Punjab Technical University, Jalandhar
B.Tech. Chemical Engg.
Scheme of Syllabi (3rd Semester)

Sr. no	Course Code	Course Title	L	T	P	Contact Hour	Univ Exam Marks/+	Sessional Marks/++	Total Marks
1	Ch-201	Mechanical Operations	3	1	-	4	60	40	100
2	Ch-203	Numerical Methods in Chemical Engineering	3	1	-	4	60	40	100
3	Ch-205	Organic & Biotechnology	3	-	-	3	60	40	100
4	Ch-207	Chemical Process Calculations	3	1	-	4	60	40	100
5	Ch-209	Fluid Flow	3	1	-	4	60	40	100
6	Ch-211	Strength of Materials	3	1	-	4	60	40	100
7	Ch-213	Strength of Materials Lab.	-	-	2	2	20	30	50
8	Ch-215	Fluid Flow Lab.	-	-	3	3	20	30	50
9	Ch-217	Numerical Methods in Chem. Engg. Lab.	-	-	4	4	20	30	50
							420	330	

TOTAL		750
Institutional Practical Training (During summer vacation after 2nd Sem)		100
TOTAL		850

Punjab Technical University, Jalandhar
B.Tech. Chemical Engg.
Scheme of Syllabi 4th Semester

Sr.no	Course Code	Course Title	L	T	P	Contact Hour	Univ Exam Marks/+	Sessional Marks/++	Total Marks
1	Ch-202	Chemical Process Tech.-I	3	-	-	3	60	40	100
2	Ch-204	Mass Transfer-I	3	1	-	4	60	40	100
3	Ch-206	Heat Transfer	3	1	-	4	60	40	100
4	Ch-208	Chemical Process Instrumentation	3	-	-	3	60	40	100
5	Ch-210	Chemical Reaction Engg.-I	3	1	-	4	60	40	100
6	Ch-212	Engineering Materials	3	-	-	3	60	40	100
7	Ch-214	Heat Transfer Lab.	-	-	4	4	20	30	50
8	Ch-216	Chemical Tech. Lab.	-	-	3	3	20	30	50
9	Ch-218	Mechanical Operation Lab.	-	-	4	4	20	30	50
		General Fitness						100	100
TOTAL							420	430	850

** **There should be industrial/institutional training of 6 weeks duration in the summer vacation after 4th semester**

Punjab Technical University, Jalandhar
B.Tech. Chemical Engg.
Scheme of Syllabi 5th Semester

Sr.no	Course Code	Course Title	L	T	P	Contact Hour	Univ Exam Marks/+	Sessional Marks/++	Total Marks
1	Ch-301	Chemical Engg. Thermodynamics	3	1	-	4	60	40	100
2	Ch-303	Mass Transfer-II	3	1	-	4	60	40	100
3	Ch-305	Chemical Process Control	3	1	-	4	60	40	100
4	Ch-307	Industrial Pollution Control	3	1	-	4	60	40	100
5	Ch-309	Chemical Process Tech.II	3	-	-	3	60	40	100
6	Ch_*	Elective-I	3	-	-	3	60	40	100
7	Ch-311	Mass Transfer Lab.	-	-	4	4	20	30	50
8	Ch-313	Chem. Reaction Engg. Lab.	-	-	4	4	20	30	50
9	Ch-315	CAD in Chemical Engg.	-	-	2	2	20	30	50
		Industrial Practical Training					40	60	100
		TOTAL					460	390	850

Punjab Technical University, Jalandhar
B.Tech. Chemical Engg.
Scheme of Syllabi 6ᵗʰ Semester

Sr.no	Course Code	Course Title	L	T	P	Contact Hour	Univ Exam Marks/+	Sessional Marks/++	Total Marks
1	Ch-302	Chemical Reaction Engg.II	3	1	-	4	60	40	100
2	Ch-304	Optimization Techniques	3	1	-	4	60	40	100
3	Ch-306	Energy Engg	3	1	0	4	60	40	100
4.	Ch-308	Project Management	3	1	0	4	60	40	100
5	Ch_*	Elective -II	3	-	-	3	60	40	100
6	Ch-310	Process Equipment Design(P)	1	-	3	4	20	30	50
7	Ch-312	Process Optimization Lab	0	0	3	3	20	30	50
8	Ch-314	Process Instrumentation Dynamic Control Lab	-	-	6	6	20	30	50
		General Fitness						100	100
		TOTAL					360	390	750

7ᵗʰ /8ᵗʰ SEMESTER

Sr.no	Course Code	Course Title	L	T	P	Contact Hour	Univ Exam Marks/+	Sessional Marks/++	Total Marks
1	Ch-401	Industrial Training	-	-	-	30	500	500	1000

Punjab Technical University, Jalandhar
B.Tech. Chemical Engg.
Scheme of Syllabi 7th / 8th Semester

Sr.no	Course Code	Course Title	L	T	P	Contact Hour	Univ Exam Marks/+	Sessional Marks/++	Total Marks
1	Ch-402	Chemical Process Simulation	3	1	-	4	60	40	100
2	Ch-404	Process Engg. & Economics	3	1	-	4	60	40	100
3	Ch-406	Safety in Chemical Plants	3	-	-	3	60	40	100
4	Ch_*	Elective-III	3	1	-	4	60	40	100
5	Ch_*	Open Elective	3	1	-	4	60	40	100
6	Ch-408	Chemical Process Plant Design(P)	1	-	2	3	20	30	50
7	Ch-410	Process Simulation Lab	-	-	2	2	20	30	50
8	Ch-412	**Seminar	-	-	2	2	-	-	-
9	Ch-414	Project	-	-	8	8	40	60	100
		General Fitness						100	100
		TOTAL					380	420	800

**Satisfactory/Unsatisfactory Grade
+ External Practical Exam.
++Internal Practical Exam.

LIST OF ELECTIVES
- ### "BIO-CHEMICAL ENGINEERING" SPECIALIZATION

1	Elective -I	Ch-317	Bio-Science
2	Elective-II	Ch-316	Biochemical Engineering
3	Elective- III	Ch-416	Bioprocess Technology

- ### "POLYMER SCIENCE & ENGINEERING" SPECIALIZATION

1	Elective -I	Ch-319	Introduction to Polymer Science & Engineering
2	Elective-II	Ch-318	Rubber & Plastic Technology
3	Elective- III	Ch-418	Polymer Reactor Design

- ### "PETROLEUM TECHNOLOGY"SPECIALIZATION

1	Elective -I	Ch-321	Petroleum Recovery Technology
2	Elective-II	Ch-320	Petroleum Refining Engg.
3	Elective- III	Ch-420	Petrochemical Technology

- ### "FOOD TECHNOLOGY" SPECIALIZATION

1	Elective -I	Ch-323	Food Chemistry
2	Elective-II	Ch-322	Food Bio-chemistry & Microbiology
3	Elective- III	Ch-422	Food Processing & Engg.

- ### "DAIRY TECHNOLOGY" SPECIALIZATION

1	Elective -I	Ch-325	Dairy Chemistry & Microbiology
2	Elective-II	Ch-324	Unit Operation in Dairy Industry
3	Elective- III	Ch-424	Technology of Milk & Milk Products

Ch - 201 MECHANCIAL OPERATIONS

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

Handling of Solids:
Properties of particulate masses: Major distinctive properties, pressures in masses of particles, angle of internal friction, angle of repose. Conveying of bulk solids: Basic idea of conveyor, conveyor selection, screw, belt, vibrating, continuous flow and pneumatic conveyors.
Storage and weighing: bulk storage, bin storage, feeders (vibrating hopper, screw feeder, belt feeder), batch and continuous weighing.
Packaging: Bags, boxes, drums, packaging operations (weighing, filling and weighing equipment, loading, wrapping, sealing, and labeling)
Mixing and Agitation: Agitation of low viscosity particle suspensions: axial flow impellers, radial flow impellers, close-clearance stirrer, unbaffled tanks, baffled tanks, basic idea for designing agitators.
Mixing of Solids: Types of mixers, various mixers for cohesive solids, power equirements, mixing index, axial mixing.
Mixers for free flowing solids: ribbon blenders, screw mixers, tumbling mixers import wheels, mixing index in blending granular solids, mixing index at zero time, rate of mixing. Size Reduction:
Principles of Commination: Criteria for commination, characteristics of products, Energy and Power requirements Rittinger's and Kick's Law and work index. Size Reduction Equipment: Crushers, Grinders, and ultrafine grinders cutting machines, equipment operation.
Screening:
Characterization of solid particles: Shape, size, specific sinface, calculation of number of particles in mixture screen analysis.
Filtration:
Classification of filters, various types of cake fitters, principles of cake filtration, clarifying fitters: liquid clarification, Gas cleaning, principles of clarification.
Cross flow Filtration: Types of membranes, permeate flux for ultrafiltration concentration polarization, partial rejection of solutes, Microfiltration, selection of filtration Equipment and centrifuges.
Settling:
Motion of particles through fluids: Terminal velocity, hindered setting, stock's law gravity setting processes: Classifiers, clarifies, thickeners, flocculation, rate of sedimentation Design-principles for clarifies and thickener.
Centrifugal Settling processes: Cyclones, hydroclones, decanters, tubular, disk and nozzle discharge centrifugal sludge separators, Centrifugal class fitters, principles of centrifugal sedimentation. Fluidization: Fluidization and fluidized bed, conditions for fluidization, minimum velocity, types of fluidization, expansion of fluidized beds and particulate fluidization continuous fluidization; industrial applications.
Books Recommended:
1. McCaba, W.L. & Smith, J.C. Unit operations of Chemical Engg. McGrawSmith J.C. Hill
2. Foust, A.S Principles of Unit operations, John Willey & Sons.
3. Coulson J.M Chemical Engg. Vol, 2, McGraw Hill
4. Badger W.L Introduction to Chemical Engg. McGraw Hill
5. Perry and Chilton Chemical Engg. Hand Book

