ACCREDITED BY NAAC

A-GRADE

COURSE STRUCTURE AND SYLLABUS

M. TECH (CHEMICAL TECHNOLOGY)

CHOICE BASED CREDIT SYSTEM (CBCS)

(With effect from 2022-2023)

CENTRE FOR CHEMICAL SCIENCES AND TECHNOLOGY

UNIVERSITY COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY, HYDERABAD (UCESTH)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

KUKATPALLY, HYDERABAD-500085, TELANGANA

CENTRE FOR CHEMICAL SCIENCES & TECHNOLOGY

UNIVERSITY COLLEGE OF ENGINEERING SCIENCE AND TECHNOLOGY

COURSE SCHEME FOR M.TECH

M.TECH SEMESTER - I

Course Number	Subject	Scheme of Studies Per Week			Credits	Int Marks	Ext Marks
		L	T	P			
1CTPC01	Program Core-I Mathematical and Statistical Methods in Chemical Engineering	3	0	0	3	40	60
1 CTPC02	Program Core-II Advanced Separation Processes	3	0	0	3	40	60
1 CTPE03	Programme Elective -I 1. Fluidization Engineering 2. Process Modeling & Simulation 3. Biochemical Engineering	3	0	0	3	40	60
1CTPE04	Programme Elective –II 1. Modern concepts in Catalysis and Surface Phenomenon 2. Advanced Chemical Engineering Thermodynamics 3. Advanced Fluid Dynamics & Heat Transfer	3	0	0	3	40	60
1A01	Research Methodology & Intellectual Property Rights	2	0	0	2	40	60
1A02	Audit course-I 1. English for Research Paper Writing 2. Disaster Management 3.Sanskrit for Technical Knowledge 4.Value Education 5.Constitution of India 6. Pedagogy Studies 7. Stress Management by Yoga 8. Personality Development through Life Enlightenment Skills	2	0	0	0	00	00
1CTL05	Chemical Process Simulation Lab	0	0	4	2	40	60
1CTL06	Advanced Separation Processes Lab	0	0	4	2	40	60
TOTAL		**16**	**0**	**08**	**18**	**280**	**420**

(L: Lecture Period, T: Tutorial Periods, P: Practical Periods)

M.TECH SEMESTER - II

Course Number	Subject	Scheme of Studies Per Week			Credits	Int Marks	Ext Marks
		L	T	P			
2CTPC07	Programme Core-III Advanced Transport Phenomena	3	0	0	3	40	60
2CTPC08	Programme Core-IV Advanced Reaction Engineering	3	0	0	3	40	60
2CTPE09	Programme Elective –III 1. Air and Water Pollution Control Engineering 2. Process Design & Synthesis 3. Advanced Process Control	3	0	0	3	40	60
2 CTPE10	Programme Elective- IV 1. Process Intensification 2. Solid Waste Treatment & Management 3. Optimization Techniques in Chemical Engineering	3	0	0	3	40	60
2A03	Audit Course-II 1. English for Research Paper Writing 2. Disaster Management 3.Sanskrit for Technical Knowledge 4.Value Education 5.Constitution of India 6. Pedagogy Studies 7. Stress Management by Yoga 8. Personality Development through Life Enlightenment Skills	2	0	0	0	00	00
2CTL11	Advanced Chemical Reaction Engineering Lab	0	0	4	2	40	60
2CTL12	Advanced Chemical Engineering Lab	0	0	4	2	40	60
2CT13	Mini Project with Seminar	0	0	4	2	100	00
Total		**14**	**0**	**12**	**18**	**340**	**360**

(L: Lecture Period, T: Tutorial Periods, P: Practical Periods)

*Students are encouraged to go to Industrial Training/ Internship for at least 2-3 months during semester break.

M.TECH SEMESTER - III

Course Number	Subject	Scheme of Studies Per Week			Credits	Int Marks	Ext Marks
		L	**T**	**P**			
3CTPE14	Programme Elective-V 1. Computational Fluid Dynamics 2. Petroleum Refinery Engineering 3. Applications of Nanotechnology	3	0	0	3	40	60
3CTOE15	Open Elective 1. Industrial Safety & Hazard Analysis 2. Fuel Cell Technology 3. Corrosion Engineering 4. Unit Operations and Optimization 5.Composite Materials 6.Waste to Energy	3	0	0	3	40	60
	Dissertation– I						
	a) Dissertation Work Review-I	0			0	0	0
3CT16	b) Dissertation Work Review-II	0	0	20	10	100	0
Total		**06**	**0**	**20**	**16**	**180**	**120**

(L: Lecture Period, T: Tutorial Periods, P: Practical Periods)

Students going for Industrial Project/ Thesis will complete these courses through MOOCs.

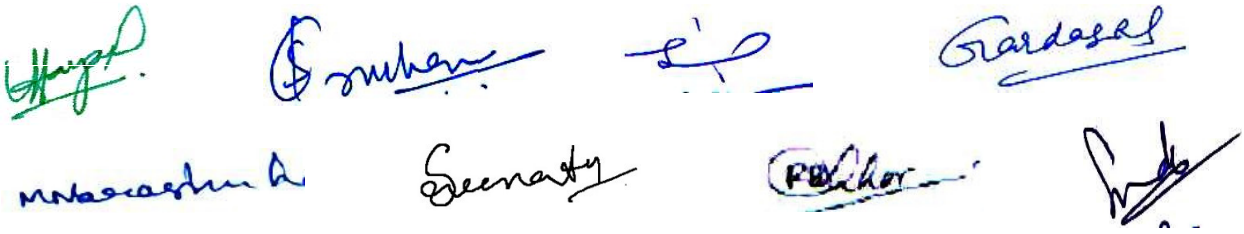
M.TECH SEMESTER - IV

Course Number	Subject	Scheme of studies per week			Credits	Int Marks	Ext Marks
		L	T	P			
4CT17	Dissertation Work Review - III	0	0	32	8	100	00
4CT18	Viva-Voce	0	0	0	8	00	100
Total		**0**	**0**	**32**	**16**	**100**	**100**

(L: Lecture Period, T: Tutorial Periods, P: Practical Periods)

Total Marks: 700+700+300+200 = 1900

TOTAL CREDITS OF THE PROGRAM: 18+18+16+16 = 68



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
MATHEMATICAL AND STATISTICAL METHODS IN CHEMICAL ENGINEERING (1CTPC01)

Teaching Scheme: Lecture: 3 hrs/week.

Course Objectives:

1. To give students an insight into various Chemical Engineering Processes using advanced Numerical and Statistical Methods.
2. To provide adequate background of Mathematics to deal with Chemical Engineering Problems
3. To understand research papers on relevant topics involving advanced Mathematics.
4. To study correlation and regression of multivariate data.
5. To evaluate Experimental design methods and statistical quality control measures.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	3	2	3	3

UNIT-I

Vectors & Vector Spaces: Fundamentals of Vector Spaces, Generalized concepts of vector space, sub-space, , Concept of basis, , and norms defined on general vector spaces, Examples of norms defined on different vector spaces, Matrices norms and Inner Products, linear dependence & dimension, An application concept of linear dependence, Gram-schmidt Orthonoramalisation Examples.

Equation Forms in Process Modeling, Introduction and Motivation, Linear and Nonlinear Algebraic Equation, ODE-IVPs and Differential Algebraic Equations, ODE-BVPs and PDEs.

UNIT-II

Function Approximation: Introduction, Least Square-Fit (Linear Regression), Newton's Interpolation Formulae, Newton's divided Difference Interpolation Polynomial, Taylor series approximation, Lagrangian interpolation (unequal intervals), Pade approximations.

Newton's Method for solving non-linear algebraic equation as an application of multivariable Taylor series Finite difference method for solving ODE-BVPs with examples, Finite difference method for solving PDEs with examples, Orthogonal Collocations method for solving ODE-BVPs, Orthogonal Collocations method for solving ODE-BVPs with examples.

UNIT-III

Solving Linear Algebraic Equations, System of linear algebraic equations, conditions for existence of solution - geometric interpretations (row picture and column picture), review of concepts of rank and fundamental theorem of linear algebra, Classification of solution approaches as direct and iterative, review of Gaussian elimination, , Block-diagonal, triangular and block-triangular systems. Iterative methods: Derivation of Jacobi, Gauss-Siedel and successive over-relaxation methods, Convergence of iterative solution schemes: analysis of asymptotic behavior of linear difference equations using Eigen values, Convergence of iterative solution schemes with examples, Convergence of iterative solution schemes.

UNIT-IV

Solving Non-linear Algebraic Equations, Method of successive substitutions derivative free iterative solution approaches, Secant method, regula-falsi method and Wegsteine iterations, Modified Newton's method and qausi-Newton method with Broyden's update.

UNIT-V

Solving Ordinary Differential Equations, Initial Value Problems (ODE-IVPs), Introduction, Existence of Solutions (optional topic), Explicit Adams –Bash forth Techniques, Implicit Adams-Moulton Techniques, General Multi-step Integration Methods(for multivariable ODE-IVPs), Predictor-Corrector Techniques, derivation and examples Runge-Kutta methods.

Text Books:

1. S. Pushpavanam, Mathematical Methods in chemical engineering, Eastern Economy Edition, 2005.
2. Philips, G. M.,Taylor, P. J. ; Theory and Applications of Numerical Analysis (2nd Ed.), Academic Press, 1996.
3. Gupta, S. K.; Numerical Methods for Engineers.Wiley Eastern, New Delhi, 1995.

Reference Books:

1. S. Pushpavanam, Mathematical Methods in chemical engineering, Eastern Economy Edition, 2005.
2. Philips, G. M.,Taylor, P. J. ; Theory and Applications of Numerical Analysis (2nd Ed.), Academic Press, 1996.
3. Gourdin, A. and M Boumhrat; Applied Numerical Methods. Prentice Hall India, New Delhi, (2000).
4. Gupta, S. K.; Numerical Methods for Engineers.Wiley Eastern, New Delhi, 1995.
5. Linz, P.; Theoretical Numerical Analysis, Dover, New York, (1979).
6. Gilbert Strang , Introduction to Applied Mathematics, Wellesley Cambridge Press (2009)

Course Outcomes:

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

- Understand the principles of modeling and Fundamentals of Vector Spaces
- Solve system of linear algebraic equations using Gauss elimination, Gauss Jordan, Gauss

Siedel methods

- Solve Non-linear algebraic equations using Secant method, regula-falsi method, Wegsteine iterations, Modified Newton's method and qausi-Newton method .
- Understand about Problem Discretization techniques and also Finite difference methods
- Solve ordinary differential equations by Euler's method, modified Euler's method, Runge Kutta method, Predictor

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
ADVANCED SEPARATION PROCESSES (1CTPC02)

Teaching Scheme: Lecture: 3 hrs/week

Course Objectives:

- To familiarize students with various advanced aspects of separation processes and the Selection of separation processes.
- To make the students understand the fundamental concepts behind the various separation processes. Separation and chromatography and to design an absorber or a membrane unit to achieve a Specified separation.
- Introduce them to new trends used in the separation technologies.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	2	3	2
CO2	3	3	2	3
CO3	3	3	3	3
CO4	3	3	3	3
CO5	2	3	3	3

UNIT-I

Introduction: Conventional separation processes - Absorption, Adsorption, Conventional separation processes - Distillation, Drying, Conventional separation processes - Extraction, Diffusion, Conventional separation processes - Leaching, Crystallization, separation techniques based on size, Advances in separation techniques based on surface properties, Advances in separation techniques based on ionic properties, Thermodynamic consistency test for VLE data, Phase rule and degrees of freedom estimations. Bubble- point and Dew- point calculations; Flash calculations, Estimation of state of the mixture.

