Syllabus for B.Tech(Chemical Engineering) Second Year

& 3rd Year (Proposed)

Revised Syllabus of B.Tech CHE (for the students who were admitted in Academic Session 2010-2011)

2nd Year - Semester III

A. THEORY							
S/L	**Code**	**Theory**	**Contact Hours/Week**				**Cr. Points**
			L	T	P	Total	
1	HU-301	Values & Ethics in Profession	3	0	0	3	3
2	CH(CHE)-302	Chemistry -2	3	1	0	4	4
3	CH(CHE)-301	Basic Environmental Engineering & Elementary Biology	3	0	0	3	3
4	ES-302	Energy Technology	3	0	0	3	3
5	CHE-301	Fluid Mechanics	3	1	0	4	4
6	CHE-302	Industrial Stoichiometry	3	1	0	4	4
Total of Theory						**21**	**21**
B. PRACTICAL							
7	CH(CHE)-392	Chemistry -2 Lab	0	0	3	3	2
8	ES-392	Energy Laboratory	0	0	3	3	2
9	CHE-391	Fluid Mechanics Lab	0	0	3	3	2
10	CHE-392	Instrumental Method of Analysis Lab	0	0	3	3	2
Total of Practical						**12**	**8**
Total of Semester						**33**	**29**

2nd Year - Semester IV

A. THEORY							
Code	**Field**	**Theory**	**Contact Hours/Week**				**Cr. Points**
			L	T	P	Total	
1	M(CS)-401	Numerical Methods	2	1	0	3	2
2	M402	Mathematics-2	3	1	0	4	4
3	CHE-401	Data structure & Database concept	3	1	0	4	4
4	CHE-402	Process Heat Transfer	3	1	0	4	4
5	CHE-403	Mechanical operation	3	1	0	4	4
Total of Theory						**19**	**18**
B. PRACTICAL							
6	HU-481	Technical Report Writing & Language Lab Practice	0	0	3	3	2
7	M(CS)-491	Numerical Methods	0	0	2	2	1
8	CHE-491	Data Structure & DBMS Lab	0	0	3	3	2
9	CHE-492	Heat Transfer Lab	0	0	3	3	2
10	CHE-493	Mechanical operation Lab	0	0	3	3	2
Total of Practical						**14**	**9**
Total of Semester						**33**	**27**

<u>Semester III</u>

Theorey

VALUES & ETHICS IN PROFESSION
HU301

Contracts:3L

Credits- 3

Science, Technology and Engineering as knowledge and as Social and Professional Activities

Effects of Technological Growth:

Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Limits of growth: sustainable development

Energy Crisis: Renewable Energy Resources

Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations, Environmental Ethics

Appropriate Technology Movement of Schumacher; later developments

Technology and developing notions. Problems of Technology transfer, Technology assessment impact analysis.

Human Operator in Engineering projects and industries. Problems of man, machine, interaction, Impact of assembly line and automation. Human centered Technology.

Ethics of Profession:

Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond, Case studies.

Profession and Human Values:

Values Crisis in contemporary society

Nature of values: Value Spectrum of a good life

Psychological values: Integrated personality; mental health

Societal values: The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution.

Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity

Moral and ethical values: Nature of moral judgements; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility.

Books:

1. Stephen H Unger, Controlling Technology: Ethics and the Responsible Engineers, John Wiley & Sons, New York 1994 (2nd Ed)

2. Deborah Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, New Jersey 1991.

3. A N Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996.

Chemistry-2
CH(CHE)-302

Contracts:3L+!T

Credits- 4

Module I

(Chemistry for Chemical Engineering)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: **10L**

Colloids: Introduction; Classification of colloids; Size and shape; preparation of sols; Origin of charge in Colloidal particles; Stability of Colloids; Kinetic, Optical & electrical properties; Electrokinetic phenomena; Electrical Double Layer; Ultracentrifuge and Molecular weight determination of Macromolecules.

Viscosity: Definition of viscosity of a liquid; Determination of Viscosity; Shear Viscosity; Intrinsic Viscosity; Molecular weight from Viscosity measurement;

Surface Tension: Introduction; Origin of Surface Tension; Surface energy; Laplace & Young-Laplace Equation, Capillarity; Contact Angle; Measurement of Surface Tension by Capillary rise method; Variation of Surface Tension of a liquid with Temperature and Concentration.

Module II: **10L**

Kinetic theory of gases, Van der Waals Equation of state, Maxwell distribution law, vapour-liquid equilibrium, Colligative property.

Adsorption: Introduction; Gibb's adsorption equation; Surface Excess; Adsorption isotherms: Freundlich, Langmuir, BET adsorption equations; Surface Films; Langmuir Balance; two-dimensional equation of state.

Module III: **10L**

Introduction to quantum mechanics: Spectral shape pf Blackbody radiation, Planck's equation and a concept of quanta, breakdown of the classical equipartition principle, basic postulates of quantum mechanics, Hamiltonian function & Hamiltonian operator, important properties of a Hamiltonian operator, Heisenberg's uncertainty principle, Schrodinger equation and its solution for an electron in a one dimensional box where potential energy is zero inside & infinity outside the box. Normalization and orthogonality of the wavefunction.

General Organic Chemistry: Common organic reactions i.e. Friedel-Crafts, Claisen Condensation, Cannizaro, Aldol condensation, Fischer-Tropsch;

Preparation and synthetic application of Acetoacetic ester, Malonic ester and Grignard's reagent;

Module IV:

10L

Aminoacids: Classification; General methods of preparation and properties of amino acids, polypeptide synthesis, General properties of proteins, colour tests, enzymes.

Lipids, fats and steroids; nucleic acid, DNA & RNA - generation and structure; cell nutrients- macronutrients, micronutrients.
Carbohydrate: Classification, Glucose and fructose, Disaccharides: Sucrose, maltose, cellobiose (introductory concept).

Revision: 5L

Text Books :

1. Physical Chemistry: G.W.Castellan, Narosa

2. Organic Chemistry: Finar; I.L. – Vol – I & II, Pearson Education

3. Organic Chemistry: Morrison & Boyd; PHI/Pearson Education.

References:

1. Physical Chemistry: P. W. Atkins: Oxford.

2. A Text book of Physical Chemistry: K. L. Kapoor: Macmillan

3. A guide Book to Mechanism in Organic Chemistry: Peter Sykes

4. Organic Chemistry: Loudon: Oxford

Basic Environmental Engineering and Elementary Biology
CH(CHE)-301
L-T-P = 3-0-0

At least 30 Hrs/Sem

There shall be one compulsory objective type question comprising 10 nos. spread over the entire syllabus and each carrying one mark. Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I 10L
Basics of environment

Biosphere, Atmosphere, Lithosphere, Hydrosphere and Pedosphere

Population growth, Mathematical Models, Resources - non-renewable and renewable, concepts of Sustainable Development.

Environmental degradation: Natural Disasters like Flood, earthquake, Landslide, Tsunami, Cyclone. Disaster Management Cycle

Man made Disasters and Hazards

Nature and scope of Environmental Science and Engineering.

Ecology
Elements of ecology: definition: species, population, community, ecosystem- Biotic and Abiotic components. Food chain Biogeochemical cycles, Biodiversity- types and its conservation

Module II 10L
Air pollution and control
Primary and Secondary Pollutants, Health effects associated with air pollutants, threshold limits, Green house effect and its impacts ,atmospheric stability, temperature inversion Sources and effect of different air pollutants- Suspended particulate matter, oxides of carbon, oxides of nitrogen,oxides of sulphur, PAN. Smog, Depletion Ozone layer:

Preliminary ideas of Air Pollution Control Equipments, (ESP. cyclone separator, bag house, catalytic converter, scrubber

Water Pollution and Control
Pollutants of water, their origin and effects: Physico Chemical, Bactriological and Biological parameters, standard limits, ideas of determination of water pollutants

Module III 10L

Noise Pollution: Definition of noise, effect of noise pollution, Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value, equivalent noise level, Noise pollution control.

Solid Waste Management : Municipal, Industrial, Commercial, Agricultural, Domestic, biomedical , Electronic & Hazardous solid wastes;

Recovery and disposal method- Open dumping, Land filling, incineration, composting and recycling.

Preliminaries of Environmental Legislation, Environmental impact assessment, Environmental Audit,

Module IV 10L
Elementary Biology
Overview of biological basics
Microbial diversity, viruses, procaryotes and eucaryotes; cell division and construction, introduction to amino acids and proteins, carbohydrates- mono and polysaccharides.
Major metabolic path ways: bio-energetics, glucose metabolism-glycolysis and the TCA cycle, respiration, control sites in aerobic glucose metabolism, metabolism of nitrogenous compounds and hydrocarbons; over view of biosynthesis, anaerobic and autotrophic metabolism.

Text Books:

1. Masters, G. M., “Introduction to Environmental Engineering and Science”, Prentice-Hall of India Pvt. Ltd.,1991.

2. Shuler & Kargi, Bioprocess Engineering --- Basic Concepts, 2nd ed. Prentice-Hall of India Pvt. Ltd.,2002

References:

1. Rao, C S, Environmental Pollution Control Engineering, New Age International, 2002

ES-302: Energy Technology **L-T-P = 3-0-0**
At least 30 Hrs/Sem

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: **10L**

Introduction: Conventional (fossil energy) and non-conventional (alternative energy) resources &reserves. Global Energy production & consumption pattern. Production &consumption pattern in India.

Solid Fuels: Biomass, Wood and Charcoal. Classification & Rank of Coal, Peat ,Lignite, Sub-Bituminous coal, Bituminous coal, Anthracite coal, Cannel &Bog head coal. Physical Properties of coal, Proximate & Ultimate Analysis of Coal, Cleaning, washing & Storage of coal.

Theory of coal Pyrolysis and Carbonization: Low Temperature Carbonization(LTC),HighTemperatureCarbonization(HTC),Horizontal & VerticalGas Retorts, Coke Ovens-Beehive& Byproduct Slot type. Recovery of byproducts. Details of Structural configuration and Operating principles.

Module II: **10L**

Liquid Fuels: Constitution of petroleum, theory of formation of crude petroleum oil.Characterization of crude oil & petroleum fuels. Operation and flow-sheet of crude distillation plant.

Thermal & catalytic cracking and reforming processes, coking, visbreaking,

Process of a typical Indian refinery. Parameters and testing logistics of petroleum products—Octane no.; Cetane no.; Aviation fuel,Power no.; Pour point; Smoke point; Char point; Cloud point; Flash point; Fire point; Aniline point and Diesel index.

Liquid fuel from coal: Bergius and Fischer Tropsch process. Other Synthetic Liquid fuels.(Benzol,shaleoil,Gashol, power alcohol

Colloidal fuel).

Module III: **10L**

Gaseous Fuels: Classification of gaseous fuel;Physico-chemical principles, Calorific Value, Wobbes index, and flame speed.

Flow sheet &operation of Producer gas, Water gas, Carburetted water gas, oil gas, coke-oven gas, blast furnace gas, Natural Gas and LPG. Coal Bed Methane.

Bio Gas: Principles and Operation of Aerobic & Anaerobic digestors, Biogas generation and management& flowsheet with special reference to waste utilization.

Module IV: **10 L**

Solar Energy: Devices for measurement of solar flux. Different types of Solar collectors (Flat plate,parabolic,concentric&heliostat),

Utilization of Solar Energy- For room heating, water heating other industrial uses -solar Pond,

Photovoltaic cells, Chemical storage etc.

Geothermal Energy & Wind Energy: Utilization of Geo thermal Energy;Operating principles of different types of Wind Energy Mills. Energy from Ocean

Nuclear energy:Sources of Nuclear fuels,Indian scenario; Nuclear reactions and power generation by Nuclear reactors-Breeder reactor- reaction &operation.

Text Books:

1. Fuels & Combustion: Dr. Samir Sarkar,Orient Longmans

2. Elements of Fuels. Furnace and Refractories: O.P .Gupta

References:

1. Non conventional energy sources, G.D.Rai Khanna Publishers

2. Non Conventional Energy Resources, D.S. Chauhan and S.K.Srivastava, New Age International Publishers.

3. Fundamentals of Renewable Energy Systems, D. Mukherjee and S. Chakrabarti, New Age International Publishers

4. Fuel and Combustion: Sharma S.P. and Chanra Mohan

Fluid Mechanics (CHE 301)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: **10 L**

Fundamental Concepts: Definition of Fluid, Continuum concept of fluid, Terminologies of fluid flow, velocity – local, average, maximum, flow rate – mass, volumetric, velocity field; dimensionality of flow; flow visualization – streamline, pathline, streak line, stress field; viscosity; Newtonian fluid; Non-Newtonian fluid; Reynold's number—its significance, laminar, transition and turbulent flows: Prandtl boundary layer, compressible and incompressible flows.

Fluid Statics: Basic equation of fluid statics; pressure variation in a static field; pressure measuring devices–manometer, U-tube, inclined tube, force on submerged bodies (straight, inclined), center of pressure.

Basic equations in integral form: Basic laws for a system; relation of system derivatives to the control volume formulation; conservation of mass; continuity equation, momentum balance equation-Introduction to Navier Stoke's and Euler's Equation, Introduction to roational and irrotational flow, momentum correction factor.

Module II: **10L**

Internal incompressible viscous flow: Introduction; flow of incompressible fluid in circular pipe; laminar flow for Newtonian fluid; Hagen-Poiseullie equation; introduction to turbulent flow in a pipe-Prandtl mixing length; energy consideration in pipe flow, relation between average and maximum velocity, Bernoulli's equation–kinetic energy correction factor; head loss; friction factor-Fanning and Darcy, Moody diagram; major and minor losses; Pipe fittings and valves, schedule no, equivalent diameter.

Module III: **10 L**

Flow measurement: Introduction; general equation for internal flow meters; Orifice meter; Venturimeter; Weirs, concept of area meters: rotameter; Local velocity measurement: Pitot tube. Hot wire anemometer, mass flowmeter.

Resistance of immersed bodies: Introduction; concept of drag and lift;; variation of drag coefficient with Reynolds number; stream-lined body and bluff body; packed bed; concept of sphericity; Ergun equation, modified friction factor.

Module IV: **10L**

Fluidization: Introduction; different types of fluidization; minimum fluidization velocity; governing equation; pneumatic conveying and other industrial uses.

Fluid moving machines: Introduction; Basic classification of pumps: Non-Mechanical Pumps—acid egg, steam jet ejector, air lift pump, Mechanical pump: Centrifugal pumps- cavitation, NPSH, Positive displacement pumps (rotary, piston, plunger, diaphragm pumps); pump specification; basic characteristics curves for centrifugal pumps; fan, blower and compressor.

Revision: 5L

Text books

1) Unit operations of Chemical Engineering: McCabe, Smith and Harriot,TMH, 6th Edn.

References:

1)Introduction to Fluid Mechanics: Fox & McDonald, John wiley

2) Fluid Mechanics, A.K. Mohanty, PHI
3) Fluidization Engineering: Kunii and Levenspiel
4) Fluid Dynamics and Heat Transfer: Knudsen and Katz, MGH
5) Transport Process and Unit Operations: Geankoplis, 3rd Edn. PHI
6) Principles of Unit Operations: Foust and Wenzel, Wiley, 1980

Industrial Stoichiometry (CHE 302)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: **10 L**

Units and Dimensions:, Conversion of Equations, Systems of Units, Dimensional Homogeneity and Dimensionless Quantities, Buckingham Pi-theorem for Dimensional Analysis,

Introduction to Chemical Engineering Calculations: Basis, Mole Fraction and Mole Percent, Mass Fraction and Mass Percent, Concentration of different forms, Conversion from one form to another, Roult's Law, Henry's law, Antoine's Equation. Clausius Clapeyron Equation.

Mathematical Requisites: Use of log-log and semi-log graph paper, Triangular

Diagram, Graphical Differentiation and Graphical Integration, Least Square Method, Curve Fitting, Method of Regression.