Ch-203 NUMERICAL METHODS IN CHEMICAL ENGINEERING

External Marks: 60   **L T P**
Internal Marks: 40   **3 1 0**
Total Marks: 100

ERRORS: Classification, significant digits and numerical stability.
LINERA ALGEBRAIC EQUATIONS : Cramer's rule, Gauss Elimination and LU Decomposition Gauss-Jordan elimination, Gauss-Seidel and Relaxation Methods.
EIGENVALUES AND EIGENVECTORS OF MATRICES: Faddeev Leverrier's Method, Power Method
NON LINEAR ALGEBRAIC EQUATIONS :Single variable successive substitutions (Fixed Point Method), Multivariable successive substitutions, single variable Newton-Raphson Technique, Multivariable Newton-Raphson Technique.
FUCTION EVALUTION: Least squares curve-fit (Linear Regression), Newton's interpolation formulae (equal intervals), Newton's Divided Difference Interpolation Polynomial, Lagrangian Interpolation Unequal intervals), differentiation formulae, Integration formulae or Quadratures (Trapezoidal, Simpson's 1/3 and 3/8 rules), Extrapolation Technique of Richardson and Gaunt
ORDINARY DIFFERNTIAL EQUATIONS (INTITIAL VALUE PROBLEMS; ODE-IVPs):The Finite difference Technique

BOOKS RECOMMENDED

TEXT BOOKS 1. Numerical methods for engineers by S.K. gupta
2. Numerical Methods for Scientific and Engineering Computation by M.K. Jain , SRK Iyengar and R.K. Jain (\New Age International)
3. Computer Oriented Numerical Methods by V. Rajaraman (PHI)

REFERENCE BOOKS:

1. Finlayson, B.A. Nonlinear Analysis in chemical engineering, MCGraw Hill, New York, 1980
2. Carberry, J.J. Chemical and Catalytic Reaction Engineering, McGraw Hill, New York, 1976
3. Villadsen J, and Michelsen, M.L. Solution of Differential Equation Models by Polynomial approximation, Prentice Hall, N.J., 1978
4. Richard G. Rice & Duong D.Do, Applied Mathematics and Modelling for Chemical Engineers, Johhn Wiley & Sons, Inc.

Ch-205 ORGANIC & BIOTECHNOLOGY

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   0   0**
Total Marks: 100

Studies of the principles (in details) of unit process viz, Nitration, Sulphonation, Halogenation, Hydrogenation and the application of these processes for the manufacture of principal organic chemicals. An introduction Biotechnology: definition and importance of biotechnology.
MICROORGANISM:
Definition, classification, characterization.
Isolation, maintenance and preservation of pure culture.
Substrates for biotechnology: natural raw materials, chemical and petrochemical feed stocks.
Genetics and biotechnology: Industrial genetics, protoplast and cell fusion technologies.
Genetic Engg. (definition and importance), polymerase chain reaction.
Bioprocess/fermentation technology:
Principles of microbial growth, bioreactors/fermentors (activated sludge method, anaerobic digester, trickle filter), media design for fermentation processes, solid substrate fermentation, downstream processing.
Enzyme technology: mode of action, classification and industrial application of enzyme.
Biological fuel generation: The ultimate energy resource (Photosynthesis|), sources of biomass, ethanol, methanol and hydrogen production from biomass.
Biotechnology and agricultural industry: Plant and animal biotechnology, biological control.
Food and Beverage technology: food and beverage fermentation, enzymes and food processing, microbial derived food products, bioprocess technology.
Environmental Biotechnology: microbial ecology, wastewater and sewage treatment, landfill composting, bioremediation.

BOOKS RECOMMENDED

1. Biotechnology by John E. Smith (3rd Edn, Cambridge University Press)
2. Unit process organic Synthesis by Groggins
3. Introduction to Microbiology by A.S. Rao (PHI)
4. Microbiology by Pelezor, Chau and Krieg
5. Niochemical Engg. fundamentals by James E. Bailey & David F. Ollis (McGraw - Hill)
6. Outlines of Chemical technology by Dryden.
7. Organix Chemistry by Morrison & Boyd
8. Organic chemistry by Stanley H. Pine (McGraw Hill)
9. Organic chemistry by Bhal & Bhal.

Ch -207 CHEMICAL PROCESS CALCULATION

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

1. Introduction to Chemical Engineering Calculations; Unit & Dimensions, Conversion of units, Mole concept, Basic Concept, Stoichiometric and composition relationship, limiting-excess-reactant, conversion yield.
2. Material Balance
   a. (Without Chemical reaction) Ideal gas-law calculations, real-gas relationships, vapour pressure of immisible liquids, solutions and problems based on raoults, Henry & Dalton's Law. Humidity, Saturation & use of phychrometric Chart.
   b. (With Chemical Reaction) Combustion, gas-synthesis, acid-alkali production and the like.
   C. recycle, purge, bypass in batch, stagewise and continuous operations in systems with or without chemical reaction.
3. Energy Balance
   a. review: Thermophysics, Thermochemistry-law of constant heat, summation, Hess's Law, standard heat of reaction, combustion and formation problems using Hess Law.
   b. Heat balances for non reacting processes and reaction processes. Theoretical flametemperature, Adiabatic reaction temperature, flame temperature, combustion calculation.
4. Material and energy balances: Applied to industrial processes such as combustion and gasification of fuels, synthesis of ammonia, production of acids and the like.

Books Recommended
1. Haugen, P.A. Watson, K.M., Ragatz R.A Chemical Process Principles Part - I
2. Himmelblau, D.M Basic Principles and Calculation in chemical engineering , Prentice Hall
3. Bhatt B.L.Vora, S.M Storochiometry, Tata McGraw Hill Publishing Co. Ltd., New Delhi
4. Process Calculations for chemical engineers Chemical Engineering development Centre, Madras
5. Felder, R.M. Rousseau, R.W. Elementrary principles of chemical Processes, Second Ed., John Wiley & Sons.
6. Reklaitis, G.V. Introduction to Material and energbalancess John Wiley & sons
7. Lewis, W.K. Radasch, A.H. Lewis, HC Industrial Stoichimetry, McGraw Hil

Ch -209   Fluid Flow

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

Fluid Static's:- Normal forces in fluids, Forces on submerged bodies, Buoyancy and stability.
Fluid Properties:- Newtonian and Newtonian Fluids, Nature of turbulence, eddy Viscosity,
Flow in Boundary Layers. Basic Equation of Fluid Flow, Bernoulli's Equations.

Navier Stokes Equations:- Denvation of Navier stokes Equation, Application of Dimensional
Analysis of Fluid Flow Problems.

Flow of Incompressible Fluids :- Laminar and Turbulent flow in pipes, Velocity distribution in
pipes, Frictional Losses in pipes and fittings, Fanning Equation, Estimation of Economics Pipe
Diameter, Denvation of HAGEN POSESULLE and f=16/ Request ions.
Flow Measurement:- Pitot tube, Office meter, venturimetr, Rot meter, Notches, Wet gas meter
etc.
Fluid Machinery:- Classification and performance of Pumps, Turbines, Compressors, Blowers,
Selection and specification, Net positive Suction Head.

Mc. Cabe, W.L. Smith, J.C. Hariott   Unit Operation of Chemical Engg.
                                                        McGraw Hill
Coulson, J.M.Richardson, J.F   Chemical Engg., Vol. 1 Pergamon
Foust, A.S Wensei, L.A, Clump   Principels of Unit Operation, John Wiely
Baoger, W.L. and Banchero, J.T   Introduction to Chemical Engg.
                                        McGraw Hill
1Fox, R.W and Mc Donald A.T   Introduction to Fluid Mechanics
                                                4th ed Jhon Wiley and sons 1996.
Chattopadhya, P.   Unit Operations of Chemical Engg. Vol.
                                                1

Ch -211 STRENGTH OF MATERIALS

External Marks: 60   **L T P**
Internal Marks: 40   **3 1 0**
Total Marks: 100

Mechanical Properties and Testing:
Concept of strength, yield strength, ultimate strength hardness, impact strength, dactility, britleness, tensile, compressive, bending, trosional, hardness and impact tests.
Theory of Bending: Review of bending moment, shear force, bending and sher stresses. Bending & shear stresses in composite bearns.
Unsymmetrical Bending: Principal axes, analytical and graphical methods, stresses due to unsymmetrical bending 7-polygen deflections of bearns under unsymmetrical bending.
Slopes and Deflections of Beams: Slopes and deflections in beams and cantilevers calculation of slopes and deflections using double integration moment area theorems and Macullay's method.
Theories of failure: Strain energy, various theories of failure, their necessity and significance, graphical representation of theories of failure.
Torsion of shafts and aprings; Torque, angle of twist and shear stresses in hollow and solid shafts with in elastic limit, assumptions intrusion, power transmitted by a shafts, analysis of close coil spring subjected to axial load couple. Shafts subjected to torsion.
Thin Cylinders: Thin cylinders subjected to internal pressure, circumferential and longitudinal stress and strains, maximum shear stress, increase in diameter and volume, thin spheres subjected to internal pressure.
Columns: Columns under uniaxial loads, buckling of columns slenderness ration, and conditions. Derivations of Euler's formula for elastic-buckling load, equivalent lenth, Rankine-Garden empirical formula.

Books Recommended:
1. Timoshenko & Young Strength of Materials
2. V.N. Vazirani & Ratwani Analysis of Structures, Vol. I Khanna Publishers.
3. R.L. Bansal Strength of Materials, Luxmi Publishers.
4. Popov Strength of Materials, Prentice Hall of India.

Ch-213 Strength of Materials Lab

External Marks: 20   **L   T   P**
Internal Marks: 30   **0   0 2**
Total Marks: 50

1. Determination of yield points, tensile strength and ultimate strength of mild steel specimen.
2. Determination of compressive strength of mild steel specimen.
3. Bending test of mild stell specimen.
4. Tensile test of a specimen of brittle material.
5. Torsion test of a mild steel specimen.
6. Determination of Brinell Hardness of ductile and brittle materials.
7. Determination of rockwell Hardness of a hard material.
8. Performance of vicker's Hardness test.
9. Determination of Impact strength of a specimen.

Ch-215 Fluid Flow Lab

External Marks: 20　　　　　　　　　　　　　　　　　　**L　T　P**
Internal Marks: 30　　　　　　　　　　　　　　　　　　**0　0　3**
Total Marks:　50

1. characteristic curves of a centrifugal pumps.
2. Determination of stability of a floating body.
3. Verification of Bernoulli's equation for flow process.
4. Measurement of flow by ventimeter, Orificom etc.
5. Measurement of flow by rotometer, V-noter.
6. Measurement of losses in various fitting and valves.
7. Measurement of losses due to contraction and expansion.
8. Verification of laminar/ turbulent flow regime in a flow process .