UNIT-II

Multi Component Separation Processes: Product qualities and theoretical stages of equilibrium based separations Multi component distillation Introduction. Key components; Estimation of minimum theoretical stages (Fenske's equation, Distribution of non-key components in overhead and bottom products at total reflux. Determination of minimum reflux ratio (Underwood's method); approximate calculation shortcut methods for multi component, multistage distillation (estimation of actual reflux ratio and theoretical stages): Fenske-Underwood-Gilliland method; Feed- Stage Location (Kirke-Bride's equation); Distribution of non-key component at actual reflux.

UNIT-III

Fundamentals of Membrane Separations, microfiltration, ultra filtration, osmosis, Reverse osmosis, electro dialysis, gas separation, pervaporation, dialysis (qualitative treatment only). Types and choice of membranes, Plate and frame, spiral wound membranes, Tubular and hollow fiber membrane reactors.

UNIT-IV

Characteristics of Organic and Inorganic Membranes, basis of membrane selection, osmotic pressure, partition coefficient and permeability, concentration polarization, electrolyte diffusion and facilitated transport, Liquid membrane separation.

UNIT-V

Special Processes: Super-critical extraction, Pressure swing adsorption (PSA). Chromatographic Methods of Separation: Gel, Solvent, Ion and High Performance Liquid Chromatography.

Text Books:

1. King C.J., "Separation Processes", Tata McGraw Hill. 1982.
2. Khoury F.M., "Multistage Separation Processes", 3rd Ed., CRC Press. 2004.
3. Humphrey, J and G. Keller, Separation Process Technology, McGraw-Hill, 1997

Reference Books:

1. Nakagawal, O. V., "Membrane Science and Technology", Marcel Dekker, 1992.
2. Wankat P.C., "Separation Process Engineering", 2nd Ed., Prentice Hall.2006.
3. Seader J.D. and Henley E.J., "Separation Process Principles", 2nd Ed., Wiley.2006
4. Basmadjian D., "Mass Transfer and Separation Processes: Principles and Applications", 2nd Ed., CRC Press.2007.
5. Phillip C. Wankat, Separation Process Engineering (2nd Edition), Prentice Hall, 2007
6. Rousseau, R. W., "Handbook of Separation Process Technology", John Wiley, New York, 2009.

Course Outcomes:

After completing the course, the students will be able to:

- List situations where liquid–liquid extraction might be preferred to distillation, make a preliminary selection of a solvent using group-interaction rule. Separation techniques based on surface properties
- Explain how crystals grow, Explain the importance of super saturation in crystallization. Describe effects of mixing on super saturation, mass transfer, growth, and scale-up of crystallization.
- Facilitate the students with the novel techniques that are required in downstream processing of biotechnology based industries.
- Explain membrane processes in terms of the membrane, feed, sweep, retentate permeate, and solute membrane interactions.
- Distinguish among microfiltration, ultra filtration Nanofiltration, virus filtration, and reverse osmosis in terms of average pore size. Explain common idealized flow patterns in membrane modules.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
FLUIDIZATION ENGINEERING (1CTPE03)

Teaching Scheme: Lecture: 3 hrs/week

Course Objectives

- To study the phenomenon of fluidization with industrial processing objective
- To study the various regimes of fluidization and their mapping.
- To study the design of equipments based on fluidization technique

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	2	3	3	3
CO2	3	3	2	3
CO3	2	3	3	3
CO4	3	3	3	3
CO5	3	2	3	2

UNIT-I

Introduction to Fluidization and Applications Phenomenon of fluidization, behavior of fluidized bed, contacting modes, advantages and disadvantages of fluidization, fluidization quality, selection of contacting mode, Beds for Industrial applications, coal gasification, synthesis reactions, physical operations, cracking of hydrocarbons.

UNIT-II

Mapping of Fluidization Regimes Characterization of Particles, mechanics of flow around single 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-III

Bubbling Fluidized Beds Davidson model for bubble in a fluidized bed, and its implications, the wake region and movement of solids at bubbles, coalescence and splitting of bubbles, bubble formation above a distributor, slug flow, Turbulent and fast fluidization - mechanics, flow regimes and design equations, Emulsion movement, estimation of bed properties, bubble rise velocity, scale up aspects, flow models, two phase model, K-L model.

UNIT-IV

Solids Movement and Gas Dispersion Vertical and horizontal movement of solids, Dispersion model, large solids in beds of smaller particles, staging of fluidized beds Gas dispersion in beds, gas interchange between bubble and emulsion, estimation of gas interchange coefficient, Heat and mass transfer in fluidized systems, Mixing in fluidized systems - measurements and models.

UNIT V

Fluidized Bed Reactors Entrainment and elutriation, Freeboard behavior, gas outlet, entrainment from tall vessel, freeboard entrainment model, high velocity fluidization, pressure drop in turbulent and fast fluidization, Slugging, Spouted beds, Circulating Fluidized Beds. Mathematical model of a homogeneous fluidized bed, Design of catalytic reactors, pilot plant reactors, information for design, bench scale reactors, design decisions, deactivating catalysts,Design of noncatalytic reactors, kinetic models for conversion of solids, models for shrinking particles, conversion of solids of unchanging size.

Text Books:

1. D. Kunii and O. Levenspiel, Fluidization Engineering, Butterworth, 1991.
2. D. Gidaspow, Multiphase flow and fluidization: continuum and kinetic theory description, Elsevier Science & Technology Books, 1993
3. L.G. Gibilaro, Fluidization-dynamics, Butterworth-Heinemann, 2001
4. S. K. Majumder, Hydrodynamics and Transport Processes of Inverse Bubbly Flow, 1st ed. Elsevier, Amsterdam (2016)

Reference Books:

1. Levenspiel O. and Kunnii D., "Fluidization Engineering", John Wiley, 1972
2. Liang-Shih Fan, "Gas-Liquid-Solid Fluidization Engineering", Butterworth, 1989.
3. Fluidization Engineering, 2nd ed., D. Kunii and O. Levenspiel, Butterworth- Heinemann, London, 1999.

Course Outcomes:

After completing the course, the students will be able to:

- Learn various industrial applications of fluidization.
- Explain the various fluidization regimes, classification of particles.
- Describe the K-L bubbling model.
- Describe the staging of fluidized beds, and calculation of the exchange coefficient.
- Understanding the applicability of the fluidized beds in chemical industries.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Sem (I Year), Chemical Technology

PROCESS MODELING AND SIMULATION (1CTPE03)

Teaching Scheme: Lecture: 3 hrs/week

Course Objectives:

- Learn to develop mathematical model for problems.
- Formulate a chemical engineering problem as a mathematical model, and select an appropriate solution method.
- To study the modeling & simulation techniques of chemical processes and to gain skills in using process simulators.
- Understand the computational requirements of various solution options and use this understanding in the selection of the solution method

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	3
CO2	3	3	2	2
CO3	3	2	3	3
CO4	3	2	2	3
CO5	3	3	3	3

UNIT-I

Introduction and Fundamental laws:
Introduction: Uses of mathematical models, Principles of formulation, Fundamental laws: Continuity Equations, Energy Equation, Equations of Motion, Transport equations, Equation of state, Equilibrium, Chemical Kinetics.

Classification of Mathematical models: steady state Vs dynamic models, lumped Vs distributed parameter models, deterministic Vs stochastic models.

UNIT-II

Numerical Methods: Introduction, Iterative Convergence Methods: Interval Halving, Newton-Raphson Method, False Position, Explicit Convergence Methods, Wegstein Method, Muller Method. Numerical Integration of Ordinary Differential Equations: Explicit, Method, Implicit Method.

UNIT-III

Examples of Mathematical models of Chemical Engineering Systems: Series of isothermal, constant- holdup CSTRs, Two heated tanks, Gas- Phase Pressurized CSTR, Non-isothermal CSTR, batch reactor, reactor with mass transfer, ideal binary distillation column.

UNIT-IV

Process Simulation Examples: binary distillation column, gravity flow tank, Non- isothermal CSTR, batch reactor, VLE dew point and bubble point calculations, countercurrent heat exchanger.
Process Simulation using Modular and Equation for Solving Approaches: Developing a

simulation model, a simple flow sheet, Sequential modular approach, Simultaneous modular approach, Equation solving approach.

UNIT-V

Artificial Intelligence & Machine Learning: Introduction of Artificial Intelligence (AI), Arithmetic, Lists, and Recursion, Backtracking and Program Control, Input and Output, Application of AI in Chemical Process Modeling, Application of AI in Optimization of Chemical Processes, Application of Neural Networks in Chemical Process Control.

Introduction of Machine Learning (ML), Learning Decision Trees, Linear Regression, Support Vector Machine, Learning in Neural Networks, Emerging Machine Learning Challenges in Chemical Engineering, Established Machine Learning Methods in Chemical Engineering: Unsupervised Learning, Supervised Learning.

Text Books:

1. Process modeling, Simulation and Control for Chemical Engineers, 2nd ed., W. L. Luyben, McGraw-Hill, New York, 1990.
2. An introduction to computational fluid dynamics, H. Versteeg, W, Malalasehra.
3. Computational Fluid Flow and Heat Transfer, K. Muralidhar, T. Sundararajan.

Reference Books:

1. Numerical Methods for Engineers and Scientists, S.S. Rao
2. Process Plant Simulation, B.V Babu, Oxford University Press, 2004.
3. Process Modeling and Simulation, Amiya K. Jana, 2012.
4. Versteeg, H.K., Malalasekera, W., an Introduction to Computational Fluid Dynamics - The Finite Volume Method, Longman
5. Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers- Rudra Pratap.

Course Outcomes:

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

- Classify different types of mathematical models
- Develop mathematical model for the given chemical engineering equipment from basic engineering principles.
- Solve PDEs using different numerical methods.
- Simulate binary distillation column, gravity flow tank, batch reactor, Non- isothermal CSTR, and counter-current heat exchanger.
- Learn the basic principles of Computational Fluid Dynamics with some examples and simulate the model equations using numerical methods.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
BIOCHEMICAL ENGINEERING (1CTPE03)

Teaching Scheme: Lecture: 3 hrs/week

Course Objectives:

- To introduce the classification of microorganisms based on the structure and characteristics of various types of cells
- To inform the importance of chemicals like lipids, sugars, polysaccharides, amino acids and proteins
- To teach the kinetics of enzyme catalyzed reactions and the effect of various parameters on enzyme activity and kinetics
- To educate the methods of enzyme immobilization and the applications of immobilized enzymes
- To train on various downstream processing strategies for product recovery and purification

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	3	2	3	3
CO4	3	3	3	2
CO5	3	2	3	2

UNIT-I

Introduction to Microbiology: Biophysics and the cell doctrine, the structure of cells, important cell types, from nucleotides to RNA and DNA, amino acids into proteins. Kinetics of enzyme catalyzed reaction: the enzyme substrate complex and enzyme action, simple enzyme kinetics with one and two substrates, other patterns of substrate concentration dependence, modulation and regulation of enzyme activity, other influences on enzyme activity.

UNIT-II

Immobilized Enzyme Technology: enzyme immobilization, industrial processes, utilization and regeneration of cofactors. Immobilized enzyme kinetics: effect of external mass transfer resistance, analysis of intraparticle diffusion and reaction.

