DEPARTMENT OF CHEMICAL TECHNOLOGY
NORTH MAHARASHTRA UNIVERSITY, JALGAON
SYLLABUS FOR M. TECH. (CHEMICAL ENGINEERING)

First Semester

Sub. No.	Paper	Teaching Scheme Hrs/ Week	Examination Scheme Marks		Total	Credit
			Internal	External		
CH: 1.1	Chemical Engineering Modeling and Optimization	03	40	60	100	3
CH: 1.2	Heat, Mass and Momentum Transfer	03	40	60	100	3
CT: 1.1	Modern Methods of Instrumental Analysis	03	40	60	100	3
CH: 1.4	Instrumental Analysis & Engineering Lab. (PR)	06	40	60	100	3
CH: 1.5	Process Dynamics and Control	03	40	60	100	3
	Total :	**18**	**200**	**300**	**500**	**15**

Second Semester

Sub no.	Paper	Teaching Scheme Hrs/week	Examination Scheme Marks		Total	Credit
			Internal	External		
CH: 2.1	Mass Transfer with Multiphase System	03	40	60	100	3
CH: 2.2	Reaction Engineering and Nano Catalysis	03	40	60	100	3
CH: 2.3	Chemical Equipment Design	03	40	60	100	3
CH: 2.4	Pollution Control in Chemical Industries	03	40	60	100	3
CH: 2.5	Membrane separation operations	03	40	60	100	3
CH: 2.6	Modern Methods of Extraction	03	40	60	100	3
CH: 2.7	Biochemical Engineering	03	40	60	100	3
PT: 2.3	Polymer Reaction Engineering	03	40	60	100	3
NT: 2.2	Science & Technology of nano-medicines	03	40	60	100	3
	Total :	**15**	**200**	**300**	**500**	**15**

Note:- CH-2.1, CH-2.2, CH-2.3 are compulsory. Select any two papers out of CH-2.4, CH-2.5, CH-2.6, CH- 2.7, PT- 2.3 and NT- 2.2

Third Semester

Sub. No.	Paper	Teaching Scheme Hrs/week	Examination Scheme		Total Marks	Credit
			Internal	External		
CH:3.1	Seminar	10	100		100	5
CH:3.2	Project	20	80	120	200	10
				Grand Total	**300**	**15**

Fourth Semester

Sub. No.	Paper	Teaching Scheme Hrs/week	Examination Scheme		Total Marks	Credit
			Internal	External		
CH: 4.1	Project	30	120	180	300	15
				Grand Total	**300**	**15**

UNIVERSITY DEPARTMENT OF CHEMICAL TECHNOLOGY
NORTH MAHARASHTRA UNIVERSITY, JALGAON

M.Tech. Chemical Engineering

Admission

Candidates holding B.Tech./ B.E. degree in Chemical Engineering or Chemical Technology with 55 % marks or any equivalent degree recognized by North Maharashtra University, Jalgaon shall be eligible for admission to M. Tech. (Chemical Engineering). Relaxation for the reservation candidates shall be as per norms. Preference will be given to candidates holding valid gate score.

Notes:-

1. The students of M. Tech. Course will have to attend 80% of lectures, practical and any other term work as may be prescribed by the university. The conduct and behavior of the student must satisfy the Head of the Department.

2. The Head of the Department will certify that the student has attended the course as prescribed and has conducted himself satisfactorily. In absence of such certificate, the student shall not be permitted to the University Examination.

3. The University examinations for all the terms shall be conducted at the end of the term.

4. The student shall have to appear personally to all parts of the examination.

5. The credit structure is based on M. Tech. credit guidelines sanctioned by University Academic Council

FIRST SEMESTER

CH-1.1 Chemical Engineering, Modeling and Optimization 3 hrs/week
Credit = 3

Basic Modeling:

Introduction to Modeling: Application & scope of coverage, Modeling Fundamentals, Chemical Engg. Modeling, Several Aspects of Modeling approach, General Modeling procedure, simulation tools, ISIM.