Ch -217 Numerical Methods in Chemical Engg.

External Marks: 20　　　　　　　　　　　　　　　　　　**L　T　P**
Internal Marks: 30　　　　　　　　　　　　　　　　　　**0　0　4**
Total Marks:　50

1. Solution of a system of linear equations in unknowns by Gaussian elimination.
2. Gauss-Seidel iterative method to solve a linear system of equations.
3. To find the inverse of matrix by Gauss-Jordan method.
4. Application of Faddeev-Leverrier's method.
5. Method for finding dominant eigenvalue and corresponding eigen vectors by power method.
6. Solution of nonlinear equation by Newton Raphson method.
7. Application of Newton's formulae for interpolation.
8. Application of LaGrange polynomial interpolation formula.
9. Application of Newton's formula for numerical differentiation.
10. Numerical integration by Trapezoidal rule.
11. Numerical integration by Simpson's rules.
12. Solution of an O.D.E. by Runge Kutta Methods.
13. Application of finite difference technique.

Ch-202 CHEMICAL PROCESS TECHNOLOGY-1

External Marks: 60   **L T P**
Internal Marks: 40   **3 0 0**
Total Marks: 100

OILS AND FATS: Status and scope, major oil seeds production in India; solvent extraction, energy and solvent requirements, minor oil seeds and other oil bearing materials, Hydrogenation of oils, Corrosion problems and materials of construction.

SOAPS AND DETERGENTS: History and growth, raw material, manufacturing of detergents, biodegradability, Fat-splitting, purification of fatty acids, soap manufacture, glycerin manufacture, materials of construction

CANE SUGAR: Cane production and varieties, manufacturing equipment and technology, cane sugar refining, baggasse utilization, energy requirements and conservation, environmental considerations, khandsari – technology, molasses based industries, materials of constructions.

REGENERATED CELLULOSE: Growth of industry, raw materials, pre-treatment, pulping, manufacture of paper, recovery of chemicals, environmental considerations, viscose rayon.

PETROLEUM REFINING: General composition of crude oil, typical refinery operations for obtaining different useful products and their utilization for manufacture of other commercial products.

POLYMERS: Status and scope, applications, classification of polymers, molecular weights and molecular weight distribution, degree of polymerization, modes of polymerization, selective industrial polymerization, including plastics, synthetic fibres, synthetic and natural rubbers and polymeric foams.

AGRICULTURAL RESIDUE UTILISATION: Availability and characteristics, use as energy producers and energy contents, modes of energy recovery, gasification, pyrolysis, deoxygenation, chemicals from agricultural residues.

BOOKS RECOMMENDED

1. Shreva,R.N. and Brink,J.A.   :Chemical Process Industries, McGraw Hill

2. Chemtech I,II,III,IV   :Indian Institute of Technology, Madras

3. Dryden,Co,Rao,M.G., and,   :Outlines of Chemical Technology,Affiliated East

   Sittig M   West Press Pvt. Ltd.,New Delhi

Ch-204   MASS TRANSFER-1

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

Diffusion in gases and liquids, Mass balance in simple situations with and without chemical reaction.

Theories of Mass transfer, Individual and overall mass transfer coefficients, Mass, heat and momentum transfer analogies, Convective mass transfer.

Mass balance in concurrent and countercurrent continuous contact equipment, Concept of operating line, Multi-stage counter current operations, Concept of ideal stage, Stage efficiencies, Design of continuous contact equipments, HTU and NTU concepts.

Gas absorption: Design of plate and packed absorption columns, Non-isothermal absorption, Simultaneous heat and mass transfer.

Drying of solids: Rate of drying curves, Through circulation drying, Continuous drying, Types of dryers.

Humidification operations: VLE & Enthalpy, Reference substance plots, vapour gas mixtures, concept of humidity and definitions, dry bulb temperature, wet bulb temperature, adiabatic saturation temperature, adiabatic saturation, psychometric charts, adiabatic operations-humidification operations and water cooling operations.

Equipments: water cooling towers & spray chambers

BOOKS RECOMMENDED:

1. Treybal, Robert E   :Mass Transfer Operations, Mc Graw Hill

2. Sherwood, Thomas K.Pigford,   :Mass Transfer, Mc Graw Hill
   Robert L and Wilke, Charles R,

3. Skelland, A.H.P   :Diffusional Mass Transfer, John Wiley & Sons,   New
                                         York

4.McCabe, Warren L.,Smith,Julian   :Unit Operations of Chemical Engg. McGraw Hill
   C. and Harriot, Petter.

Ch-206   HEAT TRANSFER

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

Modes of Heat Transfer:
Conduction:
Review of Fourier's law, one dimensional heat conduction through composites having plane wall, spherical & cylindrical geometry. Steady state heat flow with heat source through plane wall and Cylindrical surface. Thermal conductivity of materials. Insulating materials and critical thickness of insulation. Unsteady-state conduction; Lumped heat capacity system, semi-infinite solid and Heisler chart.

Convection:
Free and forced convection, Concept of thermal boundary layer, concept of overall heat transfer coefficient for laminar and turbulent flow, Heat transfer inside & outside tubes with significance of Nusselt, Prandlt, Reynold, Biot, Fourier and Peclet number. Modeling of convective heat transfer coefficient by using dimensional analysis.

Radiation:
Distribution of radiant energy, Definition of emissivity, absorpitivity, Reflectivity and Transmissivity, concept of Black and Grey bodies, Planck's law of monochromatic radiation, Kirchhoff's law, Wein's displacement law, Stefan-Boltzmann law, definition of intensity of radiation. Radiation formula for radiation exchange between simple bodies, two parallel surfaces and between any source and receiver.

Theory and correlations in Boiling Heat Transfer
Dropwise and Filmwise condensation of pure and mixed vapors, Nucleate & Film boiling, Theory and design of double pipe heat exchanger, 1-2, 2-4 Shell-and-Tube heat exchangers, Temp. correction factor for shell & tube exchangers, Theory of plate type heat exchanger, Fins and their applications, Reboiler and Condensers counter current dry contact Condenser, parallel current-wet contact Condenser.

Evaporators:
Theory and design of single effect evaporators. Various types of evaporators: Standard vertical tube evaporator, basket type vertical evaporator, forced circulation evaporator and horizontal tube evaporators. Evaporation under vacuum.

Recommended books:

AUTHOR	TITLE	PUBLISHERS
Holman	Heat Transfer	McGraw Hill
McAdams	Heat Transmission	McGraw Hill
McCabe & Smith	Unit Operation of Chem. Engg.	McGraw Hill
Kern	Process Heat Transfer	McGraw Hill
Kreith	Principles of Heat Transfer	Harper & Row
Incopera & Dewit	Heat and MassTransfer	John Wiley

Ch-208 CHEMICAL PROCESS INSTRUMENTATION

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   0   0**
Total Marks: 100

Introduction: Importance of instruments in Chemical Process industries, Classification of instruments, Static and Dynamic characteristics of instrument.

Instruments for Pressure Measurement : Use of manometers, Bourdon gauge, bellow type gauge, Measurement of vacuum and pressure Transducers

Temperature Measurement: Thermocouples, resistance thermometers, thermistors, optical and radiation pyrometers.

Flow & level measurements : Liquid level measurement-Direct and differential method and Flow measuring devices, Use of obstruction type meters, Variable area meters. Pressure probes, positive displacement type meters

Instruments for Miscellaneous Measurements : Measurement of Nuclear Radiation, Viscosity, Conductivity, Humidity and pH value, Industrial weighing and feeding systems, Instrument for gas analysis, gas chromatography, mass spectroscopy, Industrial weighing and feeding systems. Process instrumentation, Recording instruments, indicating and signaling instruments, Transmission of instrument reading, control centre, Instrumentation diagram, Instrumentation in modern plant.

Controls : Concept of Automatic process control and it's classifications, Types of controllers, instrumentation and control of typical units like Reactors and Evaporators.

Recommended books:

AUTHOR	TITLE	PUBLISHER
Harriott & Peter	Process Control	Tata McGraw Hill
Eckman	Industrial Instrumentation	Wiley Eastern
Coughanour	Process System Analysis & Control	McGraw Hill
Pollard	Process Control for Chemical and Allied Industries.	Heinnemann
Weber	Introduction to Process Dynamics & Control.	John Wiley

Ch-210 CHEMICAL REACTION ENGG-1

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

Introduction to kinetics of homogeneous reactions, Concepts of reaction rates, rate equation, order & molecularity

Material balance equation for ideal batch reactor & its use for kinetic interpretation of data and isothermal reactor design for single reactions(simple & complex rate equation)

Analysis of CSTR & PFR and their use for kinetic interpretation and design, Comparison of batch reactor, CSTR & PFR, Multiple reaction in a batch reactor, CSTR & PFR, concept of yield & selectivity

Concept of adiabatic & non-isothermal operations

Energy balance equation for batch, CSTR & PFR and their application to design of reactors, energy balance equation for semi batch reactors.

Design equation for semi batch reactors

Temperature and pressure effects, optimal temperature progression, multiple steady states in CSTR.

Non Ideality: Basics of non-ideal flow, residence time distribution, States of segregation, Measurement and application of RTD, E-Age distribution function and inter-relationship, Conversion in non-ideal reactors.

BOOKS RECOMMENDED

1. Levenspial,O   : Chemical Reaction Engineeriong ,John Willey

2. Smith J.M.   : Chemical Engineering Kinetics.Mcgraw Mill,

3. Walas S.M.   :Reaction Kinetics for Chemical Engrs,Mcgraw Hillbook co,Inc

4. Denbigh,K.   :Chemical Reactor Theory –an Introduction ,Cambridge

                                     Univ. Press

5. Scott-Fogler, H   :Elements of Chemical Reaction Engineering ,Prentice Hall

Ch-212 ENGINEERING. MATERIALS

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   0   0**
Total Marks: 100

Ferrous Metals: Important varieties of iron ores. Cast iron: types, properties and uses of cast iron. pig iron: Types of pig iron. Wrought iron: properties and uses of wrought iron. Steel: factors affecting physical properties of steel and uses of steel (No manufacturing process).

Non Ferrous Metals: Aluminium, cobalt, copper, lead, magnesium, nickel, tin and zinc their properties and uses.