Kinetics of cellular growth in batch and continuous culture, models for cellular growth – unstructured, structured and cybernetic models. Thermal death kinetics of cells and spores.

UNIT-III

Introduction to Metabolic Pathways, biosynthesis, transport across cell membranes, end products of metabolism, stoichiometry of cell growth and product formation.

Design and Analysis of Biological Reactors: batch reactors, fed-batch reactors, enzyme catalyzed reactions in CSTR, CSTR reactors with recycle and cell growth, ideal plug flow reactors, sterilization reactors, sterilization of gases, packed bed reactors using immobilized catalysts. Fermentation technology: medium formulation, design and operation of a typical aseptic, aerobic fermentation

process.

UNIT-IV

Transport Phenomena in Bioprocess Systems: Gas-liquid mass transfer in cellular systems, determination of oxygen transfer rates, overall k_La' estimates and power requirements for sparged and agitated vessels, scaling of mass transfer equipment, heat transfer.

UNIT-V

Downstream Processing: Strategies to recover and purify products; separation of insoluble products-filtration and centrifugation; cell disruption-mechanical and non-mechanical methods; separation of soluble products: liquid-liquid extractions, membrane separation (dialysis, ultra filtration and reverse osmosis), chromatographic separation-gel permeation chromatography, electrophoresis, final steps in purification – crystallization and drying.

Text Books:

1. Biochemical Engineering Fundamentals, 2nd ed., J.E. Bailey and D.F. Ollis, Mc-Graw Hill, New York, 1987.
2. Bioprocess Engineering, 2nd ed., M. L. Shuler and F. Kargi, PHI Learning Pvt. Ltd, New Delhi, 2009.
3. Biochemical Engineering by H. W.Blanch & D.S. Clark, Marcel Dekker, Inc., 1997.

Reference Books:

1. Biochemical Engineering, J. M. Lee, Prentice-Hall, New Jersey 1992.
2. Bioprocess Engineering Principles, P. M. Doran, Elsevier, Gurgaon, 2005.
3. Biochemical Engineering Fundamentals by J.E.Bailey & D. F. Ollis, McGraw Hill Book Company, 1986.
4. Biochemical Engineering by H. W.Blanch & D.S. Clark, Marcel Dekker, Inc., 1997.
5. Bioprocess Engineering (Basic Concepts) by M. L.Shuler & F.Kargi,Prentice Hall of India, 2003.

Course Outcomes:

After completing the course, the student will be able to:

- Classify microorganisms based on the structure and characteristics of various types of cells
- Analyze the kinetics of enzyme catalyzed reactions
- Explain the methods of enzyme immobilization and the applications of immobilized enzymes
- Evaluate the kinetics of cell growth including substrate utilization and product formation
- Identify various downstream processing strategies for product recovery and purification

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
MODERN CONCEPTS IN CATALYSIS AND SURFACE PHENOMENA (1CTPE04)

Teaching Scheme: Lecture: 3 hrs/week

Course Objectives:

- To give the students insight into advances in catalytic reaction engineering
- To understand the mechanisms involved in catalytic reactions
- To study the catalyst characterization techniques
- To study the advanced industrial applications in catalysis
- To understand the principles behind catalyst deactivation and study their models.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	2	3	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	2	2	3	3

UNIT-I

Introduction to Catalysis Definition of catalytic activity, Magnitude of turnover frequencies and active site concentrations, Evolution of important concepts and techniques in heterogeneous catalysis, Classification of catalysts – Homogeneous, Heterogeneous, Biocatalysts, Dual functional catalysts, Enzymes, Solid catalysts, Powder catalysts, pellets, Composition, Active ingredients, Supportive materials, Catalysts activation, Catalyst deactivation.

UNIT-II

Catalysis Adsorption and its Importance, Adsorption and potential energy curves, Surface Reconstruction, Adsorption isotherms and isobars, Dynamical considerations, Types of adsorption isotherms and their derivation from kinetic principles, Mobility at surfaces, Kinetics of surface reactions, Photochemistry on oxide and metallic surfaces, Characterization of the adsorbed molecules.

UNIT-III

Catalyst Characterization Methods – Their Working Principle and Applications – XRF, XRD, IR Spectroscopy, XPS, UPS, ESR, NMR; Infrared, Raman, NMR, Mossbauer and X-Ray Absorption spectroscopy, Surface Acidity and Toxicity, Activity, Life time, Bulk density, Thermal stability Crystal Defects, Peroviskites, Spinels, Clays, Pillared Clays, Zeolites

UNIT-IV

Significance of Pore Structure and Surface area Importance of surface area and pore structure, Experimental methods for estimating surface area – Volumetric, Gravimetric, Dynamic methods, Experimental methods for estimating pore volume and diameter – Gas adsorption and mercury porosimeter method, Models of the pore structure – Hysteresis loops, Geometric models, Wheeler's model, Dusty gas model, Random pore model, Diffusion in porous catalysts – Effective diffusivity,

Knudsen diffusion, Effect of intraparticle diffusion, Non-isothermal reactions in pores, Diffusion control.

UNIT-V

Industrial Applications– Case Studies Industrial processes involving heterogeneous solid catalyst: Synthesis of Methanol, Fischer- Tropsch Catalysis, Synthesis of Ammonia, Automobile Exhaust Catalysts and Catalyst Monolith, Photo catalytic Breakdown of Water and the Harnessing of Solar Energy. Contribution of homogeneous catalytic process in chemical industry: Oxidations of Alkenes such as production of acetaldehyde, propylene oxide etc., Polymerization such as production of polyethylene, polypropylene or polyester production

Text Books:

1. Emmett, P.H. - "Catalysis Vol. I and II, Reinhold Corp.", New York, 1954.
2. Smith, J.M. - "Chemical Engineering Kinetics ", McGraw Hill, 1971.
3. Thomas and Thomas - "Introduction to Heterogeneous Catalysts ", Academic Press, London 1967.
4. C. H. Bartholomew and R. J. Farrauto, Fundamentals of Industrial catalytic Processes, Wiley, VCH, 2006

Reference Books:

1. Emmett, P.H. - "Catalysis Vol. I and II, Reinhold Corp.", New York, 1954.
2. Smith, J.M. - "Chemical Engineering Kinetics ", McGraw Hill, 1971.
3. Thomas and Thomas - "Introduction to Heterogeneous Catalysts ", Academic Press, London 1967
4. Piet W.N.M. van Leeuwen, Homogeneous catalysis: Understanding the Art, Springer, 2004
5. Piet W.N.M. van Leeuwen, and John C. Chadwick, Homogeneous catalysis: Activity-stability – deactivation, Wiley, VCH, 2011.
6. Catalytic Chemistry :Bruce Gates.
7. Chorkendorff, J.W Niemantsverdriet 'Concept of Modern Catalysis and Kinetics'.
8. R.A Sheldon, I.Arends, U. Hanefeld 'Green Chemistry and Catalysis'.
9. M.A.Vennices 'Kinetics of catalytic reactions'.

Course Outcomes: After completing the course, the student will be able to:

- Understand the concepts of homogenous and heterogeneous catalysis, with specific examples.
- Analyze the reaction mechanisms and kinetics of homogenous and heterogeneous catalytic reactions.
- Understand the characterization of catalysts
- Explain the application and mechanisms of several types of catalysts in chemical industry.
- Understand the principles behind catalyst deactivation and study their models.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS (1CTPE04)

Teaching Scheme: Lecture: 3 hrs/week

Course Objectives:

- To give an insight of molecular and statistical thermodynamics.
- To Acquire the knowledge of Molecular theories of activity coefficients, lattice models, multi-phase multi-component phase equilibrium, VLE/SLE/LLE/VLLE, chemical equilibrium, Chemical Reaction Equilibrium.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	3
CO2	3	2	2	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	3	2	3	2

UNIT-I

Basic Relations: Review of basic postulates, Maxwell's relations, Legendre transformation, , theory of corresponding states pure component properties - entropy change of an ideal gas - the ideal gas - Behavior of real gases - equations of state isothermal and adiabatic compressibility.

Equilibrium, phase rule, single component phase diagrams, introduction to multi -component multi - phase equilibrium.

UNIT-II

Introduction to Molecular Thermodynamics: Molecular Theory of Fluids, Second Virial Coefficients from Potential Functions, Internal Energy of Ideal Gases: Microscopic view, Thermodynamic Properties and Statistical Mechanics , Hydrogen Bonding and Charge-Transfer Complexing , Behaviour of Excess Properties , Molecular Basis for Mixture Behaviour, VLE by Molecular Simulation.

UNIT-III

Phase Equilibria at Low to Moderate Pressures: Phase behavior for VLE system, Azeotropic mixture, the increment of boiling point and decrement of freezing point, phase diagram, properties of composite liquids at critical region. Margule's equation, Van- Laar equation, Wilson equation. NRTL equation, UNIFAC method, Dew point, Bubble point and flash calculations.

UNIT-IV

Introduction to Classical Statistical Mechanics, phase space, Louiville equation, crystals, intermolecular forces and potential energy functions, imperfect mono atomic gases, molecular theory of corresponding states, introduction to molecular simulations.

UNIT-V

Molecular Theories of Activity Coefficients, lattice models, multi-phase multi-component phase equilibrium, Vapour-Liquid Equilibria (VLE)/Solid-Liquid Equilibria (SLE)/Liquid-Liquid Equilibria LLE/ Vapour-Liquid-Liquid Equilibria (VLLE), Chemical equilibrium, Chemical Reaction Equilibria.

Text Books:

1. J.M. Prausnitz, R.M. Lichtenthaler and E.G. Azevedo, Molecular thermodynamics of Fluid-phase Euilibria (3rd edition) Prentice Hall Inc., New Jersey, 1996.
2. S. I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, 4th Ed., Wiley India, 2006.
3. M.D. Koretsky, Engineering and Chemical Thermodynamics, Wiley India, 2004.
4. J. M. Smith, H. C. V. Ness and M.M. Abott, Introduction to Chemical Engineering Thermodynamics, McGraw Hill, 2003.

Reference Books:

1. H. Terrel, An Introduction to Statistical Thermodynamics, Dover, 1960
2. M.P. Allen, DJ Tildesley, Computer Simulation of Liquids, Oxford, 1989
3. J.M smith. H.C.V. Ness and M.M. Abott, Introduction to Chemical engineering thermodynamics" Mc-Graw Hill International Edition (5th Edn). 1996.
4. J. M. Prausnitz, R. N. Lichtenthaler and E. G. de Azevedo, Molecular Thermodynamics of Fluid Phase Equilibria, Prentice Hall, 1999.
5. T. Letcher, Chemical Thermodynamics for Industry, Royal Society of Chemistry, London, 2004.
6. 6. A. Firoozabadi and F. Abbas, Thermodynamics of Hydrocarbon reservoirs, McGraw Hill Professional Publishing, 1999.