Formulation of dynamic Models:

Mass balance equation, balancing procedure, case studies, CSTR, Tubular reactor, Coffee percolator.

Total mass balances: case studies, tank drainage etc. Component balance case studies, waste holding tank, Extraction from solid by solvent.

Energy balance: Continuous heat mean agitated tank, heating in a filling tank, parallel reaction in semi, continuous reactor with large temperature differences.

Momentum balances: Dimensionless model equation, CSTR, Gas-Liquid mass transfer in a continuous tank reactor.

Chemical Kinetics: General modeling scheme, Liquid phase CSTR, Radical kinetics, Heterogeneous kinetics.

Modeling of stage wise processes:

Introduction, Stirred tank reactors, Configuration, Generalised model description, Heat transfer to and from reactors, Steam heating in jackets, Dynamics of the metal jacket wall, Batch reactor: Constant volume, semi batch.

CSTR: Constant volume CSTR, CSTR cascade,

Dynamic modeling:

Plug flow reactor, Plug flow reactor contactors, Liquid-Liquid extraction column dynamics, Heat Exchanger dynamics.

Optimization:

Salient features of Optimization, Classification, Process optimization using different techniques such as linear programming and dynamic programming, optimization of multistage process.

Reference Books:

1. C. L. Smith, R. N. Pike & P. W. Murill, Formulation optimization of Mathematical International text, Pensylvania (1970)
2. W. L. Luyben, Process Modeling Simulation and Controls for Chemical Engineers, Mc. Graw Hill Book Co.
3. John Inghan, Irving J, Dunnl Elmar, Henizle Jiri, E. Pernosil: Chemical Engineering Dynamics, VCH Publisher Intenatioal Inc. New York USA.
4. Klaus Hartmann, Klaus Kaplick: Analysis & Synthesis of Chemical Process Systems, Elsevier Science Publisher International New York, USA.
5. Roger G. E. Franks : Modeling & Simlation in Chemical Engineering, Wiley Interscience, New York USA .
6. Himmelblau D.M. Bischoff K. :Process system analysis and simulation.
7. Beveridge G.S.G.Schechter R.S.:Optimization theory and practice.
8. Aoki M. Macmillon : Introduction to optimization technique.

CH: 1.2 Heat Mass and Momentum Transfer 3 hrs/week
Credit = 3

Equation in change in Isothermal, Non-isothermal and Multi component system. Mechanism of momentum, heat and mass transfer. Mass transfer and Heat transfer Boundary layer flow in laminar and turbulent flow. Numerical based on it. Relation between Hydrodynamic boundary layer and Concentration boundary layer, thermal boundary layer, Numerical based on it. Mass transfer and Heat transfer fully developed flow for different profile. Analogy based on mass, heat and momentum transfer Numerical based on it. Diffusional mass transfer Condensation and Boiling, Numerical based on it Inerphase mass transfer in binary and multistage system. Macroscopic balances for isothermal and Non isothermal Systems.

Reference Books:

1) Transport Phenomena by R. Byron Bird, Warren E. Stewart Edwin N. Light foot
2) Transport process and Unit Operation by Christie J. Geankoplis
3) Heat mass and Momentum transfer by Bennet C.O. Mayers J.E.

CT-1.1 Modern Methods of Insturmental Analysis 3 hrs/week
Credit = 3

Detail study of following sophisticated instruments with reference to construction, operation principle, applications and merits and demerits:

Gas Liquid Chromatography
High Performance Liquid Chromatography
Infra Red & FTIR Spectroscopy
NMR Spectroscopy
UV Visible Spectroscopy
Mass Spectroscopy
Differential Scanning Calorimeter
Thermo gravimetric Analysis
Scanning Electron Microscope
Transform Electron Microscope & Atomic Force Microscopy
XRD – crystalline phase analysis
Surface area determination by BET- method, Particle size by light scattering method, Zeta potential
Color matching spectrophotometer and lavibond tintometer

CH-1.4 Instrumental Analysis & Engineering Lab. [Pr] 6 hrs/week
Credit = 3

Minimum 8 experiments based on Instruments Studied in "Modern Methods of Instrumental Analysis."