Alloys: Introduction to Phase-Diagrams of metals and its alloys; $Fe-Fe_3C$; Cu-Ni, Cu-Zn, Al-Cu equilibrium diagrams, methods of improving strength, and applications of metals and alloys.

Ceramics: Definition of ceramic, clay: properties of clay, earthen wares and stonewares, uses of stonewares.

Glass: Definition, classification, composition, types and properties of glass.

Refractories: Definition of refractory, classification of refractories, properties of refractories. Common refractory bricks like silica bricks, fire clay bricks, dolomite bricks, high alumina bricks and carbon bricks.

Polymers: Nylon-66, nylon-6, polyesters, polycarbonates, polyurathenes, PVC, polypropylene, rubber

Mechanical, Thermal and Electrical Properties : Tensile strength, compressive strength, shear strengtrh, ductility and malleability. Methods of improving strength; specif heat, glass transition temperature, crystalline melting temperature, thermal conductivity; dielectric strength, dielectric constant, power loss and electrical difusivity.

Corrosion: Principle of corrosion, types of corrosion, mechanism of wet or electro chemical corrosion, galvanic corrosion, atmospheric corrosion, pitting corrosion, wet like corrosion, microbiological corrosion, method of corrosion control, cathodic and anodic control, Inhibition and other precautionary measures

RECOMMENDED BOOKS

1.   Materials in Industry by W J Patton, Prentice Hall Publication.

2.   Introduction to Engineering Materials by Aggrawal, Tata McGraw Hill Publication.

3.   Material Science by Narula, Tata McGraw Hill Publication.

4.   Elements of Metallurgy by HS Bawa, Tata McGraw Hill Publication.

5.   Materials Sci & Engg. by William D. Callister, Jr, An introduction by Willy International

Ch-214 HEAT TRANSFER LAB

External Marks: 20   **L T P**
Internal Marks: 30   **0 0 4**
Total Marks: 50

1. Determination of heat transfer coefficient for different types of heat transfer equipments.

2. Wilson Plots. Unsteady state heat transfer in jacketed vessels.

3. Correlation of instantaneous heat transfer, coefficients with time for steady deposition of scale on a heating surface.

4. Heat losses from insulated pipes.

5. Performance characteristics of a shell and tube heat exchanger and an induced draft cooling tower.

6. Study and operation of long tube, forced circulation and multiple effect evaporators.

7. Duhring's plot for solutions involving non-volatile solutes

8. To find the heat transfer coefficient of heat loss by vertical cylinder by natural convection.

9. To find heat transfer coefficient for parallel flow and counter flow for double pipe heat exchanger.

10. To find heat transfer coefficient loosing heat by forced convection to air flowing through it for different air flow rates & heat flow rates.

Ch-216   CHEMICAL TECHNOLOGY LAB

External Marks: 20   **L   T   P**
Internal Marks: 30   **0   0 3**
Total Marks: 50

1. To perform proximate analysis of a given sample.

2. Determination of HCV and LCV of a given fuel by bomb calorimeter.

3. To determine the acid value of an oil/fat.

4. To determine the saponification value of an oil/fat.

5. To determine the iodine value of an oil/fat.

6. To determine the neutralisation no. of an oil/fat.

7. Preparation of phenol-formaldehyde.

8. Preparation of urea-formaldehyde.

9. Preparation of polymer product using compression moulding, Injection moulding

10. Preparation of compounded polymer sample using two rollmill

11. Determination of performance of a given polymer sample under tensile loading like stress-strain curve, modulus of elasticity etc

Ch-218 MECHANICAL OPERATIONS LAB

External Marks: 20   **L   T   P**
Internal Marks: 30   **0   0   4**
Total Marks: 50

1. Verification of Stokes Law.

2. Screen analysis of given sample for it's particle size distribution.

3. Determination of variation in pressure drop & bed height w.r.t superficial velocity for a bed of solids.

4. Determination of minimum fluidization velocity for a bed of solids.

5. Operating characteristics of crushing and grinding equipments,(Jaw crusher, Roll crusher, Ball mill)

6. Evaluation of the filtration constants for $CaCO_3$ Slurry in water and cake compressibility.

7. Determination of %age recovery of coal in froth from coal and sand mixture.

8. Determination of thickener capacity using batch sedimentation.

9. Determination of characteristics of centrifuge as a filter.

10. Determination of the separation efficiency of the classifier.

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Ch -301 CHEMCIAL ENGINEERING THERMODYNAMICS

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

Brief review of the term: state functions, types of system, internal energy, heat and work reversible and irreversible processes. Ist law of thermodynamic and its engineering applications, i.e., constant volume processes, constant pressure processes, isothermal and adiabatic processes, pumps, turbines, compressors, nozzles, heat exchangers, pitot tube, venturimeter and orifice meter, Throttling process, Joule-Thomson coefficient, liquefaction of gasses thermo chemistry includes a brief review of heat capacities and their measurement standard heat of reaction, standard heat of formation, standard heat of reaction, standard heat of reaction, standard heat of formation, standard heat of combustion, flame temperature, H-x, diagrams, heat of solution, partial, molar enthalpies, a enthalpy for phase change etc. Equation of state for real gases and their mixtures. Principle of correspond ding states and generalized compressibility factor.

Review of 2nd law of thermodynamics, entropy concept, entropy and lost work calculations. Microscopic interpretation of entropy. Third law of thermodynamics and its applications, free energy functions and their significance in phase and chemical equilibria. Clapeyron" equation and some important correlation for estimating vapour pressures. Estimation of thermodynamic properties by us using graphs and tables.

Phase Equilibria:

Partial molar properties, partial molar gibbs free energy chemical potential and its dependence on temperature and pressure. Ideal solutions (Lewis-Randel Rule).

Fugacity and its cawlculations. Dependence of fugacity on temperatures and pressure. Solution behaviour of real liquids add solids. Activity and activity coeffiecients. Variation of activity co-efficient with temperature and composition. Activity coefficients of electrolytes. Standard states. Properties of mixing. Excess properties. Gibba-Duham equation and its application to vapour-liquid equilibria.

Chemical Equilibria:

Equilibrium constant in terms of measurable properties variations of equilibrium constant with temperature and pressure.

Adiabatic reactions. Gibbs phase rule, equilibria in heterogeneous reactions. Electrochemical reactions.

Estimation of thermodynamic properties from molecular structure. A brief review of irreversible thermodynamics.

Books Recommended:

1. Smith J.M. and Van Ness, H.C Introduction to chemical engineering, Thermodynamics McGraw Hill Book Co., London

2. Dodge, B.F. Chemical Engg. Thermodynamics, McGraw - Hill Book Company, Inc., London.

3. Balzhiser, Samuels and Eliassen Chemical Engg. Thermodynamics

Ch -302 CHEMICAL REACTION ENGINEERING -II

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

Introduction to catalysis, classification of catalysts, preparation and physical characteristics of solid catalysts.
Concepts of physical absorption and chemisorption, Kinetics of solid catalysed gas phase reaction - power law and Langmuir Hinsherlwood rate equations and parameter estimation.
Diffusion of mass and heat in porous solids with and withour external diffusional resistances.
Effectiveness factor: Fixed bed catalytic reactors; single and multibed adiabatic reactors, multitublar fixed bed reactors. Design equations for fixed bed reactors using pseudohomogenous one and two-dimensional models.
Concepts of Heterogeneous models:
Parametric sensitivity. Modelling of gas-solid non-catalytic reactions and determination of parameters.
Fluid-fluid reaction modelling based on film and penetration theory.
Enhancement factor.
Reactor systems and design for gas-liquid-solid non-catalytic system.
Books Recommended:
1. Levenspiel, C. Chemical Reaction Engg. John, Wiley,.
2. Wales, S.M. Reaction Kinetics for Chemcial Engg. McGraw Hill

CH-303 MASS TRANSFER - II

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

Mass transfer equilibria for vapour liquid, liquid-liquid and solid gas system.
Distillation: Raoult's law, ideal solutions, x-y & H-x-y diagrams. Flash vaporisation and condensation.
Differential distillation. Steam distillation.
Binary distillation. McCable-Thiele and Ponchon-Savarit method. Total reflux, minimum and optimum reflux ratios. Introduction to distillation. Design of distillation columns with open steam , multiple feeds side streams & partial condensers. Approximate & plate to plate calculations for multicomponent distillation.
Liquid-liquid extraction: Extraction equipment, equilibrium diagram. Choice of solvent. Single stage and multistage counter-current extraction with/without reflux. Continuous contact extractors.
Leaching: Leaching equipment and equilibrium. Single stage and multistage cross current and counter current leaching.
Adsorption: Adsorption equilibria. Adsorption column sizing.
Crystallization: Methods of forming nuclei in solution and crystalgrowth.
Books Recommended:
1. Treybal, Robert E Mass Transfer Operations, McGraw Hill
2. Sherwood, Thomas K Charles R. Mass Transfer, McGraw Hill
3. Skell and AHP Diffusion Mass Transfer. John Wiley & Sons.
4. McCabe Warren L Unit-operations of Chemical Engg. McGraw Hill
5. King C.J Separation process, Tata McGraw Hill Pub.
6. Holland, Charless D. Fundamentals and modeling of separation Processes, Prentice Hall, Inc. New Jersey.

CH 305 CHEMCIAL PROCESS CONTROL

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

General Principles of process control , basic control elements, degree of freedom and fixing of control parameters.

Simple system analysis, laplace transformation and transfer functions, block diagrams, linerization. First and higher order systems, interacting and non-interacting systems, distributed and lumped parameter systems, dead time.

Different modes of control and their basic characteristics, controller characteristics, process characteristics.

Optimization of control system response, stability analysis and choice of indicating , recording & controlling instruments for chemical industries.

Feedback control servo and regulation control. Time domain-closed loop frequency response. Introduction to advanced control techniques as feed forward feed back, cascade, ratio, adaptive and digital computer control.

Process dynamics and applications - Process identification, dynamics and control of chemical equipment's such as exchangers, distillation columns etc.

Books Recommended:

1. D. R. Coughanower, L.b. Koppel Process system Analysis and Control
2. A. Pollard Process Control for chemical and Allied Industries, Heinemann Education Co.
3. T.W. Weber Introduction to Process Dynamics & control, John Willey Co.