Course Outcomes: After completing the course, the student will be able to:

- Understand the thermodynamic basic postulates, Maxwell's relations, Legendre transformation, pure component properties
- Derive Second Virial Coefficients from Potential Functions
- Apply the knowledge of mathematics, science and engineering fundamentals to model the phase behavior for VLE system.
- Communicate effectively the concepts of the phase space, Louiville equation, crystals, intermolecular forces and potential energy functions, imperfect mono atomic gases
- Acquire the knowledge of VLE/SLE/LLE/VLLE and Chemical Reaction Equilibrium.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
ADVANCED FLUID DYNAMICS AND HEAT TRANSFER (1CTPE04)

Teaching Scheme: Lecture: 3 hrs/week

Course Objectives:

- To teach the properties of Newtonian fluids
- To develop steady state mechanical energy balance equation for fluid flow systems, estimate pressure drop in fluid flow systems and determine performance characteristics of fluid machinery.
- To explain the dynamics of fluid flows and the governing non-dimensional parameters, apply concepts of mass, momentum and energy conservation to flows, Grasp the basic ideas of turbulence.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	2	3	2	3
CO3	2	2	3	3
CO4	3	3	3	3
CO5	3	2	3	3

UNIT-I

Properties of Fluids and Multiphase Flow: introduction: fluids and fluid properties, basic equations for flowing streams, flow of incompressible fluids, fundamental Principles of conservation, Reynolds Transport theorem, conservation of mass, conservation of linear momentum, Navier- Stokes equation, Conservation of energy, Newtonian, non- Newtonian and non-viscous fluids, determination of flow properties of fluids, flow in pipes and tanks, flow through packed bed and fluidized beds.

UNIT II

Boundary Layer Theory and Statistical Theory of Turbulence: laminar flow in closed conduits, potential flow, boundary layer theory, hydrodynamic stability, turbulence-statistical theory, measurement of turbulence intensity, turbulent flow in closed conduits, dimensional analysis in fluid dynamics.

UNIT III

Heat Transfer in Fluids: Combination of heat transfer resistance, steady and unsteady state heat conduction, Unsteady state heating and cooling of solid objects, Transient heat conduction, Convection heat transfer co-efficient, Dimensional analysis in convection heat transfer, Heat transfer during Laminar and Turbulent flow in closed conduits-Empirical correlation for high Prandtl Number of fluids.

UNIT IV

Recent Developments in Heat Exchangers: Analogy between momentum and heat transfer. Recent developments in the design of compact heat exchangers: Heat Exchanger Design, Heat Exchanger

Elements, Heat Exchanger Systems, Transient Behaviour, Regenerators, Heat Exchangers under Extreme Conditions, Heat Exchangers with Two-Phase Systems, Packed Beds, Heat Exchangers with Direct Contact, insulation design and selection

UNIT V

Heat Transfer with Phase Change

Heat transfer to Boiling Liquids: Pool Boiling of Saturated Liquids, Nucleate and Film boiling, Maximum Flux and Critical Temperature Drop. Condensation heat transfer: Film type and Dropwise condensation, Coefficients for Film type condensation, Heat transfer in Liquid metals, Flow in shell side of heat exchanger.

Text Books

1. J.G. Knudsen and D.L. Katz," Fluid Dynamics and Heat Transfer", McGraw Hill, New York, 1958.
2. O. Levenspiel, Engineering flow and Heat Exchange", Plenum Press, New York, 1998.
3. McCabe, W. L.,Smith, J. C., and Harriott,P.,"Unit Operations of Chemical Engineering", McGraw-Hill, 6th.Ed., 2001
4. Coulson, J.M., Richardson, J.F.,"Chemical Engineering",Vol. I.,Pergamon and ECBS, 1970.
5. Chapman,A.J."Heat Transfer", 4th edn. Maxwell Macmillan International Edition, 1984

Reference Books:

1. V. L. Streeter, “Fluid Dynamics”, Mc-Graw Hill, New York, 1965.
2. J.P. Hollman, “Heat Transfer”, Mc-Graw Hill, New York, 1968.
3. O. Levenspiel, Engineering flow and Heat Exchange", Plenum Press, New York, 1998.
4. Muralidhar K, and Sundararajan T. “Computational fluid flow and heat transfer” 2 nd edition, Narosa Publishing House, New Delhi, 2003.
5. Schlichting,H. and Gersten,K. “Boundary layer theory” 8 th edition, Springer Verlag, Berlin, 2000.

Course Outcomes:

After completing the course, the student will be able to

- Understand stress-strain relationship in fluids, classify their behavior and also establish force balance in static systems.
- Students will develop dimensionless groups that help in scale-up and scale-down of fluid flow systems and apply Bernoulli principle and compute pressure drop in flow systems of different configurations
- Understand Properties of fluids and multiphase flow, describe the mechanism of thermal conduction,
- Analyze the performance aspects of heat transfer with phase change
- Solve numerical problems involving heat Transfer

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
RESEARCH METHODOLOGY AND IPR (1A01)

Teaching Scheme: Lectures: 1hrs/week

UNIT-I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT-II

Effective literature studies approaches, analysis Plagiarism, Research ethics.

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT-III

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT

UNIT-IV

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT-V

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Reference Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd , 2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.

Course Outcomes:

After completing the course, the student will be able to

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Sem (I Year), Chemical Technology

AUDIT COURSE: ENGLISH FOR RESEARCH PAPER WRITING (1A02)

Course Objectives:

Students will be able to:

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title

Ensure the good quality of paper at very first-time submission

	Syllabus	
Units	**Contents**	**Hours**
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	4
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	4
4	Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.	4
5	Skills are needed when writing the Methods, skills needed when writing the 4 Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.	4
6	useful phrases, how to ensure paper is as good as it could possibly be the first-time submission.	4

Suggested Studies:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
4. Adrian Wall work , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
AUDIT COURSE: DISASTER MANAGEMENT (1A02)

Course Objectives:-Students will be able to:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in Specific types of disasters and conflict situations.
4. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Units	Syllabus	Hours
1	**Disaster:** Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.	4
2	**Repercussions of Disasters and Hazards**: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.	4
3	**Disaster Prone Areas In India** Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards With Special Reference to Tsunami; Post-Disaster Diseases and Epidemics	4
4	**Disaster Preparedness and Management** Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and other Agencies, Media Reports: Governmental and Community Preparedness.	4
5	**Risk Assessment** Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival	4
6	**Disaster Mitigation** Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.	4

Suggested Readings:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
AUDIT COURSE: SANSKRIT FOR TECHNICAL KNOWLEDGE (1A02)

Course Objectives:

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Syllabus

Unit	Content	Hours
1	• Alphabets in Sanskrit, • Past/Present/Future Tense, • Simple Sentences	8
2	• Order • Introduction of roots • Technical information about Sanskrit Literature	8
3	• Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	8

Suggested reading

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi

2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Output

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
AUDIT COURSE: VALUE EDUCATION (1A02)

Course Objectives:

Students will be able to

1. Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

Syllabus

Unit	Content	Hours
1	• Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. • Moral and non- moral valuation. Standards and principles. • Value judgments	4
2	• Importance of cultivation of values. • Sense of duty, Devotion, Self- reliance, Confidence, Concentration.Truthfulness, Cleanliness. • Honesty, Humanity.Power of faith, National Unity. • Patriotism. Love for nature ,Discipline	6
3	• Personality and Behaviour Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. • Punctuality, Love and Kindness. • Avoid fault Thinking. • Free from anger, Dignity of labor. • Universal brotherhood and religious tolerance. • True friendship. • Happiness Vs suffering, love for truth. • Aware of self-destructive habits. • Association and Cooperation. • Doing best for saving nature	6
4	• Character and Competence –Holy books vs Blind faith. • Self-management and Good health. • Science of reincarnation. • Equality, Non violence, Humility, Role of Women. • Mind your Mind, Self-control. • Honesty, Studying effectively	6

Suggested reading

1 Chakroborty , S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press ,New Delhi

Course outcomes

Students will be able to

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
AUDIT COURSE: CONSTITUTION OF INDIA (1A02)

Course Objectives:

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Syllabus

Units	Content	Hours
1	**History of Making of the Indian Constitution:** • History • Drafting Committee, (Composition & Working)	4
2	**Philosophy of the Indian Constitution:** • Preamble • Salient Features	4
3	**Contours of Constitutional Rights & Duties:** • Fundamental Rights • Right to Equality • Right to Freedom • Right against Exploitation • Right to Freedom of Religion • Cultural and Educational Rights • Right to Constitutional Remedies • Directive Principles of State Policy • Fundamental Duties.	4
4	**Organs of Governance** • Parliament • Composition • Qualifications and Disqualifications • Powers and Functions • Executive • President • Governor • Council of Ministers • Judiciary, Appointment and Transfer of Judges, Qualifications • Powers and Functions	4
5	**Local Administration:** • District's Administration head: Role and Importance,	4

	• Municipalities: Introduction, Mayor and role of Elected Representative, Municipal Corporation. • Pachayati raj: Introduction, PRI: Zila Pachayat. • Elected officials and their roles, CEO Zila Pachayat: Position and role. • Block level: Organizational Hierarchy (Different departments), • Village level: Role of Elected and Appointed officials, • Importance of grass root democracy	
6	**Election Commission:** • Election Commission: Role and Functioning. • Chief Election Commissioner and Election Commissioners. • State Election Commission: Role and Functioning. • Institute and Bodies for the welfare of SC/ST/OBC and women.	4

Suggested Reading

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
AUDIT COURSE: PEDAGOGY STUDIES (1A02)

Course Objectives:

Students will be able to:
1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Syllabus

Units	Content	Hours
1	• **Introduction and Methodology:** • Aims and rationale, Policy background, Conceptual framework and terminology • Theories of learning, Curriculum, Teacher education. • Conceptual framework, Research questions**.** • Overview of methodology and Searching.	4
2	**Thematic overview:** Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. • Curriculum, Teacher education.	2
3	• Evidence on the effectiveness of pedagogical practices • Methodology for the in depth stage: quality assessment of included studies. • How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? • Theory of change • Strength and nature of the body of evidence for effective pedagogical practices. • Pedagogic theory and pedagogical approaches. • Teachers' attitudes and beliefs and Pedagogic strategies.	4
4	Professional development: alignment with classroom practices follow-up support • Peer support • Support from the head teacher and the community. • Curriculum and assessment • Barriers to learning: limited resources and large class sizes	4
5	**Research gaps and future directions** • Research design • Contexts • Pedagogy • Teacher education • Curriculum and assessment • Dissemination and research impact.	2

Suggested Reading:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Outcomes:

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
AUDIT COURSE: STRESS MANAGEMENT BY YOGA (1A02)

Course Objectives

1. To achieve overall health of body and mind
2. To overcome stress

Suggested reading

1. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

Course Outcomes:

Students will be able to:
1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

Unit	Content	Hours
1	• Definitions of Eight parts of yog. (Ashtanga	8
2	• Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	8
3	• Asan and Pranayam i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects-Types pranayam	8

Suggested Reading:

1. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
AUDIT COURSE: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (1A02)

Course Objectives:

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Syllabus

Unit	Content	Hours
1	Neetisatakam-Holistic development of personality • Verses- 19,20,21,22(wisdom) • Verses- 29,31,32 (pride & heroism) • Verses- 26,28,63,65(virtue) • Verses- 52,53,59 (dont's) • Verses- 71,73,75,78(do's)	8
2	• Approach to day to day work and duties. • Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48, Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,Chapter 18-Verses 45, 46, 48.	8
3	• Statements of basic knowledge. • Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 • Chapter 12 -Verses 13, 14, 15, 16,17, 18 • Personality of Role model. Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42 • Chapter 4-Verses 18, 38,39 • Chapter18 – Verses 37,38,63	8

Suggested Reading

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes

Students will be able to

1. Study of Shrimad- Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
CHEMICAL PROCESS SIMULATION LABORATORY (1CTL05)

Laboratory Scheme: Lecture: 4 h/week

Objectives:

- To learn Process Modeling and Simulation of Chemical operations and processes.
- To understand Dynamic Behavior of processes.
- To understand Close loop control of processes.
- To learn Dynamic simulation of chemical processes.
- To get acquainted with Controllability Analysis of chemical processes.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	3	2	3	3

List of experiments: Simulation laboratory practical

1. Thermodynamic property estimations using property estimation and property analysis in Aspen.
2. Simulate Mixer, splitter, heat exchangers, and reactive distillation column.
3. Apply sensitivity, design specification and case study tools in Aspen
4. Solve linear and non-linear programming problems.
5. Controller tuning by Ziegler- Nichol's & Cohen- Coon methods
6. Stability analysis using Bode diagrams for control systems.
7. Simulation of Ideal Binary Distillation Column
8. Simulation of Heat/Mass Transfer coefficient in 3 phase fluidized bed column
9. Simulation studies of various unit operations using CHEMCAD.
10. Modeling and Simulation of cyclone separator

Note: Simulation can be done using C/C++ / MATLAB Package/ ASPEN PLUS/ CHEMCAD

Outcomes: After completing the course, the student will be able to
Carry out thermodynamic property estimations using property estimation and property analysis in Aspen.