Minimum eight experiments based on heat, mass, process control, modeling and simulation (CHEMCAD, MATLAB, AUTOCAD, ASPEN)

CH: 1.5 Process Dynamics and Control 3 hrs/week
Credit = 3

Analogue simulation open and closed loop systems, concept of stability, stability criteria, root locus analysis, frequency response method, controller system design by frequency response. Advanced control strategies, Optimum control settings, Control valves, valve characteristics. Theoretical analysis of complex control systems such as steam jacketed kettle, gas absorber, mass transfer and chemical reactor systems, overall process control.
Non linear process control methods, phase plane analysis, describing function technique. Analog and digital computers. Microprocessor based controllers and distributed control.

Reference Books:

1. Coughanowr Donald R.: Process system Analysis and Control, McGraw Hill
2. Luben W. L., : Process modeling ,simulation and control for Chemical engineers, McGraw Hill
3. George Stephanopoulos : Chemical Process Control , Person Education Indian Branch.

SECOND SEMESTER

CH-2.1 Mass Transfer with Multiphase System 3 hrs/week
Credit = 3

Diffusional mass transfer: Diffusional coefficient for a binary gas mixture, Diffusion of a Component through a stagnant medium and Varying Cross Sectional area. Diffusion in Biological Solution Numerical based on it. Dimensionless Correlation for convective mass transfer, Mass transfer with reaction in Fluid-Fluid- Solid system Selection of Contractors Determination of minimum reflux ratio by different methods and Problem based on multicomponent system. Design parameter for fractionating column, Simultaneous absorption and Desorption with reaction. Mass transfer accompanied by General order irreversible and reversible reaction in gas – liquid and liquid- Liquid System. Design parameter of Simson Walker Crystaliser Calculation of Number of Plate by Triangle Point Method in case of Extraction.
Reference Books:

1) Gas liquid relation by Danckwerts P.V..
2) Heterogeneous Relation Analysis example and Relation design Vol: 2 John Wiley and Sons by Doraiswamy L.K. and M.M. Sharma
3) Principle of mass and heat transfer by S.D Dawande Central Technical Publication

CH -2.2 Reaction Engineering and Nanocatalysis 3 hrs/week
Credit = 3

Review of techniques of interpretation of kinetic data, material and energy balance across reactors with reference to their design, Detail coverage of design of fixed, fluidized, trickle, moving bed reactors.
Nanocatalysis: Role of transition metals & metal oxides in homogeneous and heterogeneous catalysis and their mechanism of catalysis, manufacture of these catalysts in nano-form and their characterization.

Silica, alumina, carbon as high temperature carriers for catalysts. Use of nanocatalysts in automobile pollution control, photocatalysis of toxics in effluents, gas sensors.
Reactor design for manufacture of nanocatalysts and nanosupports: Design of flame aerosol reactors, diffusion and premixed flame reactors, co precipitation reactors, hot wall flow reactors; their mechanical features, modeling and simulations.
Catalytic vapour –liquid- solid growth mechanism for understanding particle formation and growth during chemical vapour deposition, particle dynamics and CFD simulations of flame process based on fundamental equations for flow, heat and mass transfer, aerosol dynamics in flames.

Reference Books:

1. Levenspiel O.: Chemical Reaction Engineering; Wiley Eastern.
2. Davidson J.F., Harrison D.: Fluidization: Academic Press.
3. Carberry J.J.: Chemical and Catalytic Reaction Engineering: Mc Graw Hill.
4. Satterfield C.N.: Mass Transfer in Heterogeneous Catalysis: M.I.T. Press.