Module II: **10 L**

Material Balance without Chemical Reaction: Material Balance during Mixing, Humidity and Application of Psychrometric Chart, Solubility and Crystallization, Evaporator, Distillation Column, Absorption Column, Drier, Liquid - Liquid and Solid - Liquid Extraction Units.

Module III: **10L**

Material Balance with Chemical Reaction: Single Reaction, Multiple Reactions, Reactions with Recycle, Purge and By pass, Combustion Reaction, Calculation of Excess Air, Material Balance of Unsteady State Reaction systems.

Module IV: **10 L**

Energy Balance: Enthalpy calculation for systems (single component and multi components) without Chemical Reaction with Mean and Temperature dependent Heat Capacity, Enthalpy calculation for systems with Chemical Reactions. Heat of Reaction from Heat of Formation and Heat of Combustion Data, Effect of Temperature and Pressure on Heat of Reaction, Hess's Law, Adiabatic Flame Temperature, Theoretical Flame Temperature

Energy calculation in transient condition.

Case Studies: Combined Material and Energy Balances of Industrial Process.

.**Text Books**

1. Chemical Process Principles (Part I), 2nd. Ed., O. A. Hougen, K. M. Watson, and R. A. Ragatz. John Wiley (Asian Edn.).

2. Basic Principles and Calculations in Chemical Engineering, 6th. Ed., D.M. Himmelblau: Prentice Hall,

References

1. Stoichiometry, 4th. Ed., B.I.Bhat and S.M.Vora, McGraw Hill,.

2. Elementary Principles of Chemical Processes, 3rd.Ed., R.M. Felder and R. W. Rousseau, Wiley India Edition.

PRACTICAL

CH(CHE)-392: Chemistry -2 Lab **L-T-P = 0-0-3**

Chemistry for Chemical Engineering Laboratory

At least six experiments are to be performed

1. **Iodometric estimation of Cu^{2+}.**
2. **Estimation of mixed alkalies: NaOH and Na_2CO_3.**
3. **Estimation of available chlorine in bleaching powder.**
4. **Paper chromatography/TLC for separation of amino acid/sugar.**
5. **Iodometric estimation of vitamin C.**
6. **Determination of surface tension of a liquid by drop weight method.**
7. **Estimation of saponification value of oil.**
8. **Estimation of iodine value of oil**
9. **Estimation of available oxygen in pyrolusite.**
10. **Estimation of amino acid by formol titration**

Energy Laboratory (ES 392)

At least eight experiments are to be performed

1. Proximate analysis of Coal:

2) Determination of moisture content of Coal.

3) Determination of volatile matter and ash content of Coal.

4) Determination of carbon residue of fuel oil.

5) Determination of aniline point of a fuel oil.

6) Determination of moisture content of fuel oil by Dean & Stark apparatus.

7) Atmospheric Distillation of a petroleum product.

8) Determination of Flash Point & Fire Point of an oil by Abel apparatus.

9) Determination of Flash Point & Fire Point of oil by closed-cup Pensky Martin apparatus.

10) Determination of kinematic viscosity of oil by Redwood Viscometer

11) Determination of calorific value of gaseous fuel by Junker's apparatus.

12) Determination of calorific value of solid and liquid fuel by Bomb Calorimeter.

13) Determination of vapour pressure of petroleum product using Reid apparatus.

14) Experiments on Non-conventional Energy Source using Solar Cooker/Flat Plate Collector/Bio Gas Reactor

15) Analysis of a gaseous mixture by Orsat apparatus

16) Determination of viscosity by Ostwald Viscometer

FLUID MECHANICS LABORATORY (CHE 391)

At least eight experiments are to be performed

1. Experiments on Reynolds Apparatus for determination of flow regime and construction of Fanning friction factor vs. Reynolds No. plot
2. Determination of co efficient of Discharge for Orifice meter
3. Determination of co efficient of Discharge for Venturi meter
4. Determination of co-efficient of Pitot tube and construction of velocity profile across the cross section of pipe.
5. Determination of co-efficient of Discharge for different types of weirs.
6. Determination of pressure drop for flow through packed bed and verification of Ergun equation.
7. Experiment on fluidization techniques and determination of
   (a) Minimum fluidization velocity;
   (b) Pressure drop profile
8. Determination of efficiency of a centrifugal pump.
9. Pipe line assembling and a layout drawing with standard symbols.
10. Calibration of a Rotameter
11. Determination of viscosity of Newtonian &Non-Newtonian fluid by Falling Sphere method

Instrumental method of analysis Laboratory (CHE 392)

At least six experiments are to be performed

1) Determination of Turbidity of Water using NepheloTurbidity Meter.
2) Construction of standard curve (Absorbance vs. concentration) of a pure protein by Folin's Method using Spectrophotometer.
3) Determination of Fe^{3+} by Colorimeter Method.
4) Study of migration of proteins by electrophoresis.
5) Separation of Mixture of Lipids by Thin Layer Chromatography.

6) Kinetic study of biochemical reaction by UV Spectrophotometer.

7) Estimation of an organic mixture (benzene & toluene) by Abbe refractometer.

8) Determination of any optically active substance in the presence of non-active species by a polarimeter.

9) Demonstration of analysis of gases by gas chromatography.

10) Demonstration of working of HPLC/FTIR.

Semester IV
Theory

M(CS)-401:
Numerical Methods
L-T-P = 2-1-0

Approximation in numerical computation: Truncation and rounding errors, Fixed and floating-point arithmetic, Propagation of errors. (4)

Interpolation: Newton forward/backward interpolation, Lagrange's and Newton's divided difference Interpolation.

(5)

Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Expression for corresponding error terms.
(3)

Numerical solution of a system of linear equations:

Gauss elimination method, Matrix inversion, LU Factorization method, Gauss-Seidel iterative method.

(6)

Numerical solution of Algebraic equation:

Bisection method, Regula-Falsi method, Newton-Raphson method. (4)

Numerical solution of ordinary differential equation: Euler's method, Runge-Kutta methods, Predictor-Corrector methods and Finite Difference method. (6)

Text Books:

1. C.Xavier: C Language and Numerical Methods.
2. Dutta & Jana: Introductory Numerical Analysis.
3. J.B.Scarborough: Numerical Mathematical Analysis.
4. Jain, Iyengar , & Jain: Numerical Methods (Problems and Solution).

References:

1. Balagurusamy: Numerical Methods, Scitech.
2. Baburam: Numerical Methods, Pearson Education.
3. N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
4. Soumen Guha & Rajesh Srivastava: Numerical Methods, OUP.
5. Srimanta Pal: Numerical Methods, OUP.

Subject Name : MATHEMATICS

Code: M 402

Contacts: 3L +1T = 4

Credits: 4

Note 1: The entire syllabus has been divided into four modules.
Note 2: Structure of Question Paper
There will be two groups in the paper:

Group A: Ten questions, each of 2 marks, are to be answered out of a total of 15 questions, covering the entire syllabus.

Group B: Five questions, each carrying 10 marks, are to be answered out of (at least) 8 questions.
Students should answer at least one question from each module.
[At least 2 questions should be set from each of Modules II & IV.
At least 1 question should be set from each of Modules I & III. Sufficient questions should be set covering the whole syllabus for alternatives.]

Module I: Fourier Series & Fourier Transform [8L]

Topic: Fourier Series:

Sub-Topics: Introduction, Periodic functions: Properties, Even & Odd functions: Properties, Special wave forms: Square wave, Half wave Rectifier, Full wave Rectifier, Saw-toothed wave, Triangular wave.
(1)

Euler's Formulae for Fourier Series, Fourier Series for functions of period 2π, Fourier Series for functions of period $2l$, Dirichlet's conditions, Sum of Fourier series. Examples. (1)

Theorem for the convergence of Fourier Series (statement only). Fourier Series of a function with its periodic extension. Half Range Fourier Series: Construction of Half range Sine Series, Construction of Half range Cosine Series. Parseval's identity (statement only). Examples. (2)

Topic: Fourier Transform:

Sub-Topics: Fourier Integral Theorem (statement only), Fourier Transform of a function, Fourier Sine and Cosine Integral Theorem (statement only), Fourier Cosine & Sine Transforms.
Fourier, Fourier Cosine & Sine Transforms of elementary functions. (1)

Properties of Fourier Transform: Linearity, Shifting, Change of scale, Modulation. Examples.
Fourier Transform of Derivatives. Examples. (1)

Convolution Theorem (statement only), Inverse of Fourier Transform, Examples. (2)

Module II : Calculus of Complex Variable [13L]

Topic: Introduction to Functions of a Complex Variable.

Sub-Topics: Complex functions, Concept of Limit, Continuity and Differentiability. (1)

Analytic functions, Cauchy-Riemann Equations (statement only). Sufficient condition for a function to be analytic. Harmonic function and Conjugate Harmonic function, related problems. (1)

Construction of Analytic functions: Milne Thomson method, related problems**.** (1)

Topic: Complex Integration.

Sub-Topics: Concept of simple curve, closed curve, smooth curve & contour. Some elementary properties of complex Integrals. Line integrals along a piecewise smooth curve. Examples. (2)

Cauchy's theorem (statement only). Cauchy-Goursat theorem (statement only). Examples. (1)

Cauchy's integral formula, Cauchy's integral formula for the derivative of an analytic function, Cauchy's integral formula for the successive derivatives of an analytic function. Examples. (2)

Taylor's series, Laurent's series. Examples (1)

Topic: Zeros and Singularities of an Analytic Function & Residue Theorem.

Sub-Topics: Zero of an Analytic function, order of zero, Singularities of an analytic function. Isolated and non-isolated singularity, essential singularities. Poles: simple pole, pole of order m.

Examples on determination of singularities and their nature. (1)

Residue, Cauchy's Residue theorem (statement only), problems on finding the residue of a given function, evaluation of definite integrals: $\int_0^{\infty} \frac{\sin x}{x} dx$, $\int_0^{2\pi} \frac{d\theta}{a + b\cos\theta + c\sin\theta}$, $\oint_C \frac{P(z)}{Q(z)} dz$ (elementary cases, P(z) & Q(z) are polynomials of 2nd order or less). (2)

Topic: Introduction to Conformal Mapping.

Sub-Topics: Concept of transformation from z-plane to w-plane. Concept of Conformal Mapping. Idea of some standard transformations. Bilinear Transformation and determination of its fixed point. (1)

Module III: Probability [8L]

Topic: Basic Probability Theory

Sub-Topics: Classical definition and its limitations. Axiomatic definition.
Some elementary deduction: i) P(O)=0, ii) $0 \le P(A) \le 1$, iii) P(A')=1-P(A) etc. where the symbols have their usual meanings. Frequency interpretation of probability. (1)

Addition rule for 2 events (proof) & its extension to more than 2 events (statement only). Related problems.
Conditional probability & Independent events. Extension to more than 2 events (pairwise & mutual independence). Multiplication Rule. Examples. Baye's theorem (statement only) and related problems. (3)

Topic: Random Variable & Probability Distributions. Expectation.

Sub-Topics: Definition of random variable. Continuous and discrete random variables. Probability density function & probability mass function for single variable only. Distribution function and its properties (without proof). Examples. Definitions of Expectation & Variance, properties & examples. (2)

Some important discrete distributions: Binomial & Poisson distributions and related problems.
Some important continuous distributions: Uniform, Exponential, Normal distributions and related problems. Determination of Mean & Variance for Binomial, Poisson & Uniform distributions only.

(2)

Module IV: Partial Differential Equation (PDE) and Series solution of

Ordinary Differential Equation (ODE) [13L]

Topic: Basic concepts of PDE.

Sub-Topics: Origin of PDE, its order and degree, concept of solution in PDE. Introduction to different methods of solution: Separation of variables, Laplace & Fourier transform methods. (1)

Topic: Solution of Initial Value & Boundary Value PDE's by Separation of variables, Laplace & Fourier transform methods.

Sub-Topics:

PDE I: One dimensional Wave equation. (2)

PDE II: One dimensional Heat equation. (2)

PDE III: Two dimensional Laplace equation. (2)

Topic: Introduction to series solution of ODE.

Sub-Topics: Validity of the series solution of an ordinary differential equation. General method to solve $P_o\, y''+P_1\, y'+P_2\, y=0$ and related problems. (2)

Topic: Bessel's equation.

Sub-Topics: Series solution, Bessel function, recurrence relations of Bessel's Function of first kind. (2)

Topic: Legendre's equation.

Sub-Topics: Series solution, Legendre function, recurrence relations and orthogonality relation. (2)

TOTAL LECTURES : 42

Text Books:

1. Brown J.W and Churchill R.V: Complex Variables and Applications, McGraw-Hill.
2. Das N.G.: Statistical Methods, TMH.
3. Grewal B S: Higher Engineering Mathematics, Khanna Publishers.
4. James G.: Advanced Modern Engineering Mathematics, Pearson Education.
5. Lipschutz S., and Lipson M.L.: Probability (Schaum's Outline Series), TMH.

References:

1. Bhamra K. S.: Partial Differential Equations: An introductory treatment with applications, PHI
2. Dutta Debashis: Textbook of Engineering Mathematics, New Age International Publishers.
3. Kreyzig E.: Advanced Engineering Mathematics, John Wiley and Sons.
4. Potter M.C, Goldberg J.L and Aboufadel E.F.: Advanced Engineering Mathematics, OUP.
5. Ramana B.V.: Higher Engineering Mathematics, TMH.
6. Spiegel M.R. , Lipschutz S., John J.S., and Spellman D., : Complex Variables, TMH.

Data Structure and Database concept (CHE 401)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: 10L

Linear Data structures: Sequential Representation, Arrays, Lists, Stacks, Queues, Circular Queue, De-queue

Linked List Representations: Linear Linked List, Circular Linked List, Doubly Linked List and their Application.

Recursion: Design of Recursive algorithm, Tail Recursion

Module II: 10L

Non-Linear Data Structures:

Trees : Binary Trees, Traversals, Threads, Binary Search Trees- Insertion and Deletion algorithms, AVL Tree (Definition and basic concepts)

Graphs: Breadth First Search (BFS) and Depth First Search (DFS).

Sorting and Searching:

Sorting Algorithms: Bubble sort, Insertion sort, Selection sort, Quick sort.

Searching Algorithms: Linear search, Binary search.

Module III: 10L

Database Concepts:

Introduction: File Processing System and Database System ,Concept Architecture, Data Model, scheme & instances, Data Independence, Database User, Database Administrator

Entity Relational Model: Basic Concepts, Entity-Relationship Diagram, Keys, Weak Entity Set, Generalization and Specialization

Introduction to relational algebra

Module IV:10L

Database Language: Introduction to SQL: DDL, DML.

Relational Database Design: Functional Dependencies, Different anomalies in database designing, Normalization: 1NF, 2NF, 3NFand BCNF, Lossless-Join Decomposition and Dependency Preservation.

Text Books:

Data Structure:

1. Kruse Robert L., Robert Kruse, Cl Tondo., "Data Structures and Program Design in C", Pearson
2. Aho Alfred V., Hopcroft John E., UIlman Jeffrey D., "Data Structures and Algorithms", Addison Wesley

Database Concepts:

1. Henry F. Korth and Silberschatz Abraham, "Database System Concepts", Mc.Graw Hill.
2. Elmasri Ramez and Novathe Shamkant, "Fundamentals of Database Systems", Benjamin Cummings Publishing. Company.

References:

Data Structure:

Tanenbaum A. S. , "Data Structures using 'C' "

Horowitz Ellis & Sartaj Sahani , "Fundamentals of Data Structures" , Galgotria Pub.

Database Concepts:

Date C. J., "Introduction to Database Management", Vol. I, II, III, Addison Wesley.

Process Heat Transfer (CHE 402)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks.