- Simulate Mixer, splitter, heat exchangers, reactors, distillation columns.
- Apply sensitivity, design specification and case study tools in Aspen.
- Solve linear and non-linear programming problems.
- To carry out Techno-economic feasibility using the simulation
- To apply the knowledge in ASPEN PLUS/ CHEMCAD.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Sem (I Year), Chemical Technology
ADVANCED SEPARATION PROCESSES LABORATORY (1CTL06)

Laboratory Scheme: Lecture: 4 h/week

Objectives:

- To familiarize students with various advanced aspects of separation processes and the selection of separation processes.
- To enable students to understand the principles and processes of adsorption, membrane separation and chromatography and to design an absorber or a membrane unit to achieve a specified separation.
- To introduce them to new trends used in the separation technologies.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	3	2	3	3

List of Experiments:

1. Study the reaction with mass transfer: e.g. Synthesis of calcium carbonate.
2. Batch distillation with reflux
3. Liquid- Liquid Equilibria (Tie-line data)
4. Ternary Liquid Equilibria (binodal curve)
5. Determination of stage efficiency using counter-current leaching
6. Preparation of activated carbon from biomass.
7. Separation of moisture from air using silica gel
8. Bio-oil production from waste biomass by Pyrolysis Process,
9. Bio-mass waste to biogas/syngas production
10. Elemental analysis of biomass

Outcomes: After completing the course, the student will be able to

- Knowledge of mass transfer operations and mechanical operations
- To know the synthesis of materials and applications in separation processes.
- To provide applicable solutions to separation processes.
- To apply the knowledge about the operations of Waste to Energy Plants.
- To analyse the various aspects of Waste to Energy Management Systems.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
ADVANCED TRANSPORT PHENOMENA (2CTPC07)

Teaching Scheme: Lecture: 3 hrs/week

Course Objectives:

- To familiarize the student with basic concepts of transport phenomena and brief review of mathematics.
- To enable students to understand the equations of change for isothermal flow and for non isothermal flow.
- To introduce them details of equations of change for multi component systems.
- To give them insight into properties of two-dimensional flows and aspects of dimensional analysis

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	3	2	3	3

UNIT-I

Equations of Change for Isothermal Systems: Equation of Continuity, Equation of motion, Equation of mechanical energy, Equations of change in terms of the substantial derivative, Use of the equations to solve flow problems, Dimensional analysis of the equations of change. Velocity distributions with more than one independent variable: Time dependent flow of newtonian fluids. Velocity distributions in turbulent flow -Comparisons of laminar and turbulent flows, Time smoothed equations of change for incompressible fluids, Time smoothed velocity profile near a wall, Empirical expressions for the turbulent momentum flux, Turbulent flow in ducts, Turbulent flow in jets.

UNIT-II

Macroscopic Balances for Isothermal Systems: The Macroscopic mass balance, The Macroscopic momentum balance, The Macroscopic mechanical energy balance, Estimation of the viscous loss, Use of the macroscopic balances for steady-state problems, Derivation of the macroscopic mechanical energy balance. Equations of change for non-isothermal systems: The Energy equation, Special forms of the energy equation, The Boussine sq Equation of Motion for Forced and Free Convection, Use of the equations of change to solve steady-state problems, Dimensional analysis of the equations of change for non-isothermal systems.

UNIT-III

Temperature Distributions in Solids and in Laminar Flow: Heat conduction with an electrical heat source, Heat conduction with a viscous heat source. Temperature distributions with more than one independent variable - Unsteady heat conduction in solids, Steady heat conduction in laminar,

Incompressible flow. Temperature distributions in turbulent flow - Time smoothed equations of change for incompressible non-isothermal flow, Time-Smoothed temperature profile near a wall, Empirical expressions for the turbulent heat flux temperature distribution for turbulent flow in tubes.

UNIT-1V

Macroscopic Balances for Non-Isothermal Systems: Macroscopic energy balance, Macroscopic mechanical energy balance, Concentration distributions in solids and in laminar flow: Shell Mass balances boundary conditions, Diffusion through a stagnant gas film, Diffusion with a heterogeneous chemical reaction. Concentration distributions with more than one independent variable: Time-Dependent diffusion, Time-Smoothed concentration, Time-Smoothing of the equation of continuity of A, Semi-Empirical expressions for the turbulent mass flux, Enhancement of mass transfer by a first-order reaction in turbulent flow.

UNIT-V

Interphase Transport in Multi-Component Systems: Definition of transfer coefficients in one phase, Analytical expressions for mass transfer coefficients, Correlation of binary transfer coefficients in one phase, Definition of transfer coefficients in two phases, Mass transfer and chemical reactions. Macroscopic Balances For Multi-Component Systems: Macroscopic mass balances, Macroscopic Momentum, Use of the macroscopic balances to solve steady-state problems.

Text Books:

1. L. Gary Leal, Advanced Transport Phenomena, University of California, Santa Barbara, 2007
2. Transport Processes in Chemically Reacting Flow Systems ", Rosner, Daniel E; Dover 2000.
3. Transport Phenomena in Micro Process Engineering by Norbert Kockmann, 2008
4. Advanced transport phenomena by John Charles Slattery, 1999

Reference Books:

1. Thomson W. J., Transport Phenomena, Pearson education, Asia, 2001.
2. Geankopolis C. J., Transport Processes and Unit Operations, 4th Ed., Prentice Hall (India) Pvt. Ltd., New Delhi. 2004.
3. Bird R. B., Stewart W. E. and Light Foot E. N., Transport Phenomena, Revised 2nd Edition, John Wiley & Sons, 2007.
4. Transport phenomena fundamentals by Joel L. Plawsky, 2001
5. Analysis of transport phenomena, by William Murray Deen, 1998

Course Outcomes: After completing the course, the student will be able to

- Understand the mechanism of momentum, heat and mass transport for steady and unsteady flow.
- Perform momentum, energy and mass balances for a given system at macroscopic and microscopic scale.
- Solve the governing equations to obtain velocity, temperature and concentration profiles.
- Model the momentum, heat and mass transport under turbulent conditions.
- Develop analogies among momentum, energy and mass transport.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
ADVANCED REACTION ENGINEERING (2CTPC08)

Teaching Scheme: Lecture: 3 hrs/week

Course Objective:

- To teach the design of reactor especially for heterogeneous reactions.
- To explain the energy balance, temperature and concentration profiles in different reactors, advance design aspects of multiple reactors;
- To give an insight of importance of population balance of particles. Role of Reaction Engineering in mitigation of global warming.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	3	2	3	3

UNIT-I

Preliminary Considerations in Chemical Reaction Engineering: Process design consideration for batch reactor, CSTR, PFR, Fluidized bed reactor and other reactors.

Design and operation of reactors for adiabatic, isothermal, non-isothermal conditions; Optimal performance for maximum production rate in batch reactor, CSTR, PFR reactors, Modes of operation and design aspects for semi-batch and semi-continuous reactors.

UNIT-II

Transport Processes in Heterogeneous Reactions
External mass and heat transport: Binary Diffusion, Effect of the reaction rate coefficients for surface reactions and effect of external mass transfer resistance on order of reaction and activation energy of reaction. Design and operation of PFR with recycle for constant and variable density systems. Comparison of reactors and their combinations, multiple reactor configurations.

UNIT-III

Intra-particle Diffusion: Concept of effectiveness factor and Thiele modulus and their relationships, Derivation of differential equation describing diffusion and reaction, solution to the differential Equation for a first order reaction, falsified Kinetics, Internal and external effectiveness factor. Effect of internal resistance on catalyst selectivity and poisoning.

UNIT-IV

Heterogeneous Catalytic Fixed bed Reactor Analysis and Design
Types of reactors and mode of operations: Design considerations, Contour plots of raction rate vs. temperature and extent of reaction for exothermic, reversible reactions.
Reactor Models: One Dimensional Models, Two dimensional Models of Pseudo-homogeneous and

Heterogeneous with Plug flow.

UNIT-V

Design for Fluidized bed and three Phase Reactors (Gas-Liquid-Solid)

Fluidized bed reactor models: Two phase model, KL model, Operating characteristics of FBRs. Mass Transfer in Fluidized Beds: Gas-Solid Mass Transfer, Mass Transfer between the Fluidized-Bed Phases, and Reaction in Fluidized Bed. Trickle bed reactor Models, Slurry reactor models.

Text Books:

1. J.M.Smith "Chemical Engineering Kinetics" 3rd ED., Mc Graw Hill, New York 1980
2. Froment G.F. AND Bischoff K.B., "Chemical reactor Analysis and Design" John Wiley, 1990
3. Fogler S.H., Elements of Chemical Reaction Eng.", 3rd Ed., Prentice Hall, 1999
4. Levenspiel, O., "Chemical Reaction Eng." John Wiley & Sons 1997.

Reference Books

1. R.W. Missen, CA Mims, B A Saville, "Introduction to Chemical Reaction Engineering and Kinetic Wiley & Sons, Inc., 1999.
2. J.M.Smith "Chemical Engineering Kinetics" 3rd ED., Mc Graw Hill, New York 1980
3. Froment G.F. AND Bischoff K.B., "Chemical reactor Analysis and Design" John Wiley, 1990
4. Fogler S.H., Elements of Chemical Reaction Eng.", 3rd Ed., Prentice Hall, 1999
5. Levenspiel, O., "Chemical Reaction Eng." John Wiley & Sons 1972.
6. RE Hayns and J.P Mmbaga, "Introduction to chemical reactor analysis", 2nd Edn, CRC press, 2012

Course Outcomes:

After completing the course, the student will be able to

- Ability to analyze chemical reactors, types of model reactors and reaction systems
- Develop experiments involvin chemical reactors, and analyzing and interpreting data
- Understand to solve problems of mass transfer with reaction in solid catalyzed reactions
- Determine the operating conditions for reactions at which maximum conversion of desired product can be achieved.
- Catalyst and design multiple reactors and their evaluation of performance, development of concepts of heterogeneous system and applications.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
AIR AND WATER POLLUTION CONTROL ENGINEERING (2CTPE09)

Teaching Scheme: Lecture: 3 hrs/week

Course Objective:

- The course will provide knowledge of the various pollutants, the regulatory standards, cleaning up technologies and the removal methods of various pollutants from industries.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	3	2	3	3

UNIT-I

Introduction: Water and Wastewater, Characteristics and monitoring, sampling techniques and sample preparation for water and wastewater, Traditional and advanced analytical techniques for various parameters in water and waste water.
Physicochemical processes for water and waste water quality control: Equalization, Neutralization, Aeration, Sedimentation, Coagulation and Flocculation, Filtration, Disinfection, Adsorption and Ion Exchange.