CH -307 INDUSTRIAL POLLUTION CONTROL

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

Ambient air and water standard. Principal sources of pollution. Inter relationship between energy and environmental pollution. Prevention of environmental pollution through conservation.
a) Air Pollution:
Principal air pollutants and their usual sources. Effects of air pollution on human health, animals and vegetation and materials. Atmospheric dispersion of air pollutants, temperature inversions.
Air pollution control techniques - process and equipment's used for the control of gaseous pollutants.
b) Water Pollution:
Types of water pollutants, their sources and effects.
BOD and COD
Waste water treatment techniques and equipment's flocculation, skimming, floatation, etc.
Primary Treatment through settling.
Secondary Treatment aerobic and anaerobic digestion, activated sludge process, triple filter and oxidation ponds.
Books Recommended:
1. Perkons, LC. Air pollution, McGraw Hill, N.Y.
2. Liptak, R.C. ed. Environmental engineers handbook Vol. I,II,III Chelton Book Co., Randor.
3. Willisamson, S.J. Fundamentals of air pollution addition Wesley co. N.Y.
4. Nemerow N.L Liquid wastes of Industry, Addison Wesley Co. N.Y.

CH -309 CHEMCIAL PROCESS TECHNOLOGY -II

External Marks: 60   **L T P**
Internal Marks: 40   **3 0 0**
Total Marks: 100

Water
Source:Impurities:Polluted, contaminated palatable waters, water pollutants and their effects.
Treatment - Sedimentation, coagulation, filtration softening, aeration, ion exchange reverse osmosis, disaffection, industrial waste water and sewage treatment, primary, secondary and tertiary treatments, aerobic and anaerobic treatments.
Desalination: Evaporation, Reverse Osmosis etc. Gaseous fuels: Classification, manufacture and use of LPG , wood gas, coal gas, producer gas, water gas, synthesis gas, carburetor water gas.
Industrial Gases: Manufacture and uses of hydrogen, carbondioxide, acetylene, oxygen, nitrogen, insert gases.
Fertilizers: Status of industry, grading and classification of fertilizers, saw materials, hydrogen production, fixation of nitrogen, synthesis, ammonia based fertilizers, manufacture of phosphatic fertilizers and phosphoric acid, potash fertilizers, N-P-K values. Corrosion problems and materials of construction.
Soda Ash: Manufacturing special materials of construction, solvey and modified solvey process environmental considerations, corrosion problems and material of construction.
Chlor Alkali Industry: Electrochemistry of brine electrolysis, current efficiency, energy efficiency, diaphragm cells, mercury cells, mercury pollution and control, caustic soda, chlorine, hydrochloric acid; corrosion problems and materials of construction.
Cement and Glass.
Sulphuric Acid.
Books Recommended
1. Shrye R.N. and Brink J.A. Chemical Process Industries, McGraw Hill
2. Chemical Technology, I,II,III and IV Indian Institute of Technology, Madras
3. Dryden, Charles E. Outlines of Chemical Technology affiliated East-West Press Pvt. Ltd. New Delhi.

CH -311 Mass Transfer Lab

External Marks: 20   **L T P**
Internal Marks: 30   **0 0 4**
Total Marks: 50

1. To find out the critical moisture context of the given material and to find out the equations for constant and falling rate period.
2. Determination of hold up.
3. To find the mass transfer coefficient for the vaporisation of naphthalence to air.
4. To verify the Rayleigh's equation for distillation.
5. To find the height equivalent to a theoretical plate and height of a transfer uit for the packed distillation column under total reflux.

CH- 313 Chemical Reaction Engg. Lab

External Marks: 20   **L T P**
Internal Marks: 30   **0 0 4**
Total Marks: 50

1. Study of Rate kinetic using batch reactor.
2. To find the residence time for PERS of different lengths.
3. Experiments based on CSTR
4. To follow a reaction in a fixed bed catalytic reactor for a given reaction system.
5. Environmental pollution Analysis.
6. Analysis of gaseous pollution as So2, H2S, No-Nox, Co-Co2, O3, NH3 etc.
7. Water pollution analysis.
8. Determination of TDS, SS, Dissolved
9. Domestic effluent Analysis.

Ch -315 CAD IN CHEMICAL ENGINEERING

External Marks: 20   **L T P**
Internal Marks: 30   **0 0 2**
Total Marks: 50

Fortain - 77 programming: Programming in modular form, use of COMMONK EQUINALANCE, DATA, IMPLICITY etc. Types of statements. Use of fortain - 77 in design applications of various chemical process and simulations of industrial processes.

Introduction to AutoCAD its application to machine drawing and equipment drawing. Computer graphics programming.

Process synthesis, Process flow sheeting. Strategy of process calculations. Software development for design of various chemical engineering equipment's. Executive programming. Use of generic software package.

Books Recommended:

1. Racker, A Inside Autocad, BPB Publication

2. Voismt, DD Computer Aided drafting and design.

3. Calderbank A course in programming in Fortran -77

4. Mischke C. Computer Aided Design, Prentice Hall.sssssa

6th Semester

CH -304 -OPTIMIZATION TECHNIQUES

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

Introduction: Engineering application of optimization, Design variables, constraints, objective function, variable bounds, statement and formulation of an optimization problem, Examples of chemical engg. Optimization problems, classification of optimization problems, different optimization algorithms.
Optimal Point: Local optimal point, global optimal point and inflection point. Single variable optimization techniques:
1. Optimality criterion.
2. Bracketing method (Bounding phase method).
3. Region elimination methods (Internal halving method, Golden section search method).
4. Point estimation method (successive quadratic estimation methods).
5. Gradient-based methods (Newton-Raphson method, Bisection method, Secant, Cubic search method.).
6. Root finding using optimization techniques. Multivariable Optimization Techniques:
     a. Optimality criterion.
     b. Unidirectional search method.
     c. Direct search method (Hooke-Jeeves Pattern Search method, Powell's conjugate direction method)
     d. Gradient-based methods (Steepest descent method, Newton's method, Marquardt's methods)
Construined Optimization Algorithms:
a. Kuhn - Tucker conditions
b. Transformation method (penalty function method)
c. Direct search for constrained minimization (variable elimination method, complex search method.) Linear Programming: Linear programing problems, Simplex method of linear programming technique.
Text Book:
1. Optimization for engg. Design by Kalyanmoy Deb. (PHI).
+
1. Engg. Optimization by S.S. Rao (New Age)
2. Optimization of Chemical processes By T.I. Edgar & D.M. Himmelblau (McGraw Hill).
3. Process Optimization with Applications to Metallurgy & Chemical engg. By Ray & Szekely (Wiley)
4. Optimization: Theory & Practice by Beveridge & Schechter, (McGraw Hill).
6.   Numerical methods in engg. & Sc. By B.S. Grewal (Khanna Publishers)

Ch -306 Energy Engg.

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

Energy crisis in the world and position in India

Solid Fuels: Principal solid fuel-coal, origin, composition and classification of coal, origin, composition and classification of coals, analysis and properties of coal, characteristics and distribution of Indian coals, coal preparation, Storage of coal, coal carbonization, briquetting, gasification and liquefaction of solid fuels.

Liquid Fuels:

Petroleum and Related Products:

A Introduction: Origin, occurrence and reserves, reserves, Production and consumption, classification and characteristics of Petroleum properties and characteristics, petroleum refining in India.

B. Refining Unit Process: Cracking, thermal cracking, catalytic cracking, hydrocraking, reforming thermal and catalytic reforming, alkylation, and polymerization, Isomerization.

C. Petroleum Products - Naphtha, motor gasoline, aviation gasoline, kerosene, diesel oil, gas oils, fuel oils, lubricants, petroleum waxes. Petroleum coke.

D Testing of petroleum products:

  (i) Physical test: Density and specific gravity, viscosity.

  (ii) Chemical test: Organic and inorganic constituents.

  (iii) Flammability Test: Flash point, volatility.

  (iv) Knock Rating Test: For Gasoline Octane Number.

Gaseous Fuels: Types, natural gas, methane from coal mines, producer, water carburetor water, coal, blast furnace and refinery gases, gases from biomass, LPG, gasification of coal and oil, purification of gaseous fuels.

Combustion Process and Appliances: Stoichiometry and heat balance calculations, nature and types of combustion processes, mechanism of combustion reaction, spontaneous ignition temperature, gas and oil burners, coal burning equipment's, fluidized bed combustion.

Additional Sources of Energy:

Nuclear energy: - Nuclear reactions, fuel materials, moderators and structural materials, reactors Energy by bio-processes-bio-gas Solar Energy - Photovoltaic cells, solar collectors, wind, tidal and geothermal energy.

Furnaces: General classification and description of different types of furnaces with special reference to furnaces used in ceramic, petroleum and pharmaceutical industries.

Books Recommended

1. Samir Sarkar Fuels and combustion, orient longman

2. O.P. Gupta Elements of Fuels, furnaces and Refractories

3. Wilson, P.J., Wells, G.H. Coke, cake and coal chemicals, McGraw Hill

4. Griswold, J. Fuels, combustion and Furnaces, McGraw Hill

5. Francis, W. Fuels and fuel Technology, Vol. I and II Pergarnon Press

6. McNeil D Coal combustion products, peragamen Press

7. Haslam, R.T. Russal, R.P Fuels and their combustion, McGraw Hill

7.   Brame, J.S. and King, J.C Fuels-solid liquid and Gaseous, St. Martin Press

Ch -308   PROJECT MANAGEMENT

External Marks: 60   **L T P**
Internal Marks: 40   **3 1 0**
Total Marks: 100

Small scale industries and list of products reserved under it. Relative merits and demerits of SSI and large/medium policy resolutions of 1956 and 1977. Mini plants and Govt. incentives. Present status of small scale industry in the country. Types of product and standardization of their qualities. Raw materials requirements. Utilities services, market survey, economic viability, employment potential, promotion of regional development. Trends of growth in India and abroad. Feasibility report, patterns of financial assistance, available from state/central government and financial institutions. Exploitation of R & D work from technological pools like patent office, CSIR, IIT, NRDC. Technical tie-up. Turnkey and other projects. Import license, marketing techniques, product identification and selling. Promotion of export and legal obligations.
Books Recommended:
1. Geoffery, G. Mcredity, Nerson, R.E, Neck, P.A the Practice of Enterpreneurship. Dialogue Publication.
2. S. Chaudhary Project Management Tata McGraw Hill Publishing Co., Ltd.
3. Aswathappa Factory Organisation and Management Himalya Publishing House.
4. Ramesh Bhojwan Small, medium & larie scale industries Vol. I & II small industry research institute Delhi

CH -310 PROCESS EQUIPMENT DESIGN (P)

External Marks: 20   **L T P**
Internal Marks: 30   **1 0 3**
Total Marks: 50

Each student is required to submit two bound type-written copies of a project report on the complete design including drawing with specifications of process equipment/reactors of a plant manufacturing product (s) related to one's course/subject to be worked out under the guidance of a faculty member. The design should be as far as practicable be based on the consideration of optimum, technical process operating condition and shall include proper instrumentation and control. The examination shall include a viva-voce examination on the design report.
Book Recommended:
1.R C. Bhattacharyya - Chemical Equipment Design(CBS).
2. Joshi & Mahajan - Process Equipment Design(Macomillion Indian Ltd.)