Module I 10L

Basic modes of heat transfer; Heat transfer by conduction: One dimensional steady state heat conduction, Fourier's Law, Thermal conductivity, Compound resistance in series; Steady state heat transfer analysis through extended surface; Unsteady state heat conduction with and without heat generation, Concept of thermal diffusivity; Concept of heat transfer coefficient in convective-conductive system, Critical thickness of insulation; One dimensional unsteady state heat conduction- semi infinite solid: Lumped system analysis; Use of transient – temperature charts.

Module II 10L

Heat transfer by convection: Convection heat transfer mechanism; Forced convection in systems of simple geometrics (plate, cylinder etc.), Thermal boundary layer; Co-relation for heat transfer coefficient: internal flow & external flow, Momentum & heat transfer analogies.

Free convection: concept; Analysis of free convection in hot vertical plate, Corrections of free convection over simple cylinder, sphere etc.

Module III 10L

Heat transfer of fluids with phase change: Introduction; Dropwise and film-type condensation; Film condensation on vertical surface, Nusselt equation; Condensation outside horizontal and vertical tube bank; Heat transfer to boiling liquid, Analysis of boiling curve, Nucleate boiling mechanism.

Radiation heat transfer: Introduction; Black body radiation, Plank's distribution law, Monochromatic emissive power; Wein's displacement law; Kirchoff's Law; Emissivity of Solids, Concept of gray body; Radiation between surfaces, Concept of View Factor, Radiation shield; Absorption and emission in a gaseous medium.

Module IV 10L

Heat Exchanger: Classification; Construction of shell and tube heat exchanger; LMTD, LMTD correction factor, Dirt factor, Individual and overall heat transfer coefficient; Design procedure of shell and tube heat exchanger.

Evaporation: Classification; Capacity, Steam economy; Boiling point elevation (Duhring rule); Material and energy balance of single effect evaporator; Design procedure of single effect evaporator; Introduction to multiple effect evaporator: Forward feed, Backward feed, Mixed feed, Parallel feed.

Revision: 5L

Text Books

1. Process Heat Transfer: D. Q. Kern, MGH
2. Heat Transfer Principles and Application, B. K. Dutta, PHI.
3. Units Operations of Chemical Engineering: McCabe & Smith and Harriot, MGH

References

1.Heat Transfer – A Basic Approach: M. Necati Ozisik, McGraw-Hill International Edition, Singapore.

Mechanical Operations (CHE 403)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks.

Module 1 : **10 L**

Particulate solids : Characterization of solid particles, particle shape, particle size, mixed particle sizes and size analysis, specific surface of mixture, average particle size.

Screen analysis : Type of screens, ideal screen, real screen, screen effective ness, differential and cumulative analysis, screen capacity.

Screening equipment: stationary screens and grizzlies, gyrating screens, vibrating screens and other industrial screens like trammels etc.

Transportation and storage of solids : Studies on design, performance and operation of different conveyor systems like Belt, Screw, Apron, Flight, pneumatic conveyor and elevators; Storage of solids and discharge pattern from storage bin, theory and measurement of granular solid flow through orifice.

Module 2 : **10 L**

Comminution of solids (Size Reduction) : Factors affecting comminution, comminution laws : Kick's law, Rittinger's law and Bond's law and their limitations. Crushing efficiency & power consumption.

Size reduction equipments : Primary crusher – Jaw crusher, Gyratory crusher, Secondary crusher – Roll crusher (both smooth roll & toothed roll) its selection and capacity, Grinder – Construction and operation of Hammer mill, Ball mill, Rod mill, Attrition mill, Agitated mill and their materials suitability, Ultra-fine grinder – Fluid energy mill, Cutting machines: knife cutters, Close circuit and Open circuit operation.

Module 3 : **10 L**

Separation based on particle Mechanics through liquids : Free settling and Hinderd settling, Stock's law & Newton's law regimes of settling, Gravity settling processes, gravity classifiers, sorting classifiers: sink-and-float methods, differential settling methods. Clarifiers and thickeners, flocculation, batch sedimentation, rate of sedimentation. Equipment for sedimentation: thickeners. Clarifier and thickener design, sedimentation zones in continuous thickeners. Cyclones, hydrocyclones, centrifugal decanters.

Mixing : Units and dimensions, dimensional analysis: Buckingham's theorem, Principles of agitation, agitation equipment, flow patterns: prevention of swirling/vortex, draft tubes, Standard turbine design, power consumption, power correlation, significance of dimensionless groups, effect of system geometry, calculation of power consumption in Newtonian liquids. Solid-solid mixing equipment, Mixing effectiveness and Mixing index. Agitator scaleup.

Froth Flotation : Theory, operation, types, Flotation agents, Flotation cells.

Module 4 : **10 L**

Theory and principle of solid liquid filtration, cake filters, discontinuous pressure filter: principle and working of filter press, compressible and incompressible filter cakes, filter-medium resistance, constant pressure filtration, constant rate filtration, principles of cake filtration, pressure drop through filter cake, cake washing and filtration cycle, continuous vacuum filter: principle and working of rotary drum filters, centrifugal filter: theory & working principle of centrifugal filters, filter media, filter aids, Filtration of solid from gas – bag filter.

Text books

1. McCabe, W.L, Smith J.C and Harriot, P., "Unit Operations in Chemical Engineering", McGraw-Hill, Fourth Edition, 1984.
2. Coulson, J.M., Richardson, J.F., "Chemical Engineering", Volume 2, Third Edition, Pergamon Press, 1977.

References

1. Badger and Bencharo, " Introduction to Chemical Engineering". TMH,

2. Narayanan C.M.& Bhattacharya B.C. "Mechanical opeartions for chemical engineers", Khanna.

3. R.S.Hiremath & A.Kulkarni. Mechanical Operations Vol.I

PRACTICAL

Technical Report Writing & Language Lab Practice
HU-481:
L-T-P = 0-0-3
Cr-2

Guidelines for Course Execution:

Objectives of this Course: This course has been designed:

1. **To inculcate a sense of confidence in the students.**
2. **To help them become good communicators both socially and professionally.**
3. **To assist them to enhance their power of Technical Communication.**

Detailed Course Outlines:

A. ***Technical Report Writing*** : 2L+6P

1. Report Types (Organizational / Commercial / Business / Project)
2. Report Format & Organization of Writing Materials
3. Report Writing (Practice Sessions & Workshops)

B. ***Language Laboratory Practice***

I. Introductory Lecture to help the students get a clear idea of Technical Communication & the need of Language Laboratory

Practice Sessions 2L

2. Conversation Practice Sessions: (To be done as real life interactions) 2L+4P

a) Training the students by using Language Lab Device/Recommended Texts/cassettes /cd's to get their Listening Skill & Speaking Skill honed

b) Introducing Role Play & honing over all Communicative Competence

3. Group Discussion Sessions: 2L+6P

a) Teaching Strategies of Group Discussion

b) Introducing Different Models & Topics of Group Discussion

c) Exploring Live /Recorded GD Sessions for mending students' attitude/approach & for taking remedial measure

Interview Sessions; 2L+6P

a) Training students to face Job Interviews confidently and successfully

b) Arranging Mock Interviews and Practice Sessions for integrating Listening Skill with Speaking Skill in a formal situation for effective communication

4. Presentation: 2L+6P

a) Teaching Presentation as a skill

b) Strategies and Standard Practices of Individual /Group Presentation

c) Media & Means of Presentation: OHP/POWER POINT/ Other Audio-Visual Aids

5. Competitive Examination: 2L+2P

a) Making the students aware of Provincial /National/International Competitive Examinations

b) Strategies/Tactics for success in Competitive Examinations

c) SWOT Analysis and its Application in fixing Target

Books – Recommended:

Nira Konar: English Language Laboratory: A Comprehensive Manual

PHI Learning, 2011

D. Sudharani: Advanced Manual for Communication Laboratories &

Technical Report Writing

Pearson Education (W.B. edition), 2011

References:

Adrian Duff et. al. (ed.): Cambridge Skills for Fluency

A) Speaking (Levels 1-4 Audio Cassettes/Handbooks)

B) Listening (Levels 1-4 Audio Cassettes/Handbooks)

Cambridge University Press 1998

Mark Hancock: English Pronunciation in Use

4 Audio Cassettes/CD'S OUP 2004

Numerical Methods Lab

M(CS)-491 :

L-T-P = 0-0-2

1. Assignments on Newton forward /backward, Lagrange's interpolation.
2. Assignments on numerical integration using Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule.
3. Assignments on numerical solution of a system of linear equations using Gauss elimination and Gauss-Seidel iterations.
4. Assignments on numerical solution of Algebraic Equation by Regular-falsi and Newton Raphson methods.
5. Assignments on ordinary differential equation: Euler's and Runga-Kutta methods.
6. Introduction to Software Packages: Matlab / Scilab / Labview / Mathematica.

Data Structure and DBMS Laboratory (CHE 491)

Experiments on Data Structures:

Stacks and Queues: adding, deleting elements using arrays

Linked lists: Insertion, Deletion ,Implementation of stacks & queues using linked lists.

Recursive and Non-recursive traversal of Trees

Binary Search tree-Insertion & Deletion

Searching :Linear and Binary

Sorting: Bubble, Insertion, Selection

Graph: Adjacency List and Linked Representation

Experiments on Database on RDBMS Platform (Oracle):

DDL Commands: Create Table (including constraints), Alter Table.

DML: Insert, Update, Delete

Query: Using GROUP BY , ORDER BY Clause in query, Join, Outer Join, Sub-Queries

Heat Transfer Laboratory (CHE 492)

At least eight experiments are to be performed

1. Determination of thermal conductivity of a metal bar using Fourier's equation.
2. Calculation of heat loss through a lagged pipe and determination of thermal conductivity of a given insulating material.
3. Determination of thermal conductivity of insulating powder in a spherical vessel.

4. Determination of heat transfer coefficient of air in forced convection and to study the effect of velocities on heat transfer coefficient.

5. Determination of over all heat transfer coefficient in a Counter current & Parallel flow double pipe heat exchanger.

6. Determination of over all heat transfer coefficient and efficiency of a Shell and Tube heat exchanger.

7. Determination of emissivity of an unknown surface for a given apparatus.

8. Determination of Stefan's Boltzman constant using from temperature vs. time plot.

9. Determination of economy , capacity and overall heat transfer coefficient of a single effect evaporator.

10. Determination of Biot number for unsteady state heat conduction.

11. Determination of over-all heat transfer co-efficient in film-wise & drop-wise condensation.

Mechanical Operations Laboratory (CHE 493)

At least eight experiments are to be performed

LIST OF EXPERIMENTS:

(1) **Sieve Analysis:** To analyze a given powder for its particle size distribution. / Cumulative and Differential methods of particle size distributions.

(2) **Screen Effectiveness**: To find out screen efficiency through a suitable material balance with respect to a single screen.

(3) **Jaw Crusher:** To find out the reduction ratio and capacity and to verify the laws of crushing.

(4) **Ball Mill:** To determine the optimum speed for maximum new surface area created for the given feed size and also determines the critical speed of the ball mill.

(5) **Hammer Mill** : To find out the reduction ratio and capacity and to verify the laws of crushing.

(6) **Drop weight crusher**: To verify Rittinger's law.

(7) **Batch sedimentation:** To determine the settling and sedimentation characteristics of given slurry and to calculate the area of the continuous thickener.

(8) **Froth Flotation:** To study the effect of different frothing agent in the recovery of given sample during flotation.

(9) **Filtration:** To determine the specific cake resistance and filter medium resistance in the given plate and frame filtration.

(10) **Mixing:** To determine the power number and power consumption for a given liquid in an agitated vessel.

(11) **Cyclone Separator**: Demonstration of the operation of a cyclone separator and determination of its overall efficiency

Syllabus for B.Tech(Chemical Engineering) Second Year

& 3rd Year (Proposed)

Revised Syllabus of B.Tech CHE (for the students who were admitted in Academic Session 2010-2011)

CHE Proposed 3rd Year Syllabus

B.Tech(CHE)

➢ ***B. Tech. 3rd Year, 5th Semester :–***

❖ ***Theory***

Sl. No.	Field	Code	Paper Name	Contact Hour				Credit Point
				L	T	P	Total	
1	Humanities	HU 501	Economics for Engineers	3	0	0	3	3
2	Professional Core (PC)	ChE 501	Separation Process - I	3	1	0	4	4
3	PC	ChE 502	Chemical Reaction Engineering	3	1	0	4	4
4	PC	ChE 503	Chem. Process Technology I	3	0	0	3	3
5	Free Elective	ChE 504A, EE	Electrical Machines	3	0	0	3	3
		ChE 504B, ME	Machine Design					

❖ ***Practical***

Sl. No.	Field	Code	Paper Name	Contact Hour				Credit Point
				L	T	P	Total	
6	PC	ChE 591	Mass Transfer Laboratory	0	0	3	3	2
7	PC	ChE 592	Reaction Engineering Laboratory	0	0	3	3	2
8	PC	ChE 593	Process Equipment Design & Drawing - I Laboratory	0	0	3	3	2
9	FE	ChE594A, EE	Electrical Machine Laboratory	0	0	3	3	2
		ChE594B, ME	Machine Design Laboratory					

Syllabus for B.Tech(Chemical Engineering) Second Year

& 3rd Year (Proposed)

Revised Syllabus of B.Tech CHE (for the students who were admitted in Academic Session 2010-2011)

➢ ***B. Tech. 3rd Year, 6th Semester :–***

❖ ***Theory***

Sl. No.	Field	Code	Paper Name	Contact Hour				Credit Point
				L	T	P	Total	
1	Humanities	HU 601	Principles of Management	2	0	0	2	2
2	Professional Core (PC)	ChE 601	Separation Process - II	3	1	0	4	4
3	PC	ChE 602	Chemical Engineering Thermodynamics	3	1	0	4	4
4	PC	ChE 603	Chem. Process Technology II	3	0	0	3	3
5	Professional Elective (PE)	ChE 604A	Advanced Separation Process	3	0	0	3	3
		ChE 604B	Project Engineering					
6	Free Elective	ChE 605A	Environmental Engineering	3	0	0	3	3
		ChE 605B	Industrial Safety & Hazard Analysis					

❖ ***Practical***

Sl. No.	Field	Code	Paper Name	Contact Hour				Credit Point
				L	T	P	Total	
7	PC	ChE 691	Process Equipment Design & Drawing - II Laboratory	0	0	3	3	2
8	PC	ChE 692	Feasibility Analysis	0	0	3	3	2
9	PE	ChE 693A	Environmental Engineering Laboratory	0	0	3	3	2
		ChE 693B	Engineering Drawing Laboratory					
10		ChE 694	Seminar	0	0	3	3	2

Syllabus for B.Tech(Chemical Engineering) Second Year

& 3rd Year (Proposed)

Revised Syllabus of B.Tech CHE (for the students who were admitted in Academic Session 2010-2011)

B. Tech. 4th Year, 7th Semester :–

❖ ***Theory***

Sl. No.	Field	Code	Paper Name	Contact Hour				Credit Point
				L	T	P	Total	
1	Professional Core (PC)	ChE 701	Transport Phenomena	3	1	0	4	4
2	PC	ChE 702	Instrumentation & Process Control	3	1	0	4	4
3	Professional Elective (PE)	ChE 703A	Material Science & Material of Construction	3	0	0	3	3
		ChE 703B	Petrochemical Technology					
		ChE 703C	Bio Technology & Biochemical Engineering					
4	PE	ChE 704A	Numerical Methods in Chemical Engineering	3	0	0	3	3
		ChE 704B	Ceramic Technology					
5	Free Elective	ChE 705A	Total Quality Management	3	0	0	3	3
		ChE 705B	Operation Research					

❖ ***Practical***

Sl. No.	Field	Code	Paper Name	Contact Hour				Credit Point
				L	T	P	Total	
6	HU	HU 791	Group Discussion	0	0	3	3	2
7	PC	ChE 791	Process Control Laboratory	0	0	3	3	2
8	PE	ChE 792A	Biotechnology Laboratory	0	0	3	3	2
		ChE 792B	Numerical Computation Laboratory					
9	FE	ChE 793A	Total Quality Management Laboratory	0	0	3	3	2
		ChE 793B	Operation Research Laboratory					
10	PC	ChE 794	Industrial Training					2
11	PC	ChE 795	Project Work I	0	0	6	6	2

Syllabus for B.Tech(Chemical Engineering) Second Year

& 3rd Year (Proposed)

Revised Syllabus of B.Tech CHE (for the students who were admitted in Academic Session 2010-2011)

➢ ***B. Tech. 4th Year, 8th Semester :–***

❖ ***Theory***

Sl. No.	Field	Code	Paper Name	Contact Hour				Credit Point
				L	T	P	Total	
1	Humanities	HU 801	Organizational Behavior / Project Management	2	0	0	2	2
2	Professional Elective (PE)	ChE 801A	Modeling Simulation & Optimization	3	1	0	4	4
		ChE 801B	Reactor Design And Analysis					
3	Free Elective	ChE 802A	Nanotechnology	3	0	0	3	3
		ChE 802B	Polymer Science & Engineering					

❖ ***Practical***

Sl. No.	Field	Code	Paper Name	Contact Hour				Credit Point
				L	T	P	Total	
4	Professional Core (PC)	ChE 891	Plant Design	0	0	6	6	4
5	PC	ChE 892	Project Work II	0	0	12	12	6
6		ChE 893	Grand Viva					3

5th. Semester

Theory

Economics for Engineers
HU-501
Contracts: 3L
Credits- 3

1. Economic Decisions Making – Overview, Problems, Role, Decision making process.

2. Engineering Costs & Estimation – Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types Of Estimate, Estimating Models - Per-Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve, Benefits.