UNIT-II

Biological Treatment Processes for Wastewater Quality Control: Fundamentals of Monod kinetics and application in bioreactor design principles, concepts, types and modifications of aerobic and anaerobic, suspended- growth and attached- growth treatments, Concepts of natural treatment systems, such as, Aerated lagoons, Stabilization ponds, Oxidation ditches, etc

UNIT-III

Sludge Treatment: Chemical, Biological, Incineration and disposal of sludge solids
Advanced Wastewater treatment: Nutrient removal treatments, Membrane Technologies, Advanced Oxidation Processes
Reuses of Wastewater: Concept of gray water, reuse and recycle of wastewater in industrial and agricultural purpose

UNIT-IV

Elements of Air Pollution: History of air pollution, Natural versus Polluted atmosphere, Air quality and monitoring, Source of air pollution, Effects of air pollution, regulatory control of air pollution, Stack and ambient air sampling, Collection techniques for gaseous and particulate air pollutants.
Engineering Control of Air Pollution: Control of stationery sources and mobile sources, Concept, design of control devices & system like Industrial ventilation system, Settling Chambers, Bag Filters, Inertial devices (Cyclone Separator), Electrostatic Precipitators, Particulate scrubbers etc.

UNIT-V

Control of Vehicular air Pollution: Vehicle emission standards and fuel quality, Inspection and certification programme, Catalytic converter- Concept, application and design; Various models related to air pollution treatment; Case studies from chemical industries: Air Pollution assessment and control in Petrochemical, Pharmaceutical, dyes and intermediate and other process industries.

Text Books:

1. Wastewater Treatment for Pollution Control and Reuse, by Soli J Archeivala Shyam R Asolekar, McGraw Hill Publications.
2. Wastewater Engineering: Treatment and Reuse, by George Techobanolous Franklin L. Burton, H David Stensel, Metcalf and Eddy Inc.
3. Air Pollution: Its Origin and Control by Kenneth Wark, Cecil F. Warner, Addlison, Wesley Longman.
4. Air Pollution Control Theory by Martin Crawford, McGraw Hill.

Reference Books:

1. Air and Water Pollution Control Engineering by D. N. Ghosh, S. K. Ghosh, New Central Book Agency, 2012.
2. Water Supply & Sanitary Engineering - Including Environmental Engineering & Pollution Control Act's 9th Edition (English, Paperback, J. S. Birdie, G. S. Birdie), 9th Edition, 2014.
3. Water Pollution & Treatment (Sugar Industries) by Rajeev Tyagi.
4. Air Pollution Control Engineering for Environmental Engineers (Fundamentals of Environmental Engineering) Hardcover, 2018.
5. Environmental Pollution And Control By J. Jeffrey Peirce, University Of Wisconsin At Madison; P Aarne Vesilind; Ruth Weiner, Johns Hopkins University, 1997.
6. Air Environment And Pollution by Dr. Purohit SS, Kakrani B, Agrobios, 2018.
7. Air and Water Quality Assessment, Contamination and our Surroundings by Ramesh Chandra Deka, Smita Chowdhury, Dikshita Dowerah, Pankaj Gogoi, Debajyoti Bhattacharjee, Bhupesh Kumar Mishra, Nand Kishor Gaur, Krishna Gopal Bhattacharyya, Debasish Dutta, Nishant Biswakarma, Pakiza Begum, Plaban Jyoti Sarma, 2019.

Course Outcomes: After completing the course, the student will be able to

- Recognize the causes and effects of environmental pollution
- Analyze the mechanism of proliferation of pollution
- Develop methods for pollution abatement and waste minimization
- Understand Water and Wastewater, Characteristics and monitoring, sampling techniques and sample preparation for water and wastewater, Traditional and advanced analytical techniques for various parameters in water and waste water.
- Acquire the Fundamentals and application in bioreactor design principles, concepts, types and modifications of aerobic and anaerobic, suspended- growth and attached- growth treatments

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
CHEMICAL PROCESS DESIGN AND SYNTHESIS (2CTPE09)

Teaching Scheme: Lecture: 3 hrs/week

Course Objectives:

- To understand the systematic approaches for the development of conceptual chemical process designs
- To learn the advances in problem formulation and software capabilities which offer the promise of a new generation of practical process synthesis techniques based directly on structural optimization.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	3	2	3	3

NIT-I

Introduction to fundamental concepts and principles of process synthesis and design and use of flow sheet simulators to assist process design. Process Flow sheet Models: An Introduction to Design, Chemical process synthesis, analysis and optimization. Introduction to commercial process design software such as HYSYS, Aspen plus etc., Chemical Process (reactor, heat exchanger, distillation etc) analysis using commercial software

UNIT-II

Product Design and Developments Process engineering economics and project evaluation Life Cycle Assessments of process: From design to product development, Engineering Economic Analysis of Chemical Processes, Project costing and performance analysis, Environmental concerns, Green engineering, Engineering ethics, Health and safety.

UNIT-III

Reactor Networks Geometry of mixing and basic reactor types, The Attainable Region (AR) approach, AR in higher dimensions & for other processes, Reactive Separation processes, Fundamental behavior and problems, Separation through reactions. Reactive Residue Curve Maps

UNIT-IV

Synthesis of Separation Trains Criteria for selection of Separation methods, Select ion of equipment, Ideal distillation - Column and sequence fundamentals, Sharp splits & sequencing Phase diagrams for 2, 3 and 4 components, Feasibility and vapor ow rates for single columns, Residue curve basics, Non-ideal Distillation - Azeotropic systems; detecting binary azeotropes, Residue curve maps for azeotropic systems, Topological analysis, Feasibility for single azeotropic columns, Binary VLLE and pressure swing separation, Non-ideal distillation synthesis. Equipment sequencing: VLE + VLLE, Detailed Residue Curve Maps, Residue curve maps: Interior structure

UNIT-V

Heat Exchanger network synthesis minimum heating and cooling requirements, Minimum Energy Heat Exchanger Network, Loops and Paths, Reducing Number of Exchangers, HENS basics & graphics, The pinch point approach, Stream Splitting, Performance targets, trade-off & utilities, Heat & power integration, HENS as mathematical programming

Reference Books:

1. Douglas, J. "Conceptual Design of Chemical Processes", New York, NY: McGraw-Hill Science/Engineering/Math, 1988. ISBN: 0070177627.
2. Seider, W. D., J. D. Seader, and D. R. Lewin. "Product and Process Design Principles: Synthesis, Analysis, and Evaluation",. 2nd ed. New York, NY: Wiley, 2004. ISBN: 0471216631.
3. Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwitz., "Analysis, Synthesis, and Design of Chemical Processes", 2nd Edition, 2002, Prentice Hall ISBN-10: 0-13-064792-6
4. Biegler L.T., Grossmann I.E. and Westerberg A.W., "Systematic Methods of Chemical Process Design", Prentice Hall, 1997.

Course Outcomes:

After completing the course, the student will be able to

- Analyze alternative processes and equipment
- Synthesize a chemical process flow sheet that would approximate the real process
- Design best process flow sheet for a given product
- Perform economic analysis related to process design and evaluate project profitability

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
ADVANCED PROCESS CONTROL (2CTPE09)

Teaching Scheme: Lecture: 3 hrs/week

Course Objectives:

- Develop mathematical and transfer function models for dynamic processes.
- Analyze process stability and dynamic responses.
- Empirically determine process dynamics for step response data**.**
- Ability to understand feed forward control, cascade control and Smith predictors and their applications.
- Knowledge of real time applications of process control implementation.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	3	2	3	3

UNIT-I

Review of Single Input Single Out Put (SISO) Systems: Review of first and second order systems transfer functions, Response of First order system, Properties of Transfer function, Response of First order systems. Examples of First Order systems: liquid level process with constant flow outlet, mixing process, and heating process. Response of First Order systems in series: Interacting systems & Non-interacting systems, open loop and closed loop stability aspects. Introduction to Frequency response: Substitution rule, Bode plots.

UNIT-II

Internal Model Control (IMC): Internal Model control structure, Design of IMC Controller, Design of IMC Controller for the process of First Order, Design of IMC Controller for the process of First Order with transport lag.

Non-linear Systems and Sontrol: Nonlinear control, Phase plane analysis, Phase plane analysis of damped oscillator, The Damped Oscillator, Application to Chemical reactors.

UNIT-III

Cascade, feed forward and ratio control: Analysis and design of cascade control, feed forward control, Analysis of Feed forward control, Implementing Feedforward Transfer Functions, tuning rules for feedforward feedback control, feedforward rules, ratio control schemes with application.

UNIT-IV

Model Predictive Control: Constrained and unconstrained model predictive control, design and application of model predictive control, State estimation and Prediction, Future Trajectory prediction, Constraints on Inputs, Moving Horizon Formulation, dynamic matrix control and its design procedure.

UNIT-V

State Space Methods: State Space representation of physical systems: State variables, State space description, Selection of state variables, Transfer function matrix, Transition matrix, Solution of state space models.

Text Books:

1. Process control: Modeling, Design and simulation, B.Wayne Bequette PHI, 2003.
2. Process systems analysis and control- Donald R. Coughanowr ,Mc-Graw Hill, Inc 2nd Edition, 1991
3. Astrom,K. J., and B. Wittenmark, Computer Controlled Systems,Prentice Hall India (1994).
4. Franklin, G. F.,Powell, J. D., and M. L. Workman, Digital Control Systems,Addison Wesley, 1990.
5. Process Dynamics and Control, D.E.Seborg, T. F.Edgar, D.A. Mellichamp, Wiley, 2003.

Reference Books:

1. Chemical Process Control, G. Stephanopoulos, PHI Learning Pvt. Ltd., New Delhi, 2010
2. Control System Design, by Graham C. Goodwin,Stefan F. Graebe, Mario E. Salgado,Prentice Hall, 2000.
3. Stephanopoulos, G.(1984)."Chemical process control: an introduction to theory and practice," Prentice-Hall, New Delhi.
4. Seborg, D.E.,Edgar, T.F. and Mellichamp, D.A.(2003). "Process dynamics and control," Wiley, New York.
5. Smith, C.A. and Corripio,A.B.(1997)."Principles and practice of automatic process control," Wiley, New York.
6. Johnson, C.D.(2006)."Process control instrumentation technology," Prentice-Hall, New Delhi.