Ch- 312 PROCESS OPTIMIZATION LAB

External Marks: 20   **L   T   P**
Internal Marks: 30   **0   0   3**
Total Marks: 50

1. Application of Bounding Phase Method
2. Application of Golden Section Search Mehtod
3. Application of Steepest Descent Method.
4. Application of Penalty Function Method.
Books Recommended:
1. Optimization for Engg. Design by Kalyanmoy Deb (PHI)
2. Optimizations for chemical processes by Edgar & Himmelblau (McGraw Hill)

Ch - 314 Process Instrumentation Dynamic Control Lab

External Marks: 20   **L   T   P**
Internal Marks: 30   **0   0   6**
Total Marks: 50

1. Calibration of temperature, pressure flow and composition measuring instruments.
2. Study of process characteristics.
3. Investigation of the operation of pneumatic and electronic controllers with proportional integral derivative action.
4. To determine the best setting of a controllers with controlling an actual process.
5. To solve first order or higher order differential equations with the help of an along computer and to study control problems by an along simulation.
6. To control the level of liquid in the process tank using multi process trainer for different controller settings.
7. Experiments/problems based on CAD in chemical engg.
Books Recommended:
1. George Stephanopoulos : Chemical Process Control
2. Considine U.N. : Process Instruments and Controls Handbook, McGraw Hill.
3. Andrew, W.G. : Applied Instrumentation in the process industries Vol. I,II,III.

6th/ 7th Semester
Industrial Trainning

Each student will be required to submit a report after the completion of factory training. The reports will be assessed by teachers in-charge of the programming.

8th Semester
CH -402 CHEMICAL PROCESS SIMULATION

External Marks: 60	**L**	**T**	**P**
Internal Marks: 40	**3**	**1**	**0**
Total Marks: 100			

Introduction: Definition of mathematical model, lumped parameter models, distributed parameter models, uses of mathematical models, scope of coverage, principles of formulation.
Fundamental Laws: Continuity equations, energy equations, equations of motion, transport equations, equations of state, equilibrium, chemical kinetics. Mathematical Models of Chemical Engg. Systems:

1. Series of isothermal, constant holdup CSTRs
2. CSTRs with variable holdups.
3. Isothermal/non-isothermal plug-flow reactor.
4. Two heated tanks. 5. Gas phase pressurized CSTR
6. Non isothermal CSTR 7. Single component vaporizer
8. Multi component flash drum
9. Batch reactor
10. Reactor with Mass Transfer
11. Ideal binary distillation column
12. Multi component non-ideal distillation column.
13. Batch distillation with holdup
14. PH systems
15. Lumped parameter model of a gas absorber
16. Lumped parameter model of a liquid-liquid extraction column
17. Model for Heat-exchangers
18. Model for interacting & non-interacting tanks.
19. Model for Biochemical reactor. Simulation: Meaning of simulation; simulation example of simple isothermal CSTR, simple non-isothermal CSTR and simple isothermal batch reactor

Text Book: Luyben Process Modelling, simulation and control for chemical engineers (McGraw Hill)

Reference Books:
1. Husain Chemical Process Simulation (Wiley Eastern).
2. B.W. Bequette Process Dynamics - Modeling, Analysis & Simulation (PHI International).
3. A. Suryanarayana Chemical instrumentation & Process Control (Khanna Pub.)

CH -404 PROCESS ENGINEERING & ECONOMICS

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

Cost Estimation: Factors affecting investment and production costs, Capital investments --- fixed investments and working capital. Cost indices. Estimating equipment costs by scaling 6/10 factor rule. Methods for estimation capital investment. Estimation of total product cost. Different costs involved in the total product for a typical chemical process plant.

Interest and investment costs: Simple and compound interest. Nominal and effective rates of interest. Continuous interest ordinary. Perpetuities and capitalized costs.

Taxes and Insurance: Types of taxes and tax returns, types of insurance, and legal responsibility.

Depreciation: Types of depreciation, service life salvage value, present value and methods of determining depreciation single unit and group depreciation. Profitability, Alternative Investments and Replacements: Mathematical methods of profitability evaluation.

Cash flow diagrams. Determination of acceptable investments. Alternative when an investment must be made and analysis with small invrement investment, replacement. Breakeven analysis. Balance sheet and income statement.

Optimum Design: Procedure with one variable. Optimum reflux ration in distillation and other examples.

Preliminary steps in plant design: Plant Design Factors. Project organization, plant location, preliminary data collection, process engineering.

Books Recommended

1. Peters, M.S. Timmerhaus, K.D : Plant Design and Economics for Chemical McGraw Hill, New York, Fourth Edition (1991).
2. Ulrich, G.D. : A Guide to Chemical Engineering Process Design and Economics, John Wiley (1984)
3. Guthrie, K.M. : Process Plant Estimating, Evaluation and Control, Craftsman Solano beach, Calif, (1974)

Ch -406 SAFETY IN CHEMICAL PLANTS

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   0   0**
Total Marks: 100

Origin of process hazards, laws, codes, standards, case histories. Hazards: Chemical, mechanical and physical. Health hazards of industrial substances. Explosion hazards due to chemical reaction. Fire and explosion hazard rating of process plant. Reliability and risk analysis. HAZOP and HAZAN. Consequence analysis vapour cloud modelling. Designing for safety. Measurement and calculation of risk analysis. Event probability and failure frequency analysis. Safety training, emergency planning and disaster management. Case studies.

Ch -408CHEMICAL PROCESS PLANT DESIGN (Practical)

External Marks: 20　　　　　　　　　　　　　　　　　　　**L　T　P**
Internal Marks: 30　　　　　　　　　　　　　　　　　　　**1　0　2**
Total Marks:　50

Each student shall be required to submit two bound typewritten copies of a project report on a proposed chemical plant manufacturing product/products related to ones course/subject to be worked out under the supervision of a faculty member. The report shall include mass and energy balances, type an capacity of equipment selected and recommended, plant layout, feasibility analysis highlighting market survey, pattern of assistance available from the central and state governmental agencies, banks and financial institutions. Assistance for technology, raw materials finance, Legal obligation. The student is to appear in a viva-voce examination.

Recommended Books

1. Vilbrandt & Dryden : Chemical Engg. Plant Design (McGraw Hill)
2. peters & Timmerhaus : Plant Design Economic for Chemical Engg. Plant Design (McGraw Hill)
3.F. Molyneux : Chemical Plant Design -I(Butterworths, 1963)

PROCESS SIMULATION LAB. Ch - 410

External Marks: 20　　　　　　　　　　　　　　　　　　　**L　T　P**
Internal Marks: 30　　　　　　　　　　　　　　　　　　　**0　0　2**
Total Marks:　50

1. Modeling and Simulation of isothermal CSTR
2. Modeling and Simulation of non- isothermal CSTR
3. Modeling and Simulation of isothermal batch reactor
4. Modeling and Simulation of non - isothermal batch reactor
5. Modeling and Simulation of isothermal of distillation column.

Book: Process Modeling and Simulation and Control for Chemical Engineers by W.L. Luyben (McGraw Hill)

Ch -414 PROJECT

External Marks: 40　　　　　　　　　　　　　　　　　　　**L　T　P**
Internal Marks: 60　　　　　　　　　　　　　　　　　　　**0　0　8**
Total Marks:　100

Each student is required to submit 3 bound type writen copies of a project report on a proposed research oriented work :- either theoretical & practical (e.g design of sophisticated process plant, modeling & simulation of sophisticated chemical process, optimization of sophisticated of chemical process, chemical process experimentation & data Analysis)

The object is to test the ability of the student to co-operate his entire knowledge of chemical engineering principles to judge his knowledge and originality and capacity for application of laboratory data in designing chemical plants and to determine the level of his proficiency at the end of the course.

The student is to appear in a Viva-Voce Examination

Ch -412 SEMINAR

External Marks: 40	**L T P**
Internal Marks: 60	**0 0 8**
Total Marks: 100	

Each student will have to prepare seminar and to attend the seminars, regularly. Depending on his/her performance in seminar he/she will be evaluated. Main in of this instrument is to develop presentation skills in the students.

ELECTIVE - I
Ch -317 BIO-SCIENCE

External Marks: 60	**L T P**
Internal Marks: 40	**3 0 0**
Total Marks: 100	

Classification of microorganisms: Morphological, structural and biochemical characteristics of prokaryotes and eucaryotes. Microbial nutrients and growth media. Microbial reproduction and growth. Methods inmicrobiology. Nutrient transport across cell membrane. Structure and function of carbohydrates, lipids, amino acids and peptides, nucleic acid and nucleotides, proteins, enzymes.

Books recommended:
1. Microbiology by M.J. pelozer, E.C.S. Chan and N.R. Kerig, McGraw Hill Book Co.
2. Biochemistry by L. Stryer, W.H. Freeman & Company

Ch -316 BIOCHEMICAL ENGINEERING

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   0   0**
Total Marks: 100

Introduction - role of a biochemical engineer.

Mass balance in bioprocesses:

Steady State & Equilibrium, Material Balances, Procedure for material balance calculations, Degree of reduction, Yield Coefficients, Material Balance examples in bioprocesses.

Kinetics of microbial growth:

Introduction, Batch growth pattern, Michalis-Menton Kinetics, Effect of environmental conditions on microbial growth, Kinetics of Continuous culture & Fed-batch culture, Maintenance coefficient.