3. Cash Flow, Interest and Equivalence: Cash Flow – Diagrams, Categories & Computation, Time Value Of Money, Debt repayment, Nominal & Effective Interest.

4. Present Worth Analysis : End-Of-Year Convention, Viewpoint Of Economic Analysis Studies, Borrowed Money Viewpoint, Effect Of Inflation & Deflation, Taxes, Economic Criteria, Applying Present Worth Techniques, Multiple Alternatives.

5. Cash Flow & Rate Of Return Analysis – Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate Of Return, Calculating Rate Of Return, Incremental Analysis; Best Alternative Choosing An Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity And Breakeven Analysis. Economic Analysis In The Public Sector - Quantifying And Valuing Benefits & drawbacks.

6: Uncertainty In Future Events - Estimates And Their Use In Economic Analysis, Range Of Estimates, Probability, Joint Probability Distributions, Expected Value, Economic Decision Trees, Risk, Risk vs Return, Simulation, Real Options.

7. Depreciation - Basic Aspects, Deterioration & Obsolescence, Depreciation And Expenses, Types Of Property, Depreciation Calculation Fundamentals, Depreciation And Capital Allowance Methods, Straight-Line Depreciation Declining Balance Depreciation, Common Elements Of Tax Regulations For Depreciation And Capital Allowances.
8. Replacement Analysis - Replacement Analysis Decision Map, Minimum Cost Life Of A New Asset, Marginal Cost, Minimum Cost Life Problems.

9. Inflation And Price Change – Definition, Effects, Causes, Price Change With Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates.

10. Accounting – Function, Balance Sheet, Income Statement, Financial Ratios Capital Transactions, Cost Accounting, Direct and Indirect Costs, Indirect Cost Allocation.

Readings

1. James L.Riggs,David D. Bedworth, Sabah U. Randhawa : Economics for Engineers 4e , Tata McGraw-Hill
2. Donald Newnan, Ted Eschembach, Jerome Lavelle : Engineering Economics Analysis, OUP
3. John A. White, Kenneth E.Case,David B.Pratt : Principle of Engineering Economic Analysis, John Wiley
4. Sullivan and Wicks: Engineering Economy, Pearson
5. R.Paneer Seelvan: Engineering Economics, PHI
6. Michael R Lindeburg : Engineering Economics Analysis, Professional Pub

Chemical Engineering (ChE 501)

Separation Processes - I

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module-I **10L**

Principles of molecular diffusion and diffusion between phases, Fick's Law, Diffusivity, Equation of continuity, Diffusion in solids, Knudsen diffusion. A definition of Mass transfer coefficient, other definitions of mass transfer coefficient, Correlation involving mass transfer coefficients, Theories of mass transfer, Mass transfer across interfaces, Two-resistance theory, Analogy between momentum, heat and mass transfer, Concept of stage wise processes.

Module-II **10L**

Introduction to absorption, The mechanism of absorption, Absorption equipment, Limiting gas-liquid ratio, Flooding, loading in packed column, Diameter and height calculations for packed columns, H. E. T. P., H. T. U. and N. T. U. concepts, Packed tower design, Gas film coefficient, Liquid film coefficient, Height of column based on overall coefficients. Plate type towers, Absorption factor, Number of plates by use of absorption factor, Kremser equation.

Module-III **10L**

Introduction to distillation , Vapor -liquid equilibria, Relative volatility, Ideal and non -ideal solutions, Batch Distillation, Rayleigh equation, Flash distillation, Steam distillation, Rectification of binary systems, Enthalpy- concentration diagram, Design of rectification column, Calculation of number of plates in a distillation column by Mc Cabe-Thiele method and Ponchon -Savarit method, Optimum reflux ratio, Plate efficiency.

Module-IV

a. Distillation Column internals and sizing, Azeotropic & Extractive distillation, Multicomponent distillation. **5L**

b. Adsorption: Introduction, Nature of adsorbents, Batch adsorption, Adsorption isotherms, Adsorption equipment, Breakthrough curves, Scale up, Length of unused bed, Design of fixed bed adsorption column. **5L**

Text Books :

1. Mass Transfer Operations: Robert E. Treybal, MGH, International Student Edition.
2. Principles of Mass Transfer and Separation Processes, Binay K. Dutta
3. Unit Operations in Chemical Engineering : McCabe, Smith, and Harriot. MGH, Sixth Edn.

References:

1. Transport process and Unit Operations: Geankoplis. 3rd Edn., PHI.
2. Multicomponent Distillation: Holland, C. D., PHI.
3. The Elements of Fractional Distillation: Robinson, C. S. and Gilliland, E. R. MGH.
4. Mass Transfer: Sherwood, Pigford, and Wilke, MGH.
5. Separation Processes: King, C. J. MGH.
6. Design of Equilibrium Stage Processes: Smith, B. D. MGH.
7. Distillation: van Winkle, M., MGH.

5th. Semester

Chemical Engineering

Chemical Reaction Engineering (ChE 502)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: 10L

Introduction; Definition of reaction rate;

Kinetics of homogeneous reaction: Concentration-dependent term of a rate equation, single and multiple reactions, rate equation from given mechanisms.

Elementary & Nonelementary reactions, Molecularity and order of reaction, Representation of reaction rate, Kinetics for non elementary reactions, related problems, Temperature dependent term of a rate equation: Arrhenius law, Collision theory, Transition-state Theory, related problems;

Interpretation of batch reactor data: Constant-volume batch reactor, Integral method of analysis of data: General Procedure, Irreversible unimolecular-type first-order reaction, Irreversible bimolecular-type second-order reactions, rate equation for enzymatic reaction, Zero-order reactions, Over-all order of irreversible reactions from the Half-life method, Initial rate method of analysis.

Irreversible Reactions in parallel, Autocatalytic reactions, Irreversible reactions in series, First-order Reversible Reactions,

Differential method of Analysis of data: Analysis of the Complete Rate Equation, Partial analysis of rate equation,

Variable-Volume reaction system: Its Integral method of analysis for Zero-order reactions, First order reaction, Second-order reactions;

Module II: 10L

Single ideal Reactors: Introduction; Basic division of ideal reactors, Ideal Batch Reactor,

Concept of flow reactors, Space-time and Space-velocity,

Steady-state Mixed Flow Reactor: Design Equation, Graphical Representation of Design Equation, related problem;

Steady-state Plug Flow Reactor: Design equation, graphical representation, related problem;,

Design for Single Reactions: Size and comparison of single reactors: Batch Reactor, PFR, MFR, General Graphical Comparison;

Multiple-Reactor Systems: PFRs in Series and/or in Parallel, Equal-size MFRs in Series, MFRs of different sizes in Series, Determining the best size combination of reactor size for a given combination, Reactors of Different Types in Series,

Recycle Reactor: Definition of Recycle Ratio, Design Equation, and Optimum Recycle ratio.

Module III: 10L

Design for Multiple Reactions: Introduction, Reactions in Parallel, Qualitative aspects of Product Distribution,

Quantitative Treatment of Product Distribution and of Reactor Size: Definition of Instantaneous and Overall fractional yield, graphical representation; Reactions in Series: Successive First-Order Reactions, Product Distribution, Quantitative Treatment of PFR, MFR and Batch Reactor.

Solid-Catalyzed Reaction: Introduction; Basic idea of catalysis, Catalyst properties, Steps in catalytic reaction:

Qualitative discussion on Pore Diffusion, Adsorption, Surface reaction and Desorption, Concept of Rate limiting step;

Design of reactors for gas-solid reactions: Design equation and data analysis of heterogeneous system; Quantitative aspects of Pore diffusion controlled reactions (single cylindrical pore, first-order reaction): Material balance for the elementary slice of catalyst pore, Definition of Thiele Modulus and Effectiveness Factor.

Fluid-Particle Reactions: Introduction; Different behavior of reacting solid particles; Selection of a Model; Qualitative discussion on Progressive Conversion Model & Unreacted Core Model;

Introduction to non isothermal reactions: adiabatic and temperature programmed reactions.

Module IV: 10L

Distribution of Residence Times for Chemical Reactors: General Characteristics; Residence-Time Distribution (RTD) Function;

Measurement of the RTD: Pulse Input; Related problems; Characteristics of RTD: Integral Relationships, Mean Residence Time, Different Moments of RTD; RTD in Ideal Reactor: RTD in Batch and PFR, Single CSTR, PFR/CSTR series RTD; Concept of Macromixing & Micromixing, Zero Parameter Model: Segregation Model & Maximum Mixedness Model.

Models for Nonideal Reactors: Introduction; One-Parameter Models: Tanks in Series Model, Dispersion Model: Basic Formulation, Definition of Peclet Number & Vessel Dispersion Coefficient, Boundary Conditions (Closed-Closed & Open-Open), Correction for Sloppy Tracer Input, Relation between Flow, Reaction and Dispersion.

Text Books :

1. Elements of Chemical Reaction Engineering, 4th. Edition, H. Scott Fogler, Prentice Hall

2. Chemical Reaction Engineering, 2nd. & 3rd. editions, O Levenspiel.: Wiley Eastern Ltd.

References:

1. Chemical Reactor Analysis and Design Fundamentals, J. B. Rawlings and J. G. Ekerdt. Nob Hill Publishing.

2. Chemical Engineering Kinetics, 3rd. Edition, J.M. Smith, MGH.

3. Chemical Engineering Kinetics and Reactor Design, C.G. Hill, Wiley

4. The Engineering of Chemical Reactions, 2nd. Edition, L. D. Schmidt, Oxford

5. Experiments in Catalytic Reaction Engineering, J. N. Berty, Elsevier.

5th. Semester

Chemical Engineering

Chemical Process Technology – I (ChE 503)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module 1: 10 L

Water treatment: Water for the chemical process industry, Boiler feed-water, Cooling tower water, Demineralised water, Drinking water; Treatment methodology: Ion-exchange, Membrane technology etc.

Chlor-alkali industries: Production and consumption pattern, manufacture of Chlorine-caustic soda: Raw materials, principles of manufacture, Mercury-cathode & Membrane process: flow-sheet and sequence of operation, other processes, advancement of process technology and major engineering problems, uses.

***Soda-ash* :** Production and consumption pattern, Raw materials, Solvey process Physico-chemical principles of manufacture, carbonation and ammonia recovery step, flow-sheet and sequence of operation, other processes, advancement of process technology and modified Solvey process, major engineering problems, uses.

Module II : 10 L

Industrial Acids:

Hydrochloric Acid: Raw materials, principles of manufacture, flow-sheet and sequence of operation, major engineering problems, uses.

sulfuric acid: sulfuric acid production process, Contact process, Physico-chemical principles and general theory of contact reaction with thermodynamic and reaction engineering aspects, different types of catalyst – preparation methodology and relative merits, flow-sheet and sequence of operation, details of major equipments, advancement of process technology and major engineering problems, DCDA process, uses.

Nitric Acid: Raw materials,Ostwald Process –physico-chemical principles, catalyst, process flow sheet and sequence of operation, details of major equipments, uses.

Phosphoric Acid: Raw materials, manufacturing process with process flow sheet, details of major equipments, uses.

Module III: 10 L

Fertilizer Industries:

Nitrogenous fertilizers:

Ammonia- Source of hydrogen; methods of obtaining hydrogen from different sources, source of nitrogen-liquefaction of air and distillation of liquid air.

Synthesis of ammonia- physico chemical principles, catalyst for synthesis of ammonia, process flow sheet and sequence of operation, details of major equipments.

Urea - Raw materials, manufacturing process with flow sheet, sequence of operation, major equipments details.

Ammonium sulphate: Rawmaterials, manufacturing process with flow sheet, major equipments details.

Phosphatic fertilizers: Manufacturing process of super phosphate of lime , triple super phosphate and ammonium phosphate.

Mixed fertilizers: NPK –manufacturing process, details of major equipments.

Module IV: 10 L

Ceramic and ceramic materials:

Cement: Chemical composition of Portland cement, raw materials, dry and wet process for manufacturing cement clinker, setting and hardening of cement.

Glass: Composition of glass, rawmaterials, manufacturing method of glass- pot furnace and tank furnace, annealing of glass.

Ceramic: Basic rawmaterials,white-wares, manufacturing process of porcelain and their forming operations.

Refractories: Properties of Refractories, raw materials, manufacturing techniques of acid refectories, basic Refractories, sintered and fused refractories,insulating refractories.

Text Books :

1. Dryden, C. E., and Rao, M.G. (Ed.), Outlines of Chemical Technology Affiliated East West Press

2. Austins, G.T., Sherve's Chemical Process Industries, MGH 5th Edn.

References:

1. Venkateswarlu, S. (Ed.) Chemtech (II) Chemical Engineering Development Centre, IIT, Madras

2. Kirk & Othmer (Ed.), Encyclopedia of Chemical Technology

5th. Semester

Chemical Engineering

Electrical Machines (ChE 504A, EE…..)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module-I: 10 L

D.C. Machines--Generators and Motors: Constructional features and principles of operation of shunt, Series and compound generators and motors. Performance characteristics, starting speed controls and breaking of motors.

Module-II: 10 L

Application of Static and Rotating Machines: Two quadrant and four quadrant operation of motors. Choice of D.C. motors for different applications.

Constructional features and principles of operation of 1-phase transformers, Open Circuit Test and Short Circuit Test, Equivalent Circuit, Typical applications of transformers and A.C. motors.

Module-III: 10 L

Induction motors: Principles of operations, Equivalent circuit and diagram, Torque speed characteristics, Methods of improving starting torque speed control. Starting and breaking of induction motors, Single phase induction motors and methods of starting.

Module-IV: 10 L

Synchronous Machines: Synchronous generators and motors, Principles of operations and simple equivalent circuit, Method of synchronization of synchronous generator, Application of synchronous machines and 3-phase transformer.