Course Outcomes:

After completing the course, the student will be able to

- Develop the transfer functions for first order systems such as liquid level, mixing tank and derive the transfer functions of second order systems
- Solve the IMC structures, IMC design & implementation Nonlinear control, phase plane analysis, application to chemical reactors Specify the required instrumentation and final elements to ensure that well-tuned control is achieved.
- Design & Analyze the use of block diagrams & the mathematical basis for the design of control systems, Analysis and design of cascade control, feed forward controllers and their derivation based on dynamic models, tuning & design of feed forward controllers, ratio control schemes with application
- Develop the constrained and unconstrained MPC, design and application of MPC, dynamic matrix control & its design procedure,
- Acquires the knowledge on the State Space representation of physical systems Understand the experimental implementation of advanced process control schemes and the methods for process monitoring and diagnosis

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
PROCESS INTENSIFICATION (2 CTPE10)

Teaching Scheme: Lecture: 3 hrs/week

Course Objectives:

- Understand the concept of Process Intensification.
- Know the limitations of intensification of the chemical processes.
- Apply the techniques of intensification to a range of chemical processes.
- Develop various process equipment used for intensifying the processes.
- Infer alternative solutions keeping in view point, the environmental protection, economic viability and social acceptance.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	3	2	3	3

UNIT-I

Introduction: Techniques of Process Intensification (PI) Applications, The philosophy and opportunities of Process Intensification, Main benefits from process intensification, Process Intensifying Equipment, Process intensification toolbox, Techniques for PI application.

Unit-II

Process Intensification through Micro Reaction Technology: Effect of miniaturization on unit operations and reactions, Implementation of Microreaction Technology, from basic Properties to Technical Design Rules, Inherent Process Restrictions in Miniaturized Devices and Their Potential Solutions, Microfabrication of Reaction and unit operation Devices - Wet and Dry Etching Processes.

Unit-III

Scales of Mixing, Flow patterns in reactors, Mixing in stirred tanks: Scale up of mixing, Heat transfer. Mixing in intensified equipment, Chemical Processing in High-Gravity Fields Atomizer Ultrasound Atomization, Nebulizers, High intensity inline MIXERS reactors Static mixers, Ejectors, Tee mixers, Impinging jets, Rotor stator mixers, Design Principles of static Mixers Applications of static mixers, Higee reactors.

Unit-IV

Combined Chemical Reactor Heat Exchangers: Principles of operation; Applications, Reactive absorption, Reactive distillation, Applications of RD Processes, Fundamentals of Process Modelling, Reactive Extraction Case Studies: Absorption of NOx Coke Gas Purification. Compact heat exchangers: Classification of compact heat exchangers, Plate heat exchangers, Spiral heat exchangers, Flow pattern, Heat transfer and pressure drop, Flat tube-and-fin heat exchangers, Microchannel heat exchangers, Phase-change heat transfer, Selection of heat exchanger technology, Feed/effluent heat exchangers, Integrated heat exchangers in separation processes, Design of compact heat exchanger -

example.

Unit-V

Enhanced Fields: Energy based intensifications, Sono-chemistry, Basics of cavitation, Cavitation Reactors, Flow over a rotating surface, Hydrodynamic cavitation applications, Cavitation reactor design, Nusselt-flow model and mass transfer, The Rotating Electrolytic Cell, Microwaves, Electrostatic fields, Sonocrystallization, Reactive separations, Superctrical fluids

Text Books:

1. Kamelia Boodhoo and Adam Harvey. Process Intensification for Green Chemistry Engineering Solutions for Sustainable Chemical Processing, Edited by Kamelia Boodhoo and Adam Harvey, School of Chemical Engineering & Advanced Materials Newcastle University, UK. Willey, 2013.
2. Juan¬Gabriel¬Segovia-Hernández¬ Adrián¬Bonilla-Petriciolet Editors, Process Intensi cation in Chemical Engineering Design Optimization and Control, Springer, 2016.
3. David Reay, Colin Ramshaw, and Adam Harvey, Process Intensification: Engineering for effgiciency, sustainability and flexibility, IchemE, 2nd edition, 2013, Elsevier.
4. S. K. Majumder, Hydrodynamics and Transport Processes of Inverse Bubbly Flow, 1st ed. Elsevier, Amsterdam (2016)

Reference Books:

1. Stankiewicz, A. and Moulijn, (Eds.), Reengineering the Chemical Process Plants, Process Intensification, Marcel Dekker, 2003.
2. Reay D., Ramshaw C., Harvey A., Process Intensification, Butterworth Heinemann, 2008.
3. Kamelia Boodhoo (Editor), Adam Harvey (Editor),Process Intensification Technologies for Green Chemistry: Engineering Solutions for Sustainable Chemical Processing, Wiley, 2013.
4. Segovia-Hernández, Juan Gabriel, Bonilla-Petriciolet, Adrián (Eds.)Process Intensification in Chemical Engineering Design Optimization and Control, Springer, 2016.
5. Reay, Ramshaw, Harvey, Process Intensification, Engineering for Efficiency, Sustainability and Flexibility, Butterworth-Heinemann, 2013.

Course Outcomes: At the completion of this course, students will be able to:

- Assess the values and limitations of process intensification, cleaner technologies and waste minimization options.
- Measure and monitor the usage of raw materials and wastes generating from production and frame the strategies for reduction, reuse and recycle.
- Obtain alternative solutions ensuring a more sustainable future based on environmental protection, economic viability and social acceptance.
- Analyze data, observe trends and relate this to other variables.
- Plan for research in new energy systems, materials and process intensification. Unit-I:

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
SOLID WASTE TREATMENT AND MANAGEMENT (2 CTPE10)

Teaching Scheme: Lecture: 3 hrs/week

Course Objectives:

- To understand the sources of solid and hazardous wastes.
- To understand methods of solid waste disposal.
- To evaluate the health risks posed by abandoned waste sites and waste disposal operations.
- To evaluate the legislation designed to control the production, cleanup and disposal of solid and hazardous waste disposal operations.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	3	2	3	3

UNIT-I

Sources and Characteristics of Solid Waste: Types solid wastes, Sources of solid wastes, Collection of solid wastes, Characteristics: Ultimate and Proximate analysis, Scanning Electronics Microscope, Fourier-transform infrared spectroscopy, X-ray Powder Diffraction, Solid waste volume reduction, Storage and transportation.

UNIT-II

Solid Waste Treatment System: Physical treatment Systems, Chemical treatment Systems and Biological treatment Systems, Reuse and recycling of solid waste- Incineration, Composting and Composting Plants.

UNIT-III

Ultimate Disposal: Landfill – Classification – Site selection parameters – Design aspects – Leachate control – Environmental monitoring system for Land Fill Gases, Liquids and soil condition.

UNIT-IV

Handling of Hazardous Wastes: Collection of hazardous wastes and care in handling quantities of hazardous wastes generated, Storage of hazardous wastes, Transportation and Shipment of hazardous wastes.
Final disposal of hazardous wastes: Site selection, incineration, Land filling, Leachates, Treatment and disposal.

UNIT-V

Biomedical Waste Management: Concepts, treatment, and legislations; Electronic Waste (e-waste) management- Concepts, treatment, and legislations ,case studies based on course content and related to process industries.

Text Books:

1. Integrated Solid Waste Management Engineering Principles and Management Issues by George Tchobanoglous, Hilary Theisen and Samual A Vigil, McGraw Hill Publishers
2. Hazardous Waste Management by Michael D. LaGrega, Phillip. L. Buckingham and Jeffery C Evans, Waveland Press Inc.
3. Parker, Colin and Roberts, Energy from Waste – An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985
4. Tchobanoglous, G. and Kreith, F., Handbook Of Solid Waste Management, McGraw Hill, 2002, 2nd Edition
5. Tchobanoglous, G., Theisen and Vigil, Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw Hill, 1993.

Reference Books:

1. Hazardous Waste Chemistry, Toxicology and Treatment, Stanley E. Manahan, Lewis Publishers, Chelsea, Michigan, 1990.
2. Waste Disposal in Engineered Landfills, Manoj Datta, Narosa Publishing House, 1997
3. Christensen, H. T., Solid Waste Technology & Management, Wiley, 2010, Volume 1 & 2
4. Haug, T. R., The Practical Handbook of Compost Engineering, Lewis Publishers, 1993
5. Reinhart, R. D. and Townsend, G. T., Landfill Bioreactor Design & Operation, CRC Press, 1997, 1st Edition

Course Outcome:

After completion of the course students should be able to

- Evaluate the subject from the technical, legal and economical points by learning of all terms related to general solid waste management.
- Understand municipal solid waste management system. Make physical and chemical analysis of municipal solid wastes and apply them for a management system that will be set up.
- Optimize site selection for a landfill, plan a solid waste management system for decision makers, and collect required data for a Solid Waste Management Plan.
- Analyze the problems of municipal waste, biomedical waste, hazardous waste, e-waste, industrial waste etc**.**
- Knowledge of legal, institutional and financial aspects of management of solid wastes. Become aware of Environment and health impacts solid waste mismanagement,

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
OPTIMIZATION TECHNIQUES IN CHEMICAL ENGINEERING (2 CTPE10)

Teaching Scheme: Lecture: 3 hrs/week

Course Objectives:

- To learn problem formulation of optimization.
- To realize the numerical methods of un-constrained optimization.
- To learn linear programming and its applications
- To understand the use of genetic algorithms in optimization
- To know the applications of numerical optimization.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	3	2	3	3

UNIT-I

Introduction to Process Optimization: formulation of various process optimization problems and their classification, Basic concepts of optimization-convex and concave functions, necessary and sufficient conditions for stationary points.

UNIT-II

Single Variable Optimization Methods: Bracketing methods, Exhaustive search method, Bounding phase method, Region elimination methods, Fibonacci search method, Golden section search method. Point-Estimation method: Successive quadratic estimation method.

UNIT-III

Gradient-Based Methods: Newton- Raphson method, Bisection method, Secant method, Cubic search method.

Multivariable Optimization Algorithms: Optimality criteria, Unidirectional search, Direct search methods: Evolutionary optimization method, simplex search method, Gradient-based methods: Cauchy's (steepest descent) method, Newton's method.

UNIT-IV

Constrained Optimization Algorithms: Kuhn-Tucker conditions, Transformation methods: Penalty function method, method of multipliers, Sensitivity analysis.

Direct search for constraint minimization: Variable elimination method, complex search method. Successive linear and quadratic programming, optimization of staged and discrete processes.

UNIT-V

Specialized and Non-traditional Algorithms: Integer Programming: Penalty function method. Non-traditional Optimization Algorithms

Genetic Algorithms: Working principles. Differences between GAs and traditional methods, similarities between GAS and traditional methods, GAs for constrained optimization.

Text Books:

1. Kalyanmoy Deb, Optimization for engineering design, Prentice Hail of India
2. Optimization of Chemical Processes – T. F. Edgar, D. M.Himmelblau and L. S. Lasdon, 2nd Edition, McGraw Hill, 2001.
3. Engineering Optimization: Methods and Applications - A. Ravindran, K. M. Ragsdell, G. V. Reklaitis, 2nd Edition, Wiley India, 2006.
4. Engineering Optimization: Theory and Practice - S. S. Rao, 4thEdition, John Wiley & Sons, Inc, 2009.

Reference Books:

1. G.S. Beveridge and R.S. Schechter, Optimization theory and practice, Mc Graw Hill, New York,
2. Reklljtis, G.V., Ravindran, A., and Ragdell, K.M., Engineering Optimization-Methods and Applications, John Wiley, New York,
3. S.S Rao, Optimization Theory and Applications. Wiley Eastern Ltd,1996
4. Operations Research- Theory & Applications, J. K. Sharma.