Enzyme kinetics including enzyme inhibition:

Quasi-state & Rapid Equillibrium approach to enzyme kinetics, experimental determination of rate parameters for Michalis-Menten Type Kinetics, Double-Reciprocal Plot, Eadie-Hofstee plot, Hanes-woolf plot, kinetics of Enzyme inhibition – Competitive, Un-competitive, Non-competitive inhibition & substrate inhibition.   Enzyme Immobilization.

Kinetics of substrate utilization and product formation.

Sterilization of air and media.

Batch and continuous sterilization, Physical & Chemical Methods of Sterilization, Thermal Death kinetics.

Mass transfer in biological systems.

Molecular Diffusion, Diffusion Theories, Mass Transfer Coefficient, Gas-Liquid Mass Transfer in cellular systems, Gas-Liquid Contacting modes, Oxygen Transfer from Gas bubble to Cell, Determination of Oxygen Transfer Rates, Factors Effecting Oxygen Transfer Rates.

Books Recommended:

1. Biochemical Engineering fundamentals by J.E. Bailey and D.F. Ollis, McGraw Hill Book Co.
2. Bioprocess Engg. By Shuler and f. Kargi, Prentice Hall.
3. Biochemical Engineering by J.M. Lee, Prentice Hall.

ELECTIVE - III
Ch -416 Bioprocess Technology

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

1. Mass transfer and microbial respiration: Mass transfer resistance, physical and enzymatic considerations, critical value of dissolved oxygen concentration, respiration of mycabial pellet
2. Bubble aeration and mechanical agitation, single bubbles, series of bubbles, power number v.s. seynolds number decrease of power requirement in aeration, power requirement in non-newtorian fluids, hold up bubbles in aeration vessels.
3. Correlation between oxy-transfer coefficient and operations variables (bubbles aeration with and without mechanical agitation).
4. Other factors affecting the volume of oxygen transfer (Tem. Organic substance, surface active agents, mycelium, type of sparger).
5. Scale up: Basis of scale up (physical concepts, biological concept) Examples of scale up (ower per unit volume of characteristics of fermentation broth, design sample.
6. Fermentor design (coredinal rules, materials of construction, vessel size, bearing assemblies, motor devices), aseptic operations (Pipe-lines, values, aseptic inoculation system and aseptic sampling systems).
Books recommended:
1. Shuichi Abia: Biochemical Engineering Academic Press Inc. New York.
          2. Bailey & Ollis: Biochemical Engineering Fundamentals, McGraw Hill.

ELECTIVE - I
Ch -319 INTRODUCTION TO PLYMER SCIENCE & ENGINEERING

External Marks: 60   **L T P**
Internal Marks: 40   **3 0 0**
Total Marks: 100

Introduction Polymers: Classification of polymers, polymerization process, chemistry and Kinetics of step growth and chain growth polymerization, polymerization techniques: Bulk, solution, suspension emulsion, mold, polycondensation, interfacial condensations, solid and gas phase polymerization.

Molecular weight & Size of Polymers: Number average and weight average molecular weight, significance of molecular weight, determination of molecular weight and group analysis, solution viscosity method, osmotic pressure, light scattering method, gel permeation chromatography method etc.

Polymer properties & Their testing: Glass transition temperature and associated properties, thermosetting polymers. Tensile strength & impact strength and their determination, softening point, heat distertion dielectric and power factor etc. Theology of polymeric materials.

Synthesis & Properties of Commercial Polymers: Plastic, rubber and fibers of commercial importance, polymer auxiliaries; plasticisers, stabilizers, fillers, lubricant etc. Manufacture, processing and properties of resins and fiber forming polymers such as phenol formaldehyde, urea formaldehyde, epoxy resins, urethane foam and silicon polymers; IDPE, HDPE, polypropylene, polyvinyl chloride, polystyrene, polyhutadiene, polyacrylonitrile, polyamide, etc. fiber reinforced plastics

Engineering Applications of Polymers: Elastomeric composites in tyre technology, polymers in fiber, man made fibers, acetate fiber, acrylic, nylon, olefin, polyester, rayon, saran, spendex vinyl, synthetic adesives, Bio-polymers and their applications, plastics and polymers in agriculture industry Plastics in consumer goods, polymer powders, coating and medical applications of polymers.

Polymer Degradation: Thermal, Mechanical and by ultrasonic waves, photodegradation, heat energy radiation, oxidation and hydrolysis.

Books Recommended:
1. Polymer Science V.L. Cowariker, N.V. Viswanathan & J. Sreedhar.
2. Polymer Science & Technology of Plastics & Rubber P.Ghosh
3. Text Book of Polymer Science F.W. Billmeyer

ELECTIVE -II
Ch -318 Rubber & Plastic Technology

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   0   0**
Total Marks: 100

Introduction to polymers, Classification of polymers, polymerization process, polymerization techniques, polymer properties & their testing.

Rubber & elastomers, natual & synthetic chlorinated, oxygenated, cycle rubber, Runa S. Buna N, Butyl rubber, neoprene, thiokols, polyisoprene rubber, polyurethane, Fillers, saccelerators, activators, antioxidants & other additives, mastication & compounding, vulcanization theory & technology, Latex testing, formulation, fabrication, rubbers of commercial importance.

Introduction to Plastics, Polythene, LDPE, Poly Propylene, Copolymers of ethylene, polystyreme, acrylic plastics, Polyvinyl acetate, PVC, Polytetrafluoro ethylene (PTFE), Polymidesm, Polyesters, Polyurethanes, Polycarbonates, cellulose plastics, phenolic resins, Plastic material processing technology; mouldings, extrusion, injection, blow & compression moulding, vaccum forming, compounding, designing with plastics, plastics of commercial importance.

Books Recommended
1. Polymer Science & Technology of Plastics Rubber by P. Ghosh
2. Text book of polymer science by f.w.Billmeyer.
3. Polymer Science by V.R. Gowariker, N.V. Viswanathan & J. Sreedharan.
4. Introduction to Polymer chemistry by R.B. Seymour.
5. P.J. Flory, Inter Science, Principles of Polymer Chemistry, Cornell University Press 1953.
6. Text book of Polymer Science &Engg. By Anil Kumar & S. Gupta

ELECTIVE-III
CH –418   POLYMER REACTOR DESIGN

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   0   0**
Total Marks: 100

A brief introduction to various type of polymers, polymerization methods and their importance.
Reactors: Definition, types application-fields.
Reactor Design: meaning, general design procedure
Reaction Engineering of step growth polymerization : introduction, analysis of semi batch
reactors, MWD of ARB polymerization in homogeneous continuous flow stirred-tank reactors
(HCSTRs) advanced stage of polymerizatiom,similarity solution of step growth polymerization in
films with finite mass transfer.

Reaction engineering of chain growth polymerization; introduction, design of tubular
Reactors, copolymerization, solution of equations describing isothermal radical polym
erization.
 Emulsion polymerization: introduction emulsion polymerization in homogeneous continous flow
stride tank reactors (HCSTRSs)
Detailed Design of ideal batch reactor for the prodution of Phenol-formaldehyde (novolac)
starting from phenol & formaldehyde as raw materials.

RECOMMEDED BOOKS:

1. "Fundamentals of Polymers" Anil Kumar and Rajesh K. Gupta McGraw Hill,1998.
2. "Fundamentals of Polymer Science and Engineering", Anil Kumar and K. Gupta listed
    Tata McGraw HillNew Delhi, 1978.
3. "Elements of Chemical Reaction Engg", H. Scott , Fogler (PHI)

ELECTIVE-I
Ch -321 PETRLEUM RECOVERY TECHNOLOGY
External Marks: 60   **L   T   P**
Internal Marks: 40   **3   0   0**
Total Marks: 100

ncept of lithology, reservoir, reservoir, reservoir fluids, migration of fluids.
Exploration: Meaning, methods of exploration, surface geological methods, geophysical methods,
geophysical methods.
Drilling: Concept of drilling, various drilling operations e.g. cable drilling, rotary drilling,
directional drilling etc.
drilling equipment; various rigs and its parts like draw-works, rotary table, Kelley, swivel and
drilling bits, Mud; mud parameters; specific weight, viscosity, pH etc and chemical used.
Regulation of crude oil production, pretreatment, classification of crude's methods of evaluation;
ASTM, TBA, EFV distillation.
Books recommended:
1. Nelson, W.L. Petroleum Refinery Engineering, McGraw Hill
2. Hotson, G.D. Phol Co Modern Petroleum Technology Halsted Press Division of Wiley
Eastern.
3. Tarok Ahmed, Hydrogen Phase Behaviour Gulf Publishing Co.

ELECTIVE-II
Ch -320 PETROLUEM REFINING ENGINEERING

External Marks: 60　　　　　　　　　　　　　　　　　**L　T　P**
Internal Marks: 40　　　　　　　　　　　　　　　　　　**3　0　0**
Total Marks:　100

Petroleum Refinery Process; Concept of distillation, multi component distillation cracking, catalytic cracking, hydro cracking and fluidized bed crackers; Alkyltion; reforming, hydro-forming, solvent extraction; crystallization; sweetening; hydro desulphurization; clay treatment wax removal by refrigeration process. Concepts of fuel economy; environmental and safety control.

Raw material for refinery, production, properties and specifications of petroleum products such as LPG Gasoline, Naphtha, Kerosene, Diesel oils, Lubricating oils, waxes and Bitumen etc. Storage of petroleum products; tanks, Bullets, special type of spheres etc. Transportation of petroleum products; Rail, Road, Sea and Pipeline. Importance of pipeline transportation.

Books Recommended:

1. Forest Gray, Petroleum for the Non Technical Person Penn well Book Publishing.
2. B.K. Bhaskara Rao, Modern Petroleum Refinery Processes. IBH Publishing Co. Pvt. Ltd.
3. Nelson, W.L. Petroleum Refinery Engineering, McGraw Hill

ELECTIVE-III
Ch -420 PETRO CHEMICAL TECHNOLOGY

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   0   0**
Total Marks: 100

Petro chemicals; Definition, importance and growth potential of the field.
Raw material for petrochemical industries sources, economics and advantage etc.
Production of olefin containing gases; various purification and separation processes.
Important intermediate material for petrochemical industry e.g. Aromatic, Ammonia, Butadiene, Alcohol, synthesis gas etc.
Retails and variations in processes for petrochemical feed stock e.g. cracking, polymerization and isomerisation.
Manufacture of important petrochemicals: Plastics, fertilizer, Carbon Black, Synthetic fibers, Synthetic Rubber, Synthetic Detergents. Concepts of quality and environmental pollution control in petrochemical industries.