CH- 2.3 Chemical Equipment Design 3 hrs/week
Credit = 3

Design of Heat transfer equipments in detail such as Shell and Tube heat exchangers: correction factor for Log mean temperature difference, Vibrations in shell & tube heat exchanger, Effectiveness.
Plate type Heat Exchanger: thermal Design considerations. Heat regenerators, cooling tower design considerations.
Evaporators: selection criterion, Optimum no. of effects in multiple effect systems.
Design of Separation Process Equipments: Gas liquid separators, Liquid-liquid separators, Gravity separation, Cyclone separators, Electrostatic precipitators.
Distillation: Comparisons of Plate column or packed column, Design of sieve plate column and Bubble cap column in detail.
Design of continuous dryers: Rotary dryer, fluidized bed dryer.

Reference Books:

1. Richardson, J.M., Coulson J.F. and Sinnot R. K.: Chemical Engineering Vol . 6.
2. Dawande S.D. Process Design of Equipment Vol 2.,Central Techno Publications.
3. Kern D.Q. : Process Heat Transfer.
4. Kunni D., Levenspial D. : Fluidization Engineering. Wiley Ny.

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CH-2.4 Pollution control in Chemical Industries 3 hrs/week
Credit = 3

Identification, Segregation and Control of solid / liquid/ gases Pollutants from following Chemical Industries:

Petrochemical and Petroleum refinery
Vanaspati Edible oil Refinery and Oleochemical industry
Fermentation Beverage Dairy and Suger Industries
Plastic Processing Industry
Polymer and Resin Industry
Control of Volatile Organic Emissions in Paint Industry
Pharmaceutical and Fine Chemicals

CH: 2.5 **Modern Methods of Extraction** 3 hrs/week
Credit = 3

Theory & principle of extraction, types of extraction
Liquid-Liquid extraction: Method of Liquid-Liquid extraction, Theory & practice batch & continuous process, Calculation of no. of stages in co-current and counter-current extraction by different methods, design of extraction column : number of stages, efficiencies, NTU, HTU, Height of packing, Mass transfer coefficient, etc,. Selection criterion for solvent, Modern practices / plant for extraction of different raw material.
Solid-Liquid extraction: Method of Solid-Liquid extraction, Theory & practice batch & continuous process, Calculation of no. of stages in co-current and counter-current extraction by different methods, design of extraction column : number of stages, efficiencies, Mass transfer coefficient, Characterization of alpha & alpha n selection criterion of solvent, Modern practices / plant for extraction of different raw material.
Super critical fluid extraction: Theory principle and application, Extraction of essential oils, spices oleoresins and other valuable products, Comparative study of above processes with respect to solvent losses, Recovery of solvents and energy conservation, Safety Hazards and Toxicity.
Reference Books:
1. Chemical Engg., J. M. Coulson & J. F. Richardson Vol-2.
2. Mass Transfer by Trybal
3. Baileys Industrial Oils & Fats Products edited by Hui, Jhon Wiley vol-3.

CH: 2.6 **Membrane Seperation operations** 3 hrs/week
Credit = 3

Solute Transport Parameters for membrane performance prediction in RO / UF system involving aqueous and non-aqueous solutions. Physio-chemical, polar and nonpolar criterion govering RO separation, Membrane transport mechanism, Membrane fouling and compactations, TFC Membrane development. RO/ UF/ ED process design and module analysis RO/ UF/ ED and DD in acid and enzyme recovery from sacchinified hydrolyzates. Membrane techniques in reclaimation of water and chemicals along with pollution control from industrial effluents, Cost benefit analysis in resources recycling and environmetal quality improvement by MT., Industrial processing with membrane-membrane reactor, concept in bio-technology industries and in downstream processing, Per-vaporization techniques in alcohol concentration, Gas separation by RO.
Reference Books:
1.S. Sourjan, T. Matsura, (Ed), RO/UF Principles & Applications, NRCC Publications, Ottawa-Canada, 1986.
2. Munir Cheryan, UF Application Handbook, Technomic Publishing Co., Lancaster USA, 1986.