Text Books / References:

1. Electrical Technology: Edward Hughes. Pearson Education

2.Hubert, Electrical Machines, Pearson Education

3. Applied Electricity: H. Cotton. CBS Distributors, New Delhi

4. A Text Book of Electrical Technology: Theraja and Theraja – Vol –

4. Electrical Machinery: Bhimra,

5. Electrical Machines: P.K.Mukherjee and S.Chakraborty.

5th. Semester

Chemical Engineering

Machine Design (ChE 504B, ME…)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module-I: 10L

Stress Analysis: Strain, Stress, Elasticity, Medullae of Elasticity, Simple stress, torsion, bending, stress analysis in beams and columns, Euler column formula, combined stresses (Normal and shear stress only), general notions of dynamic load and impact stresses. Analysis of Struss.

Module-II: 10L

Designing for strength: stress-strain diagram, stress concentration (static load applied steadily, static load applied suddenly, variable load), types of failure, prevention of failure, factor of safety, design of combined loading, theories of failure: maximum normal stress theory, maximum shear stress theory, choice of theory of failure, impact loading and fatigue loading, endurance strength, endurance limit, design for fatigue loading; Soderberg criterion, Goodman criterion.

Module-III: 10L

Fasteners: Riveted joints: introduction, rivet heads and methods of riveting, rivet material and rivet test, types of riveted joints, failure of rivet joints and its design. Eccentric loading on rivet and bolted joints. cotter and Knuckle joints. Keys and couplings: Introduction to keys, types of keys, introduction to coupling, different types of coupling,. Pipe joints- different types of hydraulic pipe joints. Shaft-general use, causes of failure in shaft, designing of straight shaft, design for strength, design for rigidity and stiffness. Belt drives-Introduction to different types of belt drives, general design of belt drive.

Module-IV: 10L

Design of Pressure vessel: thin and thick cylinder design, design of cylinder head, cover plate, selection of gasket, design of bolt and flange.

Text Book / References:

1. Process Equipment Design – Brownell and Young, John Wiely and sons

2. Machine Design, Norton, Pearson Education

3. Design of Machine Elements, Sharma & Purohit, PHI

4. Design of Process Equipment – Hesse and Rushton

Practical
5th. Semester
Chemical Engineering

Mass Transfer Laboratory (ChE- 591)

At least eight experiments are to be performed

1. Determination of diffusivity of volatile liquids in air using Stefan tube.
2. Study of simple batch distillation to verify Rayleigh's equation.
3. To draw vapor-liquid equilibrium diagram using Othmer still.
4. Experiment on wetted wall column to determine mass transfer co-efficient.
5. To study the performance of a rectification column.
6. To study the absorption in a packed tower.
7. To study the drying characteristics curve under constant drying condition.
8. Experiment on batch adsorption (to verify adsorption isotherms).

9. Experiment on liquid-liquid extraction (to determine the overall mass transfer coefficient for counter current operation).

10. Use of charts and nomographs in chemical engineering practice.

11. To study drying characteristics in a Rotary Dryer.

12. To determine the diffusivity of a volatile solid in gas

5th. Semester
Chemical Engineering

Reaction Engineering Laboratory (ChE-592)

At least eight experiments are to be performed

1. Experimental studies on kinetics of a non catalytic homogeneous liquid phase reaction in an isothermal batch reactor.

2. Experimental studies on kinetics of a homogeneous liquid phase reaction in an isothermal semi batch reactor.

3. Experimental studies on kinetics of a non catalytic homogeneous liquid phase reaction in a tubular plug flow reactor.(ideal plug flow reactor)

4. Experimental studies on kinetics of a non catalytic homogeneous liquid phase reaction in a Spiral plug flow reactor.

5. Experimental studies on kinetics of a non catalytic homogeneous liquid phase reaction in an isothermal CSTR.

6. Experimental studies on RTD in a packed bed reactor using pulse input of tracer and measurement of axial dispersion coefficient.

7. Experimental studies on RTD in a tubular PFR using pulse input of tracer and measurement of axial dispersion coefficient.

8. .Experimental studies on kinetics of hydrolysis of ethyl acetate in presence of acid catalyst in an adiabatic batch reactor.

9. Kinetic studies of sulfonation of toluene in an isothermal batch reactor

10. Kinetic studies on hydrolysis of benzoyl chloride in an adiabatic batch reactor.

5th. Semester

Chemical Engineering

Process Equipment Design and Drawing-I Laboratory (ChE 593)

1. Design and Drawing of Orifice meter / Venturimeter / Rota meter. (Any one)

2. Design and Drawing of shell & tube heat exchanger / Evaporator/Pressure Vessel.(Any one)

Each student shall be allotted design problems on sl. no 1& 2 at the beginning of the 5th semester and the student shall carryout complete process and mechanical design under supervision of a faculty. The student shall also prepare engineering drawing of the equipment and submit two copies of the design report in tight and bound form 7 days before commencement of 5th semester examination. Assessment would be made on the basis of the submitted report and the viva voce examination conducted by a board of examiners constituted by the Departmental Academic Committee consisting of two faculty members and class teachers with Head of the Department as Chairman during 5th. Semester examination

5th. Semester

Chemical Engineering

Electrical Machine Laboratory (ChE594A, EE….)

1. To study the open circuit and short circuit tests of a single-phase transformer.

2. To study the speed control characteristics of a D. C. shunt motor.

3. To study the saturation characteristics of a D. C. generator.

4. To study the external load characteristics of a D. C. shunt generator.

5. To study the speed-torque characteristics of an induction motor.

6. To study the open and short circuit characteristics of an alternator.

5th. Semester

Chemical Engineering

Machine Design Laboratory (ChE594B, ME ….)

1. Tension Test and Compression Test for ductile and brittle materials; stress strain diagram, determination of yield strength, ultimate strength, modulus of elasticity, percentage elongation, percentage reduction in areas, observation of fractured surfaces

2. Torsion test of circular shafts

3. Buckling test of columns/struts

4. Deflection of beams with various loads and at various locations

5. Efficiency of riveted joints – measurement by destructive tests

6. Study of Cotter joint, Knuckle joints, different couplings

7 Study of thick and thin pressure vessels—study by destructive tests in case of thin pressure vessel

Experiments are to be suitably designed consistent with the equipment.

6th. Semester
Theory

Principles of Management
HU-601
Contracts: 2L
Credits- 2

1. Basic concepts of management: Definition – Essence, Functions, Roles, Level.
2. Functions of Management : Planning – Concept, Nature, Types, Analysis, Management by objectives; Organisation Structure – Concept, Structure, Principles, Centralization, Decentralization, Span of Management; Organisational Effectiveness.
3. Management and Society – Concept, External Environment, CSR, Corporate Governance, Ethical Standards.
4. People Management – Overview, Job design, Recruitment & Selection, Training & Development, Stress Management.
5. Managerial Competencies – Communication, Motivation, Team Effectiveness, Conflict Management, Creativity, Entrepreneurship
6. Leadership: Concept, Nature, Styles.
7. Decision making: Concept, Nature, Process, Tools & techniques.
8. Economic, Financial & Quantitative Analysis – Production, Markets, National Income Accounting, Financial Function & Goals, Financial Statement & Ratio Analysis, Quantitative Methods – Statistical Interference, Forecasting, Regression Analysis, Statistical Quality Control.
9. Customer Management – Market Planning & Research, Marketing Mix, Advertising & Brand Management.
10. Operations & Technology Management – Production & Operations Management, Logistics & Supply Chain Management, TQM, Kaizen & Six Sigma, MIS.

Readings

1. Management : Principles, Processes & Practices – Bhat, A & Kumar, A (OUP).
2. Essentials for Management – Koontz , Revised edition, Tata McGraw Hill(TMH)
3. Management – Stoner, James A. F. (Pearson)
4.Management - Ghuman, Tata McGraw Hill(TMH)

Chemical Engineering

Separation Process - II (ChE 601)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module-I **10L**

HUMIDIFICATION & DEHUMIDIFICATION PROCESSES:
Introduction to Humidification and dehumidification operations, Characteristics of saturated and unsaturated vapor gas mixtures, Dry and wet bulb thermometry, Psychrometric chart, Adiabatic saturation curves, Psychrometric ratio, Gas liquid contact, Design of humidifiers, Dehumidification operation, Principle and design of cooling towers (Natural draft, forced draft and induced draft cooling towers).

Module-II **10L**

LIQUID-LIQUID EXTRACTION & LEACHING:
Introduction to Extraction, Liquid- liquid equilibria, Triangular diagram, Selectivity and choice of solvents, Stage-wise contact, Co-current & countercurrent extractor, Stage type extractors and differential extractors, Determination of number of equilibrium stages by graphical method for multistage extraction, Supercritical Fluid Extraction.

Module-III **10L**
LEACHING:
Introduction to leaching, General principle, Factors affecting the rate of extraction, Calculation of number of stages, Batch processes, Countercurrent washing, Stage calculation methods.

DRYING & CRYSTALLIZATION:
Introduction to drying, Rate of drying, Batch drying mechanism, Time of drying, the mechanism of moisture movement during drying, Classification and selection of dryer, Batch dryer and continuous dryer.
Introduction to crystallization, Theory of Crystallization, Formation and growth of crystals, Crystal yield, Rate of crystallization, Crystallizers.

Module-IV **10L**

ADVANCED SEPARATION PROCESSES:
Introduction to advanced separation processes, Classification of membrane processes, Dialysis, Ultra filtration, Reverse Osmosis, Reverse osmosis in water treatment plant, Pervaporation, Electro dialysis, Membrane fouling, Liquid membrane.

Text Books:
1. Mass Transfer Operations: Robert E. Treybal, MGH, International Student Edition.
2. Principles of Mass Transfer and Separation Processes, Binay K. Dutta, PHI
3. Transport Process and Unit Operations: Geankoplis. 3rd Edn., PHI.

References:
1. Separation Processes: King, C. J., MGH.
2. Unit Operation Handbook (Vol. I): John J. Mcketta.
3. Unit Operations in Chemical Engineering: McCabe, Smith, and Harriot. MGH, Sixth Edn.
4.Coulson, J. M. ,Richardson, J.F., Chemical Engineering, Vol 2, Pergamon Press.
5. Chemical Engineers' Handbook: Perry, J. H. MGH, 6th Edn.

6th. Semester

Chemical Engineering

Chemical Engineering Thermodynamics (ChE-602)

Module I: 10 L

Basic concepts and definitions & scope of thermodynamics. Thermodynamic systems and surroundings. Concepts of force, properties, energy, temperature, pressure, heat work, equilibrium, phase, process etc.

Volumetric properties of pure fluids: Graphical representation of P-V-T behaviour. Mathematical representation of P-VT behaviour: ideal gas law, cubic equations of state, virial equation of state and its application, Law of corresponding states, Generalised correlations for gases and liquids, acentric factor, compressibility factor.

First law of thermodynamics and its applications: First law of thermodynamics, Energy balance for closed system. Thermodynamic state and state functions. The reversible process. The adiabatic process. The constant volume and constant pressure process. Enthalpy, heat capacity. Mass and energy balance for open systems.

Module II: 10 L

Second law of thermodynamics and its application: Limitations of the first law of thermodynamics, statements of the laws. Heat engine and heat pump / refrigerator. Mathematical statement of second law. Carnot cycle and Carnot Theorems. Refrigeration cycle, criterion of irreversibility, clausius inequality, entropy and its change calculation for ideal gases. Absorption refrigeration, choice of refrigerant, Liquefaction process. The third law of Thermodynamics. *Concept of Thermodynamic scale of temperature;* Thermodynamic property relations: Maxwell relations. The Jacobian Method, Relation between heat capacities, Joule – Thomson coefficient, Clapeyron equation and enthalpy of vaporization.

Module III: 10 L

Solution Thermodynamics: Theory: Partial molar properties, partial properties in binary solution, chemical potential, Gibbs Duhem relation, fugacity, fugacity coefficient for pure species and solution. Generalized correlations for fugacity coefficient, Fugacity of liquid and solid. Ideal solution, Residual properties, phase equilibria, Lewis – Randall rule, simple models for low pressure vapor / liquid equilibrium, bubble pressure, dew pressure, bubble temperature, dew temperature and flash calculations. Modified Raoults' law, k-value correlations, Excess properties, Solution Thermodynamics: Applications:

activity & activity coefficient, Excess Gibbs free energy models – Margules, Redlick – Kister, Whol's, Van Laar, Wilson & NRTL, UNIQUAC, Group Contribution methods, Henrys law. Retrograde condensation, VLE at law to moderate pressures, Calculate the VLE data for a binary mixture from azeotropic conditions, VLE at high pressures. Thermodynamic consistency. Liquid-Liquid Equilibria (LLE), Adsorption equilibria - common adsorption isotherms.

Module IV: 10 L

Chemical Reaction Equilibria: Criterion of chemical reaction equilibrium, Application of Equilibrium Criteria to Chemical Reactions, the standard Gibbs Energy Change and the Equilibrium Constant, Effect of Temperature on the Equilibrium Constant, Evaluation and Relation of Equilibrium Constants, Equilibrium Conversions for single Reactions, Phase Rule and Duhem's Theorem for Reacting Systems, Electrochemical Equilibria and applications, Fuel Cells.

Text Books:

1. Introduction to Chemical Engineering Thermodynamics: Smith, J.M., Van ness, H.C. and Abbot, M.M., 6th Edn. MGH., 2001.

2. A Text Book of Chemical Engineering Thermodynamics, Narayanan, PHI

References:

1. Chemical Engineering Thermodynamics: Y.V.C. Rao.

2. Chemical Process Principles (Vol-2): O.A.Hougen, K.M. Watson and R.A.Ragatz.

3. Chemical and Process Thermodynamics: Kyle PHI.

6th. Semester

Chemical Engineering

Chemical Process Technology – II (ChE 603)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: 10L

Oils & Fats: Methods of extracting vegetable oils (Process Description and Flow sheet). Hydrogenation of oils (Process description & flow sheet), major engineering problems and improved technology. Soaps, Detergents & Glycerin: Classification of cleansing compounds, uses, Methods of soap production, Methods of detergent manufacture, Methods of production of Glycerin. Process description & flow sheet of each process.

Module II: 10L

Sugar and starch industries: Manufacturing process with flow diagram, Sugar refining, manufacturing process of starch and their different by-products; Glucose, Sorbitol & Polyols. Fermentation industries: Industrial Alcohol, Absolute Alcohol; their production process with flow diagram. Agrichemical industries: Elementary ideas on Pesticides, Insecticides, Fungicides, Herbicides, DDT manufacturing process with flow sheet.

Module III: 10L

Organic synthesis: nitration, sulfonation, amination, Halogenation, Hydrolysis with examples. Petrochemicals : Methanol, Vinyl chloride, Ethylene oxide, Isopropanol, Butadiene, Phenol and Pthalic anhydride – their manufacturing process with flow diagram and engineering problems

Module IV: 10L

Polymerisation: Principles of polymerization, Different methods of polymerization, manufacturing process and flow diagram for Polyethylene, PVC and Phenol formaldehyde. Rubber industry: Natural and synthetic rubber (SBR, Butyl rubber). Synthetic Fibre industry: Rayon, Nylon, Terelyne – Methods of production and flow diagrams.

Text Books :

1.Austins, G.T., Sherve's Chemical Industries, MGH 5th Edn.

2 Dryden, C. E., and Rao, M.G. (Ed.), Outlines of Chemical Technology Affiliated East West Press

3. Unit process in organic systhesis : P.H. Groggins,MGH

References:

1.. Venkateswarlu, S. (Ed.) Chemtech (II) Chemical Engineering Development Centre, IIT, Madras

6th. Semester

Chemical Engineering

Project Engineering (ChE-604A)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I **10 L**

Role of a project engineer, Development of project- Laboratory bench scale experiment to pilot & semi-commercial plant operation, scale up and scale down techniques, pre-design cost estimation, fixed capital and working capital, Manufacturing cost , plant location factors, selection of plant site, process design development, plant lay-out.

