Books

1. Metcalf and Eddy, Wastewater Engineering: Treatment And Reuse, Tata McGraw Hill publication, India.
2. Peavy H.S., Rowe D.R., Tchobanoglous, G. Environment Engineering, McGraw Hill Book Company, New Delhi.
3. Levenspiel O., Chemical Reaction Enggineerinmg, John Wiley and Sons publication
4. Treybal R.E., Mass Transfer Operations, McGraw-Hill publication.
5. Coulson & Richardson vol-II, Butterworth Heinemann Publication, New Delhi.

NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR
CHEMICAL ENGINEERING DEPARTMENT

Name of Subject	**Industrial and Municipal Solid Waste Management**	Subject Code	**CL41332(CL)**
Semester	M. Tech. ï 3rd Semester	Board of Studies	Chemical Engg.
Maximum Marks	70	Minimum marks	25
Lecture period works	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	0	4

Details of Course:

Unit I

Introduction: Classification of industrial wastes, Characterization of industrial and municipal solid wastes (MSW).

Unit II

Rules and guidelines for waste handling, storage, treatment and management. Minimization of waste generation and recycle and reuse option.

Unit III

Municipal Solid Wastes (MSW): Handling, storage and management of MSW. Value extraction from MSW.

Unit IV

Landfill, biocomposting, mechanical and biological treatment (MBT), thermomechanical and thermal processing. Landfill gas and leachate management. Design of typical landfill, biocompost and thermal processing units.

Unit V

Industrial Solid Wastes (ISW): Hazardous and non-hazardous waste; Handling, storage and management of non-hazardous ISW. Bio-chemical, chemical and thermal treatment of ISW. Energy and material extraction from ISW. Case studies of a few industries for solid wastes handling, storage and management.

Name of Text Books

1. Tchobangolous G., Theisen H. and Vigil S.A., ñIntegrated Solid Waste Management: Engineering Principles and Management Issuesò, McGraw Hill. 1993

2. Tedder D.W. and Pohland F.G., ñEmerging Technologies in Hazardous Waste Managementò, ACS. 1990

3. Pichtel J., ñWaste Management Practices: Municipal, Hazardous and Industrialò, CRC. 2005

4. Conway R.A. and Ross R.D., ñHandbook of Industrial Waste Disposalò, Van-Nostrand Reinhold. 1980

5. ñPollution Control Acts, Rules, Notifications issued there underò CPCB, Ministry of Env. and Forest, G.O.I., 3rd Ed. 2006