CH 2.7 **Bio-Chemical Engineering** 3 hrs/week
Credit = 3

Enzymes kinetics, immobilized enzymes and their application. Recombinant DNA and its applications. Bioconversion of renewable sources to organic chemicals. Bio Technology of food and food bio energy.

Kinetics of growth, bio mass production, substrate utilization and product yield. Batch, plug flow and chemostat cultures, mixed cultures. Aeration and agitation. Oxygen and demand supply. Surface and submerged fermentation. Bio reactors, their design and operation, sterilization. Process control instruments, product recovery.

Recent advances in production of microbial proteins, antibiotics, vaccines, organic acids, steroid transformations etc. Industrial effluent and their treatments, environmental pollution and its control.

Reference books :

1. Aiba, s. ,Humphrey , A. E. , Mills , N. F. , : Biochemical Engneering: Academic Press.
2. Bailey, J. E. ,Biochemical Engineering Fundamentals. : McGraw Hill.
3. Atkinson, B. , :Biochemical Reactors : Pion Ltd. London.

PT: 2.3 **Polymer Reaction Engineering** 3 hrs/week
Credit = 3

Classification of polymerization reactions. addition polymerization reaction mechanisms and rate equations; Dead – end radical polymerization; molecular weight distribution in batch and continuous reactors; avg. molecular weight and experimental determination based on viscosity, osmotic pressure etc. semi-batch reactor operation; Design of batch and continuous reactors. Heat removal from polymerization reaction.

Heterogeneous polyaddition reactions; Suspension and emulsion polymerization; Smith-Ewart's theory and Stock Mayer's equation; continuous emulsion polymerization; Anionic and Cationic poly addition; Co-polymerization; Mayo's equation and reactivity ratio; Alfred- Price equation; Rate of co polymerization and y factor; Skiest's equation.

Polycondensation reactions; Flory's equation and molecular weight distribution; Molecular weight regulations. Typical case studies of polymers like PE, PP and PS .

Reference books:

1. G. M. Burnett, Mechanism of polymer Reactions, Interscience, 1954.
2. F. M. Bovey, A. K. Medalia, I. M. Kolthoff, Emulsion Polymerisation, Interscience, 1955.
3. G. E. Harn, Co polymerization, Intersicence, 1969.
4. F. W. Billemeyer, (Ed.) Encyclopaedia of Polymer science and Technology, Interscience, 1969.

NT 2.2 **Science & Technology of Nano Medicines** 3 hrs/week
Credit = 3

Present status of pharmaceuticals and fine chemicals, outline of biochemistry of cells of living organisms.
Concepts of nano medicines, physical properties of molecules and supermolecular complexes within cells.
Molecular machinery and manufacturing with due stress on programmable medical micromachines, tiny supercomputers through molecular computing, concept of nano robots / molecular robotics smaller than a cell and their role in elimination of cancer, infection, clogged articles etc., retardation of aging phenomenon.
Role of nano technology in bio technology, engineered enzymes, coated colloids in cosmetics in pharmaceuticals, encapsulated drugs for sustained release, sunscreen and UV protective cosmetics, bio medical tagging and bio magnetic separation, diagnostic content agent, bio medical implants.

Third Semester

CH-3.1 **Seminar** 10 hrs/week
Credit = 5

Presentation on selected topics with due emphasis on latest developments

CH 3.2 **Project** **20** hrs/week
Credit = 10

Finalization of particular research problem thorough literature review, preliminary experimental work, Presentation of Project report and viva - voce based on project work.

Semester IV

CH-4.1 **Project** 30 hrs/week
Credit = 15

The entire semester will be devoted for detail experimental work on a research problem selected in III semester. The student will present his findings in the form of neatly typed and bound thesis within one month after approval of his synopsis. He will have to appear before panel of experts for defending his Thesis.