Module II **10 L**

Time value of money, simple interest, Nominal & effective interest rates, continuous interest, present worth & discount, Annuities, perpetuities and capitalized cost, Depreciation,: Types of depreciation, Depletion, Concepts of service life, Salvage value and Book value; Depreciation calculation by straight line method, Text book and double declining balance method, sum-of-the-years digit method and sinking fund method.

Module III **10 L**

Profitability analysis method: Return on investment (ROI), payout period, Net present worth (NPW), Discounted cash flow rate of return, (DCFR), effect of inflation on profitability,

Alternative investment,; Choices among various alternatives, Replacements, Methods of profitability evaluation for replacements.

Optimum design, Break-even point, Optimum production rate, Optimum conditions in cyclic operations, optimum economic pipe diameters, optimum flow rate,& cooling water.

Module IV **10 L**

Project scheduling: Bar chart, Milestone chart, Concept of network analysis,: PERT, CPM, statistical distribution associated with PERT network, Earliest expected time, and latest allowable occurrence time calculation, Slack, determination of critical path, concept of float.

Text Books:

1. Plant Design & Economics for Chemical Engineers- By M. Peter & K.D. Timmerhaus, 4rth edn, MGH
2. Chemical Engineering Plant Design-By Himmelblau.

PERT CPM, L. S. Srinath, East West Press

6th. Semester

Chemical Engineering

Advanced Separation Processes (ChE 604B)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: 10 L
Membrane Separation Process: Types of membranes, structural properties of membranes, Mechanical properties of membranes. Organic & Inorganic membranes, advantages & disadvantages and applications of various membranes, membrane modules, transport mechanism in membrane process, formation of liquid membrane, operational aspects of liquid membrane, effect of various operating conditions on the performance of LSM, advantages & disadvantages of liquid membrane.

Module II: 10 L
Ultrafiltration: UF modules, applicability, concentration polarization.

Reverse Osmosis: Fundamentals of RO, Osmotic pressure, relation between chemical potential & osmotic pressure, factors affecting the performance of RO plant, RO membrane module, membrane age, advantages, disadvantages and

application of RO process.

Module III: 10 L
Pervaporation: Theory of Pervaporation, separation factor, factors affecting pervaporation – Classical Pervaporation, Air heated pervaporation, Osmotic Distillation, Thermopervaporation, Reactive pervaporation, advantages of pervaporation, application of pervaporation.

Chromatographic Separation: Theory of Chromatographic separation, selectivity or separation factor, Efficiency of chromatographic system, types of Chromatography, Liquid Chromatography, Liquid-Solid Chromatography, High performance liquid chromatography; development of model equations for Chromatography, Numerical problems; Advantages & Disadvantages of Chromatographic Separation.

Electrophoresis: Basic principles, Proteins and amino-acids separation; Operation of vertical and horizontal electrophoresis- casting gel, plating, SDS- PAGE Electrophoresis

Module IV: 10 L
Gas Separation: Theory of gas separation and permeability, permeability ratio and Knudsen diffusivity, factors affecting permeability, separation factors, application of gas separation process.

Dialysis: Theory of Dialysis, separation factor in Dialysis, Fluid film resistance in dialysis, dialysis membrane, application of dialysis process.

Revision: 5 L
Text Book:
1. J.D. Seader and Ernet J. Henlay; Separation Process Principles.
2. C.J. King; Hand Book of Mass Transfer.
References:
1. Synthetic Membranes: Bunge
2. Membrane Handbook by Ho and Sircar, Marcel Dekkar
3. Ultrafiltration Handbook by Munir and Cheriyan Ultrafiltration, CRCPress.
4. Practical Biochemistry: Principles & Techniques, Wilson & Walker, 5ed. Cambridge Univ. press

6th. Semester

Chemical Engineering

Environmental Engineering (ChE 605A)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: 10 L

Types of environments and their pollutants. Classification of pollutants. Legislative aspects including water act. 1974, Air Act 1981 and efflument standards. EPA

Air pollution : Sources and effects of different air pollutants, Sampling and analysis of air pollutants, Air pollution control methods and equipment, Cyclone Separator, Baghouse, ESP, Venturi Scrubber

Module II: 10 L

Water pollution: Sources, sampling and classification of water pollutants, determination of basic parameters and computations associated with: BOD, COD, TS, TDS, SS;

Waste water treatment: primary, secondary, tertiary and advanced; aerobic treatment with special reference to activated sludge, trickling filter, RBDC and RBRC, EA; non conventional: WSP, anaerobic treatment with special reference to AFFR, UASB

Module III: 10 L

Solid waste management: Sources and classification, public health aspects, Methods of collection and disposal methods: open dumping, landfill, incineration, composting, vermiculture; Solid waste management using bioremediation for specific pollutants like chromium. Mercury, ammonia / urea, phenolic sludges. Management and handling of Bio-medical waste; E-waste – classification and re-use and disposal; Hazardous waste management – Electro-chemical and photo-chemical oxidation - dye waste, chrome slag – case studies.

Module IV: 10 L

Pollution control in selected process industries – fertilizer industries, petroleum refineries and petrochemical units, pulp and paper industries, Tanning industries, Sugar industries, Dairy, Alcohol industries, Electroplating and metal finishing industries, Radioactive wastes, ranking of wastewater treatment alternatives. Case Studies.

Text Books:

1.Environmental Pollution Control Engineering – C S Rao, New age

2 Wastewater Engg. – Metcalf & Eddy, TMH

References:

1.Pollution Control in process industries – S.P.Mahajon

2.Introduction to Environmental Engineering – Connwell & Devis. TMH.

3.Air Pollution – Rao,

4. Standard Methods APHA /AWWA

5. Wastewater treatment for pollution control – S.J.Arceivala, TMH

6th. Semester

Chemical Engineering

Industrial Safety and Hazard Analysis (ChE605B)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: 10L

Definition of safety, Hazard and Risk, Safety program, Engineering ethics, Inherent safety, Safety regulations, OSHA, Process safety management, Windroses, Hazards due to fire, explosions and toxic chemicals, Distinction between fire and explosion,Upper Flammability limit and Lower Flammability Limit, Fire Triangle, BLEVE, Runaway reaction.

Module II: 10L

Tools for hazards identification: HAZOP, Fault Tree, Event Tree, FMEA, Dow Fire and Explosion Index, Mond Index, Safety Audits..

Module III: 10L

Risk analysis concept and methodology: Risk concept and measure of risk, Risk acceptance criteria, Quantitative risk analysis, Probit number.

Module IV: 10L

Engineering control of chemical plant hazards, Intensification and attenuation of hazardous materials, Industrial plant layout, Ventilation, Fire prevention, Personnel protection devices, Laboratory safety, Emergency safety, Safety systems and disaster management. Case studies, Flixborough (England), Bhopal (India), Seveso (Italy), Pasadona (Texas)

Text Books :

1. Chemical Process Safety: Fundamentals with Applications: D. A. Crowl and J.F.Louvar, Prentice Hall, 1990

References:

1. Safety in Chemical Process Industries: 0. P. Kharbanda, E. A. Stallworthy, Heinmann Professional Publishing LTD.,1988

2.. Hazardous Waste management: C. A. Wentz, MGH.

3..Environmental Risks & Hazards, S.L. Cutter, Prentice Hall,1994

6th. Semester
Chemical Engineering
Practical

Process Equipment Design and Drawing-II Laboratory (ChE 691)

1. Design and Drawing of a Reactor.
2. Design and Drawing of Distillation column/Absorption tower/ Dryer.(Any one)

Each student shall be allotted design problems on sl. no 1& 2 at the beginning of the 6th semester and the student shall carryout complete process and mechanical design under supervision of a faculty member. The student shall also prepare engineering drawing of the equipment and submit two copies of the design report in tied and bound form 7 days before commencement of 6th semester examination. Assessment would be made on the basis of the submitted report and the viva voce examination conducted by a board of examiners constituted by the Departmental Academic Committee consisting of two faculty members and class teachers with Head of the Department as Chairman during 6th. Semester examination

6th. Semester

Chemical Engineering

Feasibility Analysis (ChE 692)

Each student shall have to carry out Techno Economic Feasibility Analysis of a proposed chemical plant with a given production rate assigned to him /her at the beginning of the 6th semester.. The student shall have to submit two copies of the report in tight and bound form 7 days before commencement of 6th semester examination. Assessment would be made on the basis of the submitted report and the viva voce examination conducted by a board of examiners constituted by the Departmental Academic Committee consisting of two faculty members and class teachers with Head of the Department as Chairman during 6th. Semester examination

6th. Semester

Chemical Engineering

Environmental Engineering Laboratory (ChE 693A)
(At least eight experiments are to be done)

1. Determination of COD of Wastewater
2. Determination BOD of Wastewater obtained from Dairy /Sweetmeat shop/kitchen waste
3. Determination of Oil & Grease of Wastewater obtained from Petrol Pump
4. Determination of excess Chlorination using Chloroscope
5. Determination of concentration of particulate matter in ambient air using high volume/RSPM sampler.
6. Determination of Bacteriological Parameters of Drinking water.
7. Determination of concentration of arsenic in contaminated ground water.
8. Determination of concentration of Chromium in tannery wastewater
9. Determination of concentration of Mercury in wastewater/ contaminated sludge
10. Determination of concentration of iron in ground water.

Book: Standard Methods APHA /AWWA

6th. Semester

Chemical Engineering

Engineering Drawing (ChE693B)

Drawing of the following: (S. No. 8 and any three of the remaining items)

1. Flange Coupling

2. Hydraulic Pipe Joints

3. Valves

4. Stuffing Box

5. Belt-Pulley

6. Screw Jack

7. Cylinder heads & Cover plates.

8. Assembly Drawing of any Chemical Engineering equipment.

Text Book/ References: 1. Machine Drawing: N.D. Bhatt & V.M.Panchal: Anand India.

6th. Semester

Chemical Engineering

Seminar (ChE 694)

A Seminar topic will be allotted to individual student according to his/her subject of interest. A thorough report should be prepared based on which seminar presentation and question-answer session will be conducted. Assessment of the student would be done by the faculty members on the basis of presentation, performance in the question - answer session and the report submitted.

7th. Semester

Chemical Engineering

Transport Phenomena (ChE 701)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: 10L

Concept of unified approach to Momentum, Heat and Mass Transport through Transport Phenomena - Assumptions of Transport phenomena; Similarity of Mass, Momentum and Energy transfer, Diffusivities, Transport Theorem.

Review of Vectors & Tensors:

Viscosity, Newton's law of viscosity, calculation of momentum flux, Non-Newtonian fluids – Bingham model, Ostwald-de Waele model, Eyring model, Reiner-Philippoff model.

Shell momentum balance and boundary conditions.

Module II: 10L

Momentum Transport:

Flow of a falling film with constant/variable viscosity, Flow of Newtonian or Non- Newtonian fluid through a circular tube, Flow of Newtonian or Non- Newtonian fluid through annulus, Flow of two adjacent immiscible fluids, Flow of a film on outside of circular tube, Creeping flow around a sphere.

Equations of Continuity and Motion in rectangular (Cartesian) coordinate system, Expression of stress tensor for Newtonian and non-Newtonian fluids; Special forms of equation of Motion – Euler equation, Navier-Stokes equation.

Transformation of equations of Continuity and Motion to cylindrical coordinate system by changing variables and using vector calculus.

Use of the above conservation equations – Steady incompressible flow through circular tube, Laminar flow between two flat stationary/moving plates, Shape of the surface of a rotating fluid.

Concept of Boundary layer and Boundary layer theory. Concept of turbulence, Time-smoothed quantities, Reynolds' decomposition, RANS (Reynolds Averaged Navier-Stokes equation).

Dimensional analysis of equations of Continuity and Motion.

Module III: 10L

Energy Transport:

Modes of heat transfer; concepts of (a) thermal conductivity – constant and temperature dependent, (b) thermal diffusivity and (c) heat transfer coefficient. Fourier's law of heat conduction. Shell energy balance and boundary conditions – Heat conduction with electrical, nuclear, viscous and chemical heat source, Heat conduction through composite walls, Heat conduction in fins, Heat conduction from a sphere to stagnant fluid.

Free convection – flow between two vertical walls.

Equation of energy (general convection-diffusion equation) – rectangular coordinate system. Use of the Energy equation - Unsteady state conduction in finite and semi-infinite slabs.

Concept of thermal boundary layer vis-a-vis hydrodynamic boundary layer – effect of Prandtl number on thermal boundary layer thickness.

Module IV: 10L

Mass Transport:

Concentrations, Velocities and Mass and Molar fluxes. Concept of Mass diffusivity and Mass transfer coefficient. Fick's law of diffusion.

Shell mass balance and boundary conditions – Diffusion through stagnant gas film, Diffusion in a falling film, Diffusion with heterogeneous chemical reaction, Equations of Continuity for binary mixture, simplification of general equation for special cases.

Dimensional analysis of the equations of Continuity – role of Schmidt number.

Generalized Transport Equation:

General Advection-Diffusion equation - conservation equations (Motion, Energy and Species concentration) in terms of general variable (Φ) and diffusivity. Concept of coupled equations.

Text Book:

1. Transport Phenomena: R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot. , John Wiley & Sons Inc. Asian Students Edition.

References:

1. Transport Phenomena, R.S.Brodkey and H.C. Herskey, Mc.Graw Hill, 1988.

2. Transport Processes and Unit Operations, C.J. Geankoplis, Prentice Hall, III Edition, 1993.

7th. Semester

Chemical Engineering

Instrumentation and Process Control (ChE 702)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: 10 L

Introduction: Principles of measurement. Error Analysis, Static and dynamic characteristics of instruments.

Temperature measurement: Filled system Thermometer, Thermocouples, Resistance Thermometers, radiation and optical pyrometers;

Pressure: Manometers: U tube manometer, inclined limb manometer, Ring balance manometer, elastic deformation: bourdon, bellows, diaphragm and electrical type gauges: strain gauge, piezoelectric, pressure transducers (inductive/capacitive).

Vacuum gauges: mechanical, electrical and ionization types;

Flow: Head flow meters, area flow meters, positive displacement flow meters, mass and magnetic flow meters;

Level: Direct and inferential type; composition.

Module II: 10L

Different forcing functions: Step, Impulse, Ramp, Sinusoidal and frequency inputs & their graphical representation.

First order system; transfer function; response of different forcing functions; two first order systems in series- non- interacting & interacting Second order system: under- damped, critically damped & over damped, Transportation lag.

Module III: 10 L

P, PI, PD, PID & their transfer function, different types of control valves; characteristic curve & transfer function, servo & regulatory control.

Elementary idea of feed forward, feed back, cascade, ratio.

Block diagram of different chemical process units, open loop & closed loop transfer function, simple models : stirred tank, shell &tube heat exchanger, distillation column, different types of controllers .

Module IV: 10L

Definition of stability, concept of unbound function, Routh Array, Bode stability analysis, Nyquist stability criteria, Root Locus method, Zeigler-Nichols controller settings, adaptive & digital control. Concept of PLC & DCS.

Text Books:

1. D.Patranabis, “Principles of Industrial Instrumentation”, Tata McGraw Hill, Publishing Ltd, New Delhi, 1999

2. Process system analysis & Control – D. R. Coughanowr MGH.

3 Chemical Process Control – G. Stephanopoulus PHI.

4. Industrial Instrumentation Fundamentals, A.E. Fribance, McGraw – Hill Education

References:

1. Industrial Instrumentation, D.P. Eckmann, Wiley Eastern Limited

7th. Semester

Chemical Engineering

Material Science & Material of Construction (ChE-703A)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module - I: 10L

Structure of materials-Various types of bonds; Crystalline Structure of Solids- concepts of unit cell and space lattice, packing factor; X-ray diffraction for determining crystal structure; Mechanical properties: Strength, hardness, toughness, ductility, brittleness of Engineering Materials**;** Elastic, an-elastic and visco-elastic behaviour of materials; Electrical, Electronic, Optical & Optoelectronic properties of material; Inorganic & organic amorphous materials and their structural & property characteristics; Optical fibers.