Course Outcomes:

After completion of the course students should be able to

- Apply the knowledge of optimization to formulate the problems. Analyze the optimization criterion for solving problems.
- Distinguish different methods of optimization and to suggest a technique for specific problem, Apply simplex method for linear optimization problems.
- Understand advanced optimization techniques like Genetic algorithms; understand how optimization can be used to solve the industrial problems of relevance to the chemical industry.
- Apply the basic theoretical principles in optimization, formulate the optimization problem, and choose appropriate method/solver for solution of the optimization problem.
- Analyze of different optimization techniques, Ability to solve various multivariable optimization problems

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – II Sem (I Year), Chemical Technology

AUDIT COURSE: ENGLISH FOR RESEARCH PAPER WRITING (2A03)

Course Objectives:

Students will be able to:

4. Understand that how to improve your writing skills and level of readability
5. Learn about what to write in each section
6. Understand the skills needed when writing a Title

Ensure the good quality of paper at very first-time submission

	Syllabus	
Units	**Contents**	**Hours**
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	4
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	4
4	Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.	4
5	Skills are needed when writing the Methods, skills needed when writing the 4 Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.	4
6	useful phrases, how to ensure paper is as good as it could possibly be the first-time submission.	4

Suggested Studies:

5. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
6. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
7. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book.
8. Adrian Wall work , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
AUDIT COURSE: DISASTER MANAGEMENT (2A03)

Course Objectives:-Students will be able to:

5. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
6. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
7. Develop an understanding of standards of humanitarian response and practical relevance in Specific types of disasters and conflict situations.
8. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Units	Syllabus	Hours
1	**Disaster:** Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.	4
2	**Repercussions of Disasters and Hazards**: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.	4
3	**Disaster Prone Areas In India** Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards With Special Reference to Tsunami; Post-Disaster Diseases and Epidemics	4
4	**Disaster Preparedness and Management** Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and other Agencies, Media Reports: Governmental and Community Preparedness.	4
5	**Risk Assessment** Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival	4
6	**Disaster Mitigation** Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.	4

Suggested Readings:

4. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
5. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
6. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
AUDIT COURSE: SANSKRIT FOR TECHNICAL KNOWLEDGE (2A03)

Course Objectives:

5. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
6. Learning of Sanskrit to improve brain functioning
7. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
8. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Syllabus

Unit	Content	Hours
1	• Alphabets in Sanskrit, • Past/Present/Future Tense, • Simple Sentences	8
2	• Order • Introduction of roots • Technical information about Sanskrit Literature	8
3	• Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	8

Suggested reading

4. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi

5. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

6. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Output

Students will be able to

4. Understanding basic Sanskrit language
5. Ancient Sanskrit literature about science & technology can be understood
6. Being a logical language will help to develop logic in students

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
AUDIT COURSE: VALUE EDUCATION (2A03)

Course Objectives:

Students will be able to

1. Understand value of education and self- development
4. Imbibe good values in students
5. Let the should know about the importance of character

Syllabus

Unit	Content	Hours
1	• Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. • Moral and non- moral valuation. Standards and principles. • Value judgments	4
2	• Importance of cultivation of values. • Sense of duty, Devotion, Self- reliance, Confidence, Concentration.Truthfulness, Cleanliness. • Honesty, Humanity.Power of faith, National Unity. • Patriotism. Love for nature ,Discipline	6
3	• Personality and Behaviour Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. • Punctuality, Love and Kindness. • Avoid fault Thinking. • Free from anger, Dignity of labor. • Universal brotherhood and religious tolerance. • True friendship. • Happiness Vs suffering, love for truth. • Aware of self-destructive habits. • Association and Cooperation. • Doing best for saving nature	6
4	• Character and Competence –Holy books vs Blind faith. • Self-management and Good health. • Science of reincarnation. • Equality, Non violence, Humility, Role of Women. • Mind your Mind, Self-control. • Honesty, Studying effectively	6

Suggested reading

1 Chakroborty , S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press ,New Delhi

Course outcomes

Students will be able to

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
AUDIT COURSE: CONSTITUTION OF INDIA (2A03)

Course Objectives:

Students will be able to:

4. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective
5. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
6. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Syllabus

Units	Content	Hours
1	**History of Making of the Indian Constitution:** • History • Drafting Committee, (Composition & Working)	4
2	**Philosophy of the Indian Constitution:** • Preamble • Salient Features	4
3	**Contours of Constitutional Rights & Duties:** • Fundamental Rights • Right to Equality • Right to Freedom • Right against Exploitation • Right to Freedom of Religion • Cultural and Educational Rights • Right to Constitutional Remedies • Directive Principles of State Policy • Fundamental Duties.	4
4	**Organs of Governance** • Parliament • Composition • Qualifications and Disqualifications • Powers and Functions • Executive • President • Governor • Council of Ministers • Judiciary, Appointment and Transfer of Judges, Qualifications • Powers and Functions	4
5	**Local Administration:** • District's Administration head: Role and Importance,	4

	• Municipalities: Introduction, Mayor and role of Elected Representative, Municipal Corporation. • Pachayati raj: Introduction, PRI: Zila Pachayat. • Elected officials and their roles, CEO Zila Pachayat: Position and role. • Block level: Organizational Hierarchy (Different departments), • Village level: Role of Elected and Appointed officials, • Importance of grass root democracy	
6	**Election Commission:** • Election Commission: Role and Functioning. • Chief Election Commissioner and Election Commissioners. • State Election Commission: Role and Functioning. • Institute and Bodies for the welfare of SC/ST/OBC and women.	4

Suggested Reading

5. The Constitution of India, 1950 (Bare Act), Government Publication.
6. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
7. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
8. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Students will be able to:

5. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
6. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
7. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
8. Discuss the passage of the Hindu Code Bill of 1956.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
AUDIT COURSE: PEDAGOGY STUDIES (2A03)

Course Objectives:

Students will be able to:
1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Syllabus

Units	Content	Hours
1	• **Introduction and Methodology:** • Aims and rationale, Policy background, Conceptual framework and terminology • Theories of learning, Curriculum, Teacher education. • Conceptual framework, Research questions**.** • Overview of methodology and Searching.	4
2	**Thematic overview:** Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. • Curriculum, Teacher education.	2
3	• Evidence on the effectiveness of pedagogical practices • Methodology for the in depth stage: quality assessment of included studies. • How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? • Theory of change • Strength and nature of the body of evidence for effective pedagogical practices. • Pedagogic theory and pedagogical approaches. • Teachers' attitudes and beliefs and Pedagogic strategies.	4
4	Professional development: alignment with classroom practices follow-up support • Peer support • Support from the head teacher and the community. • Curriculum and assessment • Barriers to learning: limited resources and large class sizes	4
5	**Research gaps and future directions** • Research design • Contexts • Pedagogy • Teacher education • Curriculum and assessment • Dissemination and research impact.	2

Suggested Reading:

8. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
9. Agrawal M (2004) curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
10. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
11. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
12. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
13. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
14. www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Outcomes:

Students will be able to understand:

4. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
5. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
6. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
AUDIT COURSE: STRESS MANAGEMENT BY YOGA (2A03)

Course Objectives

1. To achieve overall health of body and mind
2. To overcome stress

Suggested reading

1. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

Course Outcomes:

Students will be able to:
1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

Unit	Content	Hours
1	• Definitions of Eight parts of yog. (Ashtanga	8
2	• Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	8
3	• Asan and Pranayam i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects-Types pranayam	8

Suggested Reading:

3. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur
4. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
AUDIT COURSE: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (2A03)

Course Objectives:

2. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Syllabus

Unit	Content	Hours
1	Neetisatakam-Holistic development of personality • Verses- 19,20,21,22(wisdom) • Verses- 29,31,32 (pride & heroism) • Verses- 26,28,63,65(virtue) • Verses- 52,53,59 (dont's) • Verses- 71,73,75,78(do's)	8
2	• Approach to day to day work and duties. • Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48, Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,Chapter 18-Verses 45, 46, 48.	8
3	• Statements of basic knowledge. • Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 • Chapter 12 -Verses 13, 14, 15, 16,17, 18 • Personality of Role model. Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42 • Chapter 4-Verses 18, 38,39 • Chapter18 – Verses 37,38,63	8

Suggested Reading

3. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
4. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes

Students will be able to

4. Study of Shrimad- Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
5. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
6. Study of Neetishatakam will help in developing versatile personality of students.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
ADVANCED CHEMICAL REACTION ENGINEERING LABORATORY (2CTL11)

Teaching Scheme: Lab 4 hrs/week

Objectives:

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

1. To provide through understanding of Reaction Engineering.
2. To design reactor and identity type of reactor by suiting chemical kinetics and using information from thermodynamics, heat and mass transfer economics.
3. Characteristics of a fluidized bed reactor
4. Understanding of corrosion reaction and monolithic catalytic reactors.

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	3	2	3	3

List of Laboratory Experiments:

1. Analyze the characteristics of a fluidized bed reactor
2. Kinetics of a (solid-liquid) Esterification reaction in a batch reactor
3. Study the performance of combination of Reactors and RTD analysis
4. Study the kinetics in Adiabatic Batch reactor.
5. Study the performance of Combined Flow Reactor.
6. Studies of Catalyst performance of gas-liquid feed by using Fixed Bed Catalytic Reactor.
7. Studies of Catalyst performance of Liquid-liquid feed by using Fixed Bed Catalytic Reactor.
8. Studies of Catalyst performance in a microwave reactor.
9. Study the performance of Advanced Flow Reactor.
10. Preparation of mixed metallic/ alloy catalysts

(i) Pd-Cu/Al_2O_3 (ii) Ni-Cu/ Al_2O_3 Ni-Cu/ CrO_2

Outcomes:

1. Students will able to know the solid-liquid, liquid –liquid reactions.
2. Students will be able to know the micro reactor based process intensification.
3. Students will be able to know the monolithic catalytic reactors applications.
4. Students will be able to learn the Characteristics techniques of a fluidized bed reactor
5. Students will understand of corrosion reaction and monolithic catalytic reactors.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – II Sem (I Year), Chemical Technology
ADVANCED CHEMICAL ENGINEERING LABORATORY (2CTL12)

Teaching Scheme: Lab 4 hrs/week

Objectives:

1. Analyze characteristics of a fluidized bed dryer
2. Estimate efficiency of compact heat exchangers
3. Evaluate the performance of a process intensification in catalytic reactions, ultrasound assisted reactions, reactive distillation column, micro reactor and advanced flow reactor
4. Design controller for a given process
5. Evaluate the performance of membrane separation process for water purification
6. Characterize electrochemical phenomena such as corrosion

Mapping of Course Outcomes with Programme Outcomes

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	2	3
CO3	3	2	3	3
CO4	3	3	3	3
CO5	3	2	3	3

List of Laboratory Experiments:

1. Estimate the Characteristics of a Fluidized bed dryer
2. Study the heat transfer in Helical Coil heat exchanger
3. Study the Rheological studies of Non-Newtonian fluids
4. Study the operation of Cyclone Separator
5. Experimental investigation of Reactive distillation in Packed Column
6. Find out the separation efficiency of given Advanced Flow Reactor
7. Study the pH control in a process
8. High Performance Liquid Chromatography (HPLC) study of two available drugs.
9. Gas Chromatography (GC) study of two available drugs.
10. Identification and Estimation of drug molecules by using UV-Visible Spectrophotometer

Outcomes:

1. Students will able to plan experiments and present the experimental data meaningfully
2. Ability to apply theoretical concepts for data analysis and interpretation
3. Capability to visualize and understand chemical engineering unit operations related to fluid and particle mechanics, and mass transfer.
4. Ability to plan experiments and operate several specific instruments
5. Ability to analyze and interpret the experimental data