Module - II: 10 L

Mechanism of plastic deformation, slip and twinning, structural imperfections: elementary concepts of point, line, surface & volume imperfections; Influence of dislocations/Line imperfections on the mechanical properties of materials***;*** Strain hardening and recrystallization; Elementary aspects of creep, fatigue, fracture; Phase Diagrams- Solidification and structure of metals, Grain boundaries; Phase equilibrium and phase diagrams of binary alloys; Phase diagram of ternary systems; Iron-Carbon diagram; Heat Treatment –Introduction and purposes of heat treatment; T-T-T Curve; Corrosion-Concepts and forms of corrosion; Corrosion Mechanism and prevention; Protective materials and coating.

Module – III: 10 L

Basic principles of metal extraction: Pyrometllurgy: calcinations, roasting—oxidizing, predominance area diagrams, multiple hearth, flash and fluo-solid, sintering, smelting, slag and its classification.

Steelmaking process flow diagram: Iron making (Operation involved in Blast furnace)– Steel making (oxygen blown converter – LD) – Secondary steel making / refining (ladle processing, vacuum degassing, ladle furnace processing) – Continuous casting - with emphasis on application of the concepts of physicochemical principles involved, moving/packed bed reactor, gas-liquid two-phase flow, heat transfer with phase change (solidification).

Module - IV: 10 L

Principles of Hydrometallurgy and Electrometallurgy, Extraction of Aluminum: Hall-Heroult process, Electrolytic refining; Sources of Zinc & Copper: Pyro & Hydro metallurgical extraction of copper & Zinc; Extraction of Lead, Recent development in Lead smelting.

Text Books:

1. Raghavan, V. Material Science and Engineering, Prentice Hall of India

2. Ray, Sridhar & Abraham. Extraction of non ferrous metal, EWP

References:

1. Lawrence, H. Vanvlack, Elements of Material Science and Engineering

Pearson Education.

2. Lakhtin, Engineering Physical metallurgy; MIR publishers.

3. L. Von Bogdandy and H.J Engell: The Reduction of Iron Ores, Springer-Verlag, NY.

4. R.I.L Guthrie: Engineering in Process Metallurgy, Oxford University Press (Paperback edition 1992).

7th. Semester

Chemical Engineering

Petrochemical Technology (ChE 703B)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: 10 L

Petrochemical Industries & their feed stocks: Brief History and Survey of Petrochemical Industries in India. Different feed stocks used for Petrochemical Industries and their sources. Feed stocks used by Petrochemical Industries in India and their sources. Impurities in feed stocks and processes for their removal.

Natural Gas processing. General idea of LNG, CNG, NGL, LPG and their generation.

Production and Utilization of Synthesis gas: Process of Synthesis gas production by steam reforming of Natural Gas and Naphtha and partial oxidation of Fuel Oil.

Production of Methanol from Synthesis gas. Chemicals from Synthesis gas by Oxosynthesis. Production of liquid fuels from Synthesis gas by Fischer – Tropsch process.

Module II: 10 L

Name of Major Petrochemical products and their applications. First, Second and Third generation petrochemical products.

Production of Ethylene, Propylene,and Butadiene by Naphtha/Gas cracking.

Petrochemicals based on Ethylene, Propylene and Butadiene : Like VCM, VAM, Ethylene Oxide, Ethylene Glycol, Ethanol Amines from Ethylene. Acrylonitile, Isopropanol, Propylene oxide, Glycerine, Acrylic acid, Acrolein from Propylene. Production of Butadiene.

Module III: 10 L

Production, Separation and Utilization of Aromatics :- Catalytic Reformation of Naphtha and production of Xylenes. Separation of Xylenes. Isomerization of Meta xylene.

Pyrolysis Gazoline hydrogenation and separation of BTX aromatics. Production of Benzene, Toluene, Xylenes from BTX aromatics by distillation. Production of Benzene from Toluene. Uses of xylenes.

Alkylation of Benzene. Production of Styrene, Cumene and Phenol.

Production of Phthalic Anhydride etc.

Synthetic Detergents: Classification of detergents. Production of Linear Alkyl Benzene (LAB) from Superior Kerosene and Benzene. Sulphonation of LAB for production of Synthetic Detergents. Additives for synthetic detergents. Hard and soft detergents.

Module IV: 10 L

Plastomers, Elastomers and Synthetic fibres. : Various methods of polymerization and their mechanisms. Production processes of LDPE, LLDPE and HDPE. Basic difference among the three and their applications. Production of PVC and Polystyrene.

Production of Polypropylene. Production of SBR, PBR and Butyl rubber. Production of ABS plastics. Production of Polyamide (Nylon 6 and Nylon 6,6) , Polyester and Acrylic fibres.Production of Phenol Formaldehyde resins.

Text Books :

.1. Petrochemical processes: Chauvel ,Gulf Publishing

2. A Text on Petrochemicals: B.K.B. Rao, Khanna Publishers

References:

1. The Petroleum chemicals Industry: R. F. Goldstein and A. L. Waddams.

2. Advanced Petrochemicals: Dr. G. N. Sarkar, Khanna Publishers

3. Introduction to Petrochemicals, Sukumar Maity. Oxford and IBH Publishing Co.

7th. Semester

Chemical Engineering

Biotechnology & Biochemical Engineering (ChE 703C)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: 10L

Basic Biochemistry & Microbiology
Introduction, microbial diversity, viruses, procaryotes, eubacteria, archaebacteria, eucaryotes, cell construction, gram staining technique, general discussion on and structure of amino acids and proteins, carbohydrates and polysaccharides, lipids, fats and steroids, nucleic acids, RNA and DNA, cell nutrients, macro and micro nutrients.

Different culture techniques, preparation of media and observation of characteristics, aseptic technique, obtaining bacterial colonies, counting bacteria.

Metabolic regulation, DNA replication, transcription, translation, metabolic pathway control, mechanism to transport across cellular membranes, cell receptors and cellular differentiation.

Module II : 10L
Enzyme Kinetics and Protein Engineering
Example of material balance of bioprocess, Enzymes and substrates, Standard proteins, mechanistic models for simple enzyme kinetics, derivation of Michaelis-Menten equation, Briggs-Haldane assumption, experimental determination of rate parameters: Lineweaver-burk, Eadie-Hofstee and Hanes-Woolf plot, interpretation of K_m and V_m,
Model for complex enzyme kinetics: Allosteric enzymes, Principles of enzyme inhibition – Competitive, nonco Effects of pH and temperature, insoluble substrates

Immobilized Enzyme systems: Methodology – entrapment, surface Immobilization, diffusional limitations: surface-bound enzymes on nonporous and materials.

Module III : 10L
Bioseparation Technology

Separation of insoluble biomolecules and products: filtration, centrifugation, coagulation and flocculation.Cell disruption: Mechanical and non-mechanical methods.Separation of soluble products, precipitation, Salt precipitation: modification of solvent and solute properties, pH change, iso-electric precipitation.

Application of Chemical Engineering principles in Bio-separation, aqueous two-phase extraction, adsorption, dialysis, micro filtration and Ultrafiltration, Reverse osmosis.

Chromatographic separation: Classification of chromatographic processes, affinity chromatography: inhibitors: their preparation and uses, method of linkages, elusion chromatography, molecular sieving chromatography, HC and HPLC.

Column chromatography: material balance, numerical examples.

Electrophoresis: General principles, SDS-PAGE, experimental methodologies, iso-electric focusing.

Industrial aspects of separation of bio-molecules, Material balances, mathematical analysis and modeling: Case studies.

Module IV: 10L

Biochemical Reaction Engineering

Cell growth kinetics, Substrate limited growth, the logistic equation, rate loss, stoichiometry, mass balances, design equations, numerical problems, wash out, oxygen limited fermentation, scale up concepts of bio-reactors, chemostat and its applications, continuous culture devices, case studies on penicillin production.

Books:
1.Bioprocess Engineering—Basic Concepts, second ed. Schuler & Kargi, PHI, 2002

2.Microbiology-5ed (Paperback) Pelczar, N R K M J Tata Mgraw Hill, 2005

References:

1.Bioprocess Engineering Principles (Paperback) Doran, PM Elsevier India (2009)
2.Chemical Engineering, V2, 5ed. Coulson Richardson, Elsevier

3.Practical Biochemistry: Principles & Techniques, Wilson & Walker, 5ed. Cambridge Univ. press

4.Process Biotechnology Fundamentals 2nd/ed by S N Mukhopadhyay, Viva books, 2005

7th. Semester

Chemical Engineering

Numerical Methods in Chemical Engineering (CHE 704A)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: **10L**

Error Analysis: Taylor series expansion, Truncation error. Round-off error vs. Chopping-off error. Propagation of Error

Solution of simultaneous linear equations: Gauss elimination Method, Gauss-Jordon Method -Pivoting and ill-conditioning, Condition number of a matrix. Iterative method - Jacobi iteration, Gauss-Seidel Method. SOR method, Application in steady-state solution of isothermal CSTR in Series in which a first-order reaction is taking place and multiple reactions in CSTR. Tri-Diagonal Matrix Algorithm (TDMA).

Module II: 10L

Solution of Non-linear equations:

Bisection method, Newton-Raphson method, Secant method, Modified Newton-Raphson method for multiple roots - Application in thermodynamic property calculation, bubble point and dew point calculation. Finding of multiple roots of a polynomial. Solution of a set of non-linear equations - Newton's method, Jacobian matrix, charactertics equations and stability analysis of solution. Steady-state solution of a non-isothermal CSTR in which a first-order reaction is taking place.

Module III: **10L**

Curve-fitting **:** Linear least-square method for straight line and polynomial. Lagrange interpolation.

Numerical Solution of ODE: Initial and boundary value problem- Explicit ADAMS-BASHFORTH Techniques like Euler's Method, ADAMS-BASHFORTH 2nd and fourth order methods. Implicit ADAMS-MOULTON techniques including Implicit Euler. Runge-Kutta Method(2nd, 3rd and 4th order), Euler's predictor-corrector method (Heun' method)- finite difference method (forward, backward and central differences), Stability analysis of ODES of Euler methods, Runge-Kutta methods, step-size control. Solution of a set of ODEs. Application in chemical and bio-chemical reaction.

Module IV: **10L**

Numerical Integration: Trapezoidal rule, Simpson's 1/3rule.

Numerical Solution of PDE: Explicit, Implicit and Crank-Nicholson method for elliptical and parabolic equation. Convergence and stability criteria of these methods. Application in unsteady-state heat transfer through a slab and unsteady-state tubular reaction problem.

Text Book :

1.Numerical Methods for Engineers: Santosh Kr. Gupta, New Age International (P) Limited

2.Applied Numerical Methods with Personal Computers: Alkis Constantinides, MGH

References :

1Numerical methods for Mathematics, Science and Engineering: John H. Mathews , PHI

2Applied Numerical Methods: Carnahan, H.A.Luther and J.O.Wilkes, Wiley

3.Numerical Methods for Engineers With Software and Programming Applications: Steven C. Chapra, Raymond P. Canale , TATA Mc-Graw-Hill Publishing Company Limited

7th. Semester

Chemical Engineering

Ceramic Technology (ChE 704B)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I 10 L

Introduction to Ceramics: Definition & Classification of ceramic materials based on composition, properties & applications (Refractories, cement, Glass & Whitewares, Electro-ceramics & magnetic ceramics & Fine ceramics & Glass-ceramics, Cermets);

Fundamental Structural principles, composition, properties & uses: Natural ceramic minerals & materials such as Clay family, Quartz/Quartzite, Feldspar, sillimanite, Bauxite family, Dolomite, Magnesite, etc &

Synthetic Ceramic Raw Materials such as sintered Al_2O_3, fused Al_2O_3, Mullite, Mag-Al Spinel, ZrO_2, TiO_2/ Titanate, Ferrites, spinel etc. Importance of synthetic ceramic raw materials, Preparation & composition; General techniques of preparation: powder preparation: Sol-Gel, Co-precipitation, solvent vaporization; Characterization & uses.

Thermal changes and behaviours of ceramic materials: Bauxite family, magnesite, dolomite, chromite, graphite, clay minerals

Module II 10 L

Materials properties & behaviours: Particle mechanics and rheology, Newtonian fluid, plastic flow, dilatant liquid, thixotropy, Deflocculation, effect of electrolytes on Zeta potentials applications in ceramic processings.

Beneficiation Processes, Comminution: Equipments, milling, particle size distribution. **Principles of ceramic fabrication:** Size reduction, size separation, Body preparation, Filtration, Methods of forming;

Forming processes: Dry pressing, cold isostatic pressing, plastic forming – Extrusion, Jiggering, Jolleying; Casting process: Slip Casting, Drying –drying processes, Mechanisms in drying, defects shaping, surface finishing, and glazing. Firing – Firing system, Pre sintering processes, sintering, and vitrification and cooling.

Module III 10 L

Refractories: Introduction: raw materials, Fabrication and firing, General manufacturing techniques, Properties and applications of following refractories: Acid (Silica) Refractories, Basic Refractories, Burnt refractories – Sintered and fused refractories: - Chemically bonded and Direct bonded; Insulating Refractories;

Testing of important properties of refractories: Total Porosity, gravity, C.C.S, Cold MOR, Hot MOR, PCE, RUL, Compressive Strength, Spalling Resistance, corrosion resistance.

Cement: Definition & different types of cement, Raw materials and their physico – chemical characteristics, manufacturing processes of Pozzolana, Portland cement, cement making kilns viz, Rotary and shaft kiln. Refractory used in Rotary kiln, reactions occurred in different zones of rotary kiln. Testing of different properties of cement: Hydraulicity, Soundness, Compressive strength, Heat of setting & hardening etc;

Module IV 10 L

Glass: Definition of glass: Thermodynamic study for glass formation, Glass transitions Conditions of vitrification; **Glass processing:** selection of raw materials, effects of different oxides on glass properties, batch preparation, melting in glass tank furnace, refining of glass, Forming process: Blowing, molding , shaping etc; .

Properties of glass: Optical properties of glasses namely, Refractive index, Birefringence, ultraviolet– visible absorption, Colloidal colours, Solarisation, Infra-red absorption, Photosensitive/Photo chromic glasses.

Whitewares: Definition, Raw materials, compositions, Body preparation & fabrication, Drying, Firing, Glazing & decorations, Defects & remedies, Current trend & future challenges.

Powder Metallurgy: process description, Maintenance of metal powders, Blending of powders, Compaction, Pre-sintering, Sintering, Secondary operation, Products of powder metallurgy, Advantage of the process, Disadvantages & limitation, Design.

Text Books:

2. Elements of Ceramics - F.H Norton
3. Introduction to Ceramics - W.D Kingery
4. Industrial Ceramics - Singer & Singer.

Reference:

5. S. Kumar: Hand book of ceramics ; Vol – I & II
6. The Technology of Ceramics and Refractories – P.P. Budnikov.
7. Cement Chemistry by F.W. H. Taylor
8. Concrete Technology by Neville.

7th. Semester

Chemical Engineering

Total Quality Management (ChE 705A)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: 10L

Basic concepts– Three paradigms of management and evolution of concept of quality management, Organization: its basic objectives and goal, Mission and Vision, customer and secondary customer, Deming's wheel, bottom line: profit vs quality, historical defilements: Juran, Deming, Ischikawa and Taguchi, Kaizen, JIT. Basic statistical concepts associated with quality management, measurement of central tendency and dispersion, range versus variance, quality and process capability, probability distributions, concept of statistical quality control.

Module II: 10L

Use of control charts and process engineering techniques for implementing the quality plan: X—R chart, moving average chart, p-chart, c-chart and control chart for continuous production

Acceptance sampling: single–double and multiple sampling, AOQ, AQL, LTPD, Chain sampling plan, Dodge-Romig plan.

Module III: 10L

Tools and techniques for improvement in TQM: type A techniques with a special reference to FPC & FD, QFD, SWOT analysis; type B techniques with a special reference to brainstorming, stratification, Ischikawa diagram, check sheet, Pareto diagram Philosophy and concept of quality circle: formation, steering committee, power and functions of leader, dy. Leader, coordinator, facilitator, case studies.

ModuleIV: 10L

Different standards: ISO, BS and bureau of Indian standards, details of ISO 9000 series, ISO 14000 series and SA 8000 and the certification authorities, productivity control management.

Text Books /

1. Statistical quality control, Grant,MGH.

References:

1. Total Quality Management- A Practical Approach: H. Lal, New Age International

Qualty Circle : S R Udpa,

2. Total Quality Management – A Primer: Sundara Raju S. M., TMH.

3. Fundamentals of Quality Control Improvement, Mitra, PHI

4. TQM -SK Ghosh, Oxford

7th Semester

Chemical Engineering

Operations Research (ChE 705B)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I 10L

Definition of O.R. , Characteristics of O.R. , Necessity of O.R. in industry, O.R. and Decision making , Scope of O.R. in management, Objectives of O.R. , Types of mathematical models, Role of computer in O.R., Requirements for linear programming problem (L.P.P.), Examples on the application of L.P.P., Graphical solution of Two Variables L.P.P., Canonical and standard Forms of L.P.P., Development of Simplex Method with examples, The Big-B Method with examples.

Module II 10L

Transformation Model with examples, Assignment Model with examples, Duality in L.P.P. with problems, Sensitivity Analysis with problems.

Module III 10L

Dynamic Programming, its need and problems, Decision Theory with problems, Game Theory with problems.

Module IV 10L

Queuing Models With Problems (Model I, II, III only), PERT &CPM with problems.

Text Books

1. Optimization Theory & Applications- S.S.Rao, Wiley Eastern Ltd.
2. Operations Research- An Introduction-7th edition, -H.A.Taha (EEE) PHI.
3. Operations Research with C Programs- S. Kalavatty- Vikas Publishing House Pvt. Ltd.
4. Operations Research- K.Swarup, P.K.Gupta, &Man Mohan –Sultan Chand & Sons.

7th. Semester

Chemical Engineering

Processes Instrumentation and Control Laboratory (ChE 791)

(At least eight experiments)

1.0 Temperature Measurement using Resistance Temperature Detector (RTD), Thermocouple.

2.0 Pressure gauge calibration using Dead Weight Tester

3.0 Liquid-Level Measurement using Air-Purge Method

4.0 Measurement using Load Cell

5.0 Study on Responses of First and second-Order Interacting and non-interacting Systems

6.0 Studies on Characteristics of Control Valve

7.0 Studies on the Stability and tuning of a Flow Controller

8.0 Response of a P & PI Controller

9.0 Demonstration of Bourdon tube, diaphragm gauge.

7th. Semester

Chemical Engineering

Biotechnology Laboratory (ChE 792A)

(At least eight experiments)

1. Media preparation and Staining Techniques (Simple, Gram staining, spore staining).
2. Studies on Growth Kinetics of microbial cells and to determine intrinsic kinetic parameters.
3. Studies on sterilization and death rate kinetics.
4. Kinetic studies on hydrolysis of protein using proteolytic enzymes.
5. Studies on enzyme immobilization techniques and to find out enzyme loading.
6. Separation of proteolytic enzymes by Ultra filtration Technique.
7. Studies on isolation of enzymes by protein precipitation technique.
8. Application of electrophoresis technique in enzyme technology.
9. Kinetic Studies on production of ethyl alcohol using *Saccharomyces cerevisiae.*

7th. Semester

Chemical Engineering

Numerical Computations Laboratory (CHE 792B)

Numerical Methods (Programming language: C/FORTRAN)

1. Solution of Linear System by Gauss Elimination method and Gauss-Seidel iterative method: Steadystate solution of isothermal CSTR in Series in which a first-order reaction is taking place.

2. Solution of a non-linear equation by Newton-Raphson method.

3. Solution of a set of non-linear equations by Newton method: steady-state solution of a nonisothermal CSTR in which a first-order reaction is taking place.

4. Solution of one-dimensional unsteady state heat conduction problem using Taylor series based Finite Difference Method – Explicit scheme, Implicit scheme using Tri-diagonal Matrix Algorithm (TDMA).

5. Numerical solution of ODEs by Runge-Kutta method : Unsteady-state solution of Multiple reactions in a CSTR or Binary distillation column

Use of MATLAB / POLYMATH software to solve following problems:

6. Solution of Linear System: Steady-state solution of isothermal CSTR in Series in which a first-order reaction is taking place.

7. Solution of a set of non-linear equations: Steady-state solution of a non-isothermal CSTR in which a first-order reaction is taking place

7th. Semester

Chemical Engineering

Total Quality Management Laboratory (ChE 793A)

Case studies have to be carried out by each student. The report in duplicate has to be submitted in typed and bound form 7 days before commencement of the seventh semester examination. Assessment would be made on the basis of the submitted report and the viva voce examination conducted by a board of examiners constituted by the Departmental Academic Committee consisting of two faculty members and class teachers with Head of the Department as Chairman during 7th. Semester examination

7th. Semester

Chemical Engineering

Operation Research Laboratory (ChE 793B)

Case studies have to be carried out by each student. The report in duplicate has to be submitted in typed and bound form 7 days before commencement of the seventh semester examination. Assessment would be made on the basis of the submitted report and the viva voce examination conducted by a board of examiners constituted by the Departmental Academic Committee consisting of two faculty members and class teachers with Head of the Department as Chairman during 7th. Semester examination

7th. Semester

Chemical Engineering

Industrial Training (ChE 794)

Students will be sent for training to a chemical industry for a period of 4 to 6 weeks after completion of 6th. Semester examination. After completion of the training the students will submit a comprehensive report consisting of general overview of the plant, process description of with process flow diagram, details of different equipments with specifications, process instrumentation and control, product with production capacity, raw materials utility and energy consumed per unit of product**.** Assessment would be made on the basis of the submitted report and the viva voce examination conducted by a board of examiners constituted by the Departmental Academic Committee consisting of two faculty members and training coordinator with Head of the Department as Chairman during 7th. Semester examination

7th. Semester

Chemical Engineering

Project Work I (ChE 795)

Each student shall be required under the supervision of a faculty/ joint supervision of a faculty and an external expert to prepare a project work after carrying out investigation on an industrial research problem. The research work has to be carried out by the student himself occasionally consulting his supervisor(s). The work has to be allotted to the student at the beginning of the seventh semester indicating the work to be carried out by the student. The report in duplicate has to be submitted in typed and bound form 7 days before commencement of the seventh semester examination. Assessment would be made on the basis of the submitted report and the viva voce examination conducted by a board of examiners constituted by the Departmental Academic Committee consisting of two faculty members and the supervisor and an external examiner with Head of the Department as Chairman during 7th. Semester examination

8th. Semester

Chemical Engineering

Modeling, Simulation and Optimization (ChE 801A)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: **10L**

Introduction to system. Deterministic process and stochastic process, Concept of Physical modeling and mathematical modeling. Uses of mathematical models in Chemical Engineering, Concept of simulation and process analysis.

Lumped and distributed parameters models. Modeling of simple hydraulic tank, enclosed vessel, mixing vessel, simultaneous mass and energy balance, Continuous heating in a stirred tank using jacket and using coil. Modeling of cone-shaped tank.

Module II: **10L**

Modeling of Heat and Mass Transfer: Modeling of counter current double pipe heat exchanger, counter current heat exchanger involving separation of a mixture gases by permeating through a semi permeable material.

Modeling of a multi-component flash drum (Steady state and Rigorous model)

Simulation of multi-component distillation column: Theoretical model for an equilibrium stage, MESH equations, Wang-Henke bubble method, sum-rate method.

Module III: 10L

Chemical Reactor Simulation: Modeling and simulation of isothermal and non-isothermal operation of batch reactor, isothermal and non isothermal CSTR and Semi-batch reactor, Steady-state multiplicities in CSTR, Thermal stability analysis of CSTR, Non-isothermal operation of a single-homogeneous gas phase reaction in PFR, Diffusion and chemical reaction-catalytic reaction in packed bed reactor.

Module IV 10L

Introduction to Flow sheeting: Concept of flow sheeting, various methods of flow sheeting-equation oriented approach and modular approach.

Process Optimization: Concept and utility of process optimization one variable optimization (Newton's method, Secant methods, dichotomous search, Fibonacci, golden search method), Constrained Optimization: Simplex method,

Unconstrained optimization: Direct search technique and gradient search technique.

Text Book/:

1. Luyben, W.L., Process modeling simulation and Control, MGH

2. Modeling & Simulation in Chemical Engg. R.E.Franks, John Willey & Sons

References

1. Henley and Seader, Multistage separation

2. Froment and Bischoff, Chemical reactor analysis and design, Weiley.

3. Westerberg, A.W., Hutchinson, H.P., Motard, R.L., and Winter,P., Process Flowsheeting, CUP(1979)

6. Chemical Process Simulation : Wiley Eastern Ltd., New Delhi, Asghar Hussain

7. Edger, T.F. and Himmelblau, D.M., Optimization of Chemical Process, MG

8th. Semester

Chemical Engineering

Reactor Design and Analysis (ChE801B)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: 10L

General Introduction, Stoichiometry, Rate equations, Effect of temperature on reaction rate, Evaluation of kinetic parameters by differential, integral and half life methods, Factors affecting homogeneous and heterogeneous reaction rates. Constant volume and variable volume problem.

Module II: 10L

Reactors: Types of reactors, Advantages and Disadvantages, Reactor Selection, Applications

Homogeneous Reactor Design: Formulation of ideal reactor design equations for simple models of batch, mixed flow and plug flow reactors.

Combination of reactors of various types in either series or parallel operation.

Selection of proper contacting patterns for multiple reactions occurring in either series or parallel.

Design of bioreactors (batch, PFR and chemostat) for enzymatic and microbial fermentation.

Module III: 10L

Description of heterogeneous catalytic reactors, e.g**.** packed bed reactor, tubular reactor, mixed flow reactor, slurry reactor, trickle bed reactor.

Design of heterogeneous catalytic reactors, calculation of catalyst requirement, flow regimes, pressure drop.

Differential and Integral reactors

Diffusional resistances and their effect on catalytic reactor design.

Design of Fluidized Bed Reactor.

Reactor Internals: component and use.

Evaluation of conversion in non ideal reactors from RTD study using experimental data and model equations.

Module IV: 10L

Introduction to non isothermal reactor design, Energy balance equations for batch and flow reactors, Evaluation of batch and flow reactor volumes for adiabatic reaction.

Reactor Safety: Temperature excursion, temperature runway, stability criteria.

Trouble Shooting: High reactor pressure drop, Pressure pulsing of reactors, Channeling, Flow maldistribution.

Text Books / References:

1. Chemical Engineering Kinetics, 3rd. Edition, J.M. Smith . MGH
2. Elements of Chemical Reaction Engineering, 4th. edition, H. Scott Fogler, Prentice Hall

References

1. Chemical Reaction Engineering, 2nd. & 3rd. editions, O Levenspiel.: Wiley Eastern Ltd.
2. Chemical Reactor Analysis and Design Fundamentals, J. B. Rawlings and J. G. Ekerdt. Nob Hill Publishing.
.3 Chemical Engineering Kinetics And Reactor Design, C.G. Hill, Wiley
4. The Engineering of Chemical Reactions, 2nd. Edition, L. D. Schmidt, Oxford

8th. Semester

Chemical Engineering

Nanotechnology (ChE802A)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module 1 (10 Lectures):

Introduction to the physics of solid state; Structure & Bonding

Elements of nanoscience & nanotechnology.

Module 2 (10 Lectures):

Synthesis of nanomaterials: General approaches, Physical Methods, Chemical Methods & Biological Methods;

Properties of nanomaterials: Mechanical, Structural, Thermal, Electrical & Optical properties.

Module 3 (10 Lectures):

Characterization techniques of nanomaterials: Microscopy; Spectroscopy; & Diffraction techniques; Some special nanomaterials: Carbon nanotubes, Porous silicon, Zeolites, Aerogels, Core-shell nanoparticles.

Module4 (10 Lectures):

Application: Nanolithography, Nanocomposites, Nanoparticles as catalyst, conducting polymers; nanotechnology: DNA Nanowires, Nanomedicines.

Text book:

1. NANOTECHNOLOGY: Principles & Practices; Sulabh K. Kulkarni, Capital Publishing Company, Kolkata

References

1. Principles of nanotechnology: N. Phani kumar; Scitech, Kolkata
2. Introduction to nanotechnology: Charles P. Poole & Frank Li Owens, Wiley India (p) Ltd, New Delhi

8th. Semester

Chemical Engineering

Polymer Science and Engineering (ChE 802B)

There shall be one compulsory objective type question comprising 10 Nos. spread over the entire syllabus and each carrying one mark.

Two questions are to be set from each module out of which five questions are to be answered taking at least one from each module. All questions carry equal marks

Module I: 10 L

Definitions and concepts of terms used in polymer engineering, Classification of polymers; Polymer structures, functionality; polymerization reactions – mechanism of polymerization; stereospecific polymerization, copolymerization.

Module II: 10 L

Polymerization reactors, polymerization processes, characterization of polymers, analysis of polymerization reactions, polymer degradation.

Module III: 10 L

Molecular weight and molecular weight distribution in polymers, properties of polymers – physical, chemical, mechanical and electrical properties of polymers, elementary idea on polymer rheology, polymer blends.

Module IV:10 L

Polymer processing: modeling – compression & transfer, injection & jet; casting; extrusion, calendaring, lamination, spinning & finishing.

Text Books:

1. Text Book of Polymer Science, F. W. Billmeyer, John Wiley, New York

2. Polymer Science & Technology, P.Ghosh, TMC

References

1. The elements of Polymer Science & Engineering, Alfred Rudin, Academic Press, 2nd

Edition.

2. Introduction to Polymers, R. J. Young, Chapman & Hall, London

8th. Semester

Chemical Engineering

Plant Design (ChE 891)

Each student shall be required under the supervision of a faculty to carry out plant design of an industrially important process to be assigned by the concerned faculty. The design work has to be carried out by the student himself occasionally consulting his supervisor. The problem has to be allotted to the studentat the beginning of the eighth semester indicating the plant capacity.. The report in duplicate has to be submitted in typed and bound form 7 days before the commencement of the eighth (Final) semester examination. Assessment would be made on the basis of the submitted report and the viva voce examination conducted by a board of examiners constituted by the Departmental Academic Committee consisting of two faculty members and the supervisor and an external examiner with Head of the Department as Chairman during 8th. Semester examination

8th. Semester

Chemical Engineering

Project Work II (ChE 892)

Each student shall be required under the supervision of a faculty / joint supervision of a faculty and an external expert to prepare a project work after carrying out investigation on an industrial research problem. The research work has to be carried out by the student himself occasionally consulting his supervisor(s). The work has to be allotted to the student at the beginning of the seventh semester indicating thework to be carried out by the student. The report in duplicate has to be submitted in typed and bound form 7 days before the commencement of the eighth semester examination. Assessment would be made on the basis of the submitted report and the viva voce examination conducted by a board of examiners constituted by the Departmental Academic Committee consisting of two faculty members and the supervisor and an external examiner with Head of the Department as Chairman during 8th. Semester examination

8th. Semester

Chemical Engineering

Grand Viva Voce (ChE 893)

This is a Viva – Voce examination to ascertain the student's overall grasp of the principles of Chemical Engineering and allied subjects. Assessment would be made on the basis of the viva voce examination conducted by a board of examiners constituted by the Departmental Academic Committee consisting of three faculty members with Head of the Department as Chairman during 8th. Semester examination.