BOOKS RECOMMENDED;
1. B.K. Bhaskara Rao, Modern Petroleum Refinery Processes Oxford & IBH Publishing Co. Pvt. Ltd.
2. Steiner, H Industries to Petroleum Chemicals. Pergammon Press.
3. Waddone, A.C. Chemcial from Petroleum, Johu Murry
4. Top Chev, A.V. Synthetic Materials from petroleum, pergammon press.

ELECTIVE - I
Ch-323 Food Chemistry

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   0   0**
Total Marks: 100

1.   Chemical constituents of different food and food products: Water, Protein, Carbohydrates, Lipids, Vitamins, Minerals, Colour, Flavour.
2.   Proximate analysis of foods: Chemical and Instrumental methods of analysis   of fat, protein, carbohydrate (sugar, dietary fibre), minerals, vitamins.
3.   Carbohydrate: Definition, classification nomenclature, structure, physical and chemical properties, polysaccharides (amylose, amylopectin, cellulose, pectin)
4.   Protein : Definition, classification, amino acids, structure, physical and   chemical properties, hydrogenation of oils
5.   Lipids : Definition, classification, nomenclature, structure, physical and   chemical properties, hydrogenation of oils
6.   Changes and interaction in food constituents during maturation and ripening   of fruits
7.   Colour: Plants pigments, structure and properties of chlorophyll, anthocynanin   and carotenoids.
8.   Flavour: Different kinds of flavour in foods
9.   Texture : Effect of processing on texture of foods

Books recommended :

1.	Food Chemistry	Meyer
2.	Food Chemistry	Belitz
3.	Basic Food Chemistry	Lee
4.	Food Chemistry	Fennema
5.	Pearson's composition and analysis of food	Krik and Swyer
6.	Biochemistry	Stryer
7.	Biochemistry	Lehninger

ELECTIVE -II
- **CH –322 FOOD BIO-CHEMISTRY & MICROBIOLOGY**

External Marks: 60   **L T P**
Internal Marks: 40   **3 0 0**
Total Marks: 100

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Enzymes: Structure & Biosynthesis, Enzmic reaction mechanism and control. Activators and inhibitors.

Kinetics and measurement of enzyme activity and rate of reaction.
Metabolic pathways in plants, animals and microorganisms.
Cell structure. Elements of human nutrition.
Recommended dietary allowances and food value of different food products.
Study of microorganisms including bacteria, virus, yeast and mold. Morphology, structure, classification and methods of measurement of growth. Reproduction, isolation and cultivation of microbes.
Control of microbial growth and spoilage. Mutation Applied Microbiology.
Books Recommended:
1. Food Microbiology: Frazier & Westoff (Tata McGraw Hill)
2. Priochemistry of foods: Eskin & others (Acad. Press)
3. Biochemistry : Stryer (Freeman)
4. Prescott & Dunn's industrial Microbiology (McMillan)

Ch-422 ELECTIVE -III FOOD PROCESSING AND ENGINEERING

External Marks: 60   **L T P**
Internal Marks: 40   **3 1 0**
Total Marks: 100

Spoilage of foods and causative agents. Factors affecting spoilage. Methods of food preservation, e.g. dehydration, thermal processing, freezing, chemical and adiation.
Their principles and applications. Processing of different food products including cereals and pulses, milk and dairy products, fruit and vegetable products, meat, fish poultry and eggs, bakery and confectionery products, edible oils and fats.
Fermented foods.
Books Recommended:
1. A complete course in canning: Lopes (Canning Trade, Baltimoe)
2. Chem. & Technology of Cereals as food feed: Matz (Avi)
3. Bakery Technology & Engineering, Mtz (Avi).
4. Modern Dairy Technology: Robinson (Fcisevior).
5. Freezing Preservation of Foods: Tresster & Other (Avi)
6. Food dehydration: Van Arsdale & Copley (Avi)
7. Commercial Fruit & Veg. Processing; Woodrof & Lub. (Avi)

ELECTIVE - I
Ch -325 DAIRY CHEMISTRY & MICROBIOLOGY

External Marks: 60   **L T P**
Internal Marks: 40   **3 0 0**
Total Marks: 100

Definition of milk, constituents and gross composition of milk. Factors affecting composition of milk, legal standards. Physical properties of milk; Freezing point, viscosity, surface tension, buffer value, refractive index, recknagel effect, density specific gravity.
Physico-chemical changes in milk during heating. Effect of metals on milk and effect of milk on metals. Milk lipi ds-milk glycerides, fatty acids classification phospolipids.
Milk proteins-nomenclature and classification-isolation, fractionaction and determination of major milk proteins-stability of milk proteins.
Lactose-structure-solubility-hydrolysis, status of lactose in milk.
Milk enzymes-minerals-salt balance, vitamins in milk.
Preservatives, neutralizers and adulterants in milk and their detection.
History and development of microbiology-importance of microbes in milk and milk products.
Microorganisms associated with milk and milk products: bacteria, yeast, molds and viruses; characteristics (morphological and biochemical) of important groups; classification based on growth, temperature (Psychorotrophs, mesophiles, thermoduries and thermophiles).
Hygienic milk production: Possible soruces of entry of microorganisms at various stages of production and their control. Role of micoorganisms in spoilage of milk and milk products, microbial interactions (synergism, metabiosis, antibiosis), undesirable fermentation (souring, curdlin, nbitty cream), proteolysis lipolysis, abnormal flavour and discoloration).
Mastitic milk: Types of causative microorganisms and somatic cells secreted in milk, their detection and significance from processing and public health point of view; effect on fermented milks. Milk as a vehicle of pathogens; prevention of milk borne diseases.
Antimicrobial substances in milk: Immunoglobulins, lactoferin; lactanins, lysozyme, lactoperoxidase, bifidus factor etc.
Mold inhibitors; chemicals inhibiting the growth of molds and their use in industry.
Books Recommended:
1. Principles of Dairy Chemistry by R.J. enness & S. Patton.
2. Fundamentals of Dairy Chemistry by Webbm Johnson & Arnold.
3. Chemistry and Testing of Dairy products by A.V. Atherton & J.A. Newlander.
4. Dairy Microbiology by Fister and Nelson and other.
5. Dairy Microbiology by k.C. Mahanta.
6. Baxteria in 7. Relation to Milk supply by Chalmers.
8. Standard Methods for Analysis of Dairy Products 15th Edition.
9. IS: 1479 (1960) Part -I, Rapid Examination of Milk
10. IS: 1479 Part - III, Bacteriological Analysis of milk.

ELECTIVE -II
Ch -324 UNIT OPERATION IN DAIRY INDUSTRY

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   0   0**
Total Marks: 100

Sanitization: Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, standards, glass piping, plastic tubing and fittings, gaskets, installation, care and maintenance tubing and fittings. Description of equipment, working and maintenance of can washers, bottle washers; factors affecting weashing operations, power requirement of can and bottle washers. C.I.P cleaning and desing of systems:

Mechanical separation: Fundamentals involved in separation. Sedimentation, principles involved in filtration, types rates of filtration, pressure drop calculations. Gravity settling, principles of centrifugal separation, different types of entrifuges, application in dairy industry, clarifiers, triprocess cream separator, self desludging centrifuge, bactofuge, clarifixator, care and amintenance of separators and clarifiers.

Homogenization: Classification, single stage and two stage homogenizers, aseptic homogenizer pumps. Power requirement, care and maintenance of homogenizers, aseptic homogenizers. Pasteurization; batch , flash and continuous (HTST) pasteurizes, flow diversion vlave, pasteurizer controls, hot water circulation systems, care and maintenance of pasteurizers. Different types of sterilizers; in bottle sterilizers, autoclaves, continuous sterilization plant and aseptic filling machine, oare and maintenance of sterilizers.

Filling operations: Principles and working of different types of bottle fillers and capping machines, Pouch filling machines (Prepack and aspetic filling), bulk handling systems, care and maintenance. Equipments used for mixing, evaporation, drying and gas-solid, liquid-solid separation in dairy industry.

Membrance Processing: Ultrafiltration and revearse omsmosis materials for membrance construction, ultitrafiltration of milk. Effect of milk constituents on permeation rates, reverse osmosis, mode of operation, membrances for electrodialysis. Freezing: Thermal properties of frozen foods; thermodynamics of freezing, prediction of freezing rates, plank's equation, design of food freezing equipments, air blast freezers, plate freezers and immersion freezers, plate freezers and immersion freezers, batch and continuous ice-cream freezers.

Freeze dehydration: Heat and mass transfer, calculation of drying times, industrial freeze dryers.

Books recommended:
1. Unit Operations - Mc Cabe and smith
2. Food engineering system - Farral, Vol I & II
3. Dairy Engineering by Farral
4. food Engineering and Dairy Technology by Kesseler

ELECTIVE - III
Ch -424 TECHNOLOGY OF MILK AND MILK PRODUCTS

External Marks: 60   **L   T   P**
Internal Marks: 40   **3   1   0**
Total Marks: 100

Market Milk: Definition of milk and illegal/BIS standards for market milk; Necessity for pasteurization; different methods of pasteu rization tests for pasteurized milk and quality control; separation and clarification milk and their purpose. Fat rich; dairy products:

Cream: Efficiency of cream separation and factors affecting it, control of fat concentration in cream, grading, neutralization, standardization pasteurization and colling of cream, preparation and properties of different types of creams; table cream, sterilized cream, whipped cream, plastic steam and frozen cream. Types of creams; table cream, sterilized cream, whipped cream, plastic cteam and frozen cream.

Butter: Introduction to butter making processes, theory of churning, batch and continuous methods, overrun in butter, control of fat losses in butter milk, packaging and storage low fat spreads.

Ghee and Butter Oil: Methods of manufacture of ghee and butyler oil, composition and changes during manufacturing fat contents, grading, rancidity, antioxidants, packaging and storage.

Condensed and dried milk: manufacture , packaging and storage of condensed milk; process steps and flow lime concentration of milk, klroller/spray drying of mild; fow diagram properties of dried milks and sweetended condensed milk different varieties of dried milk; evaporated milk and its processing; storage and condensed and dried milk; recent developments in dried milk manufacture; drying of new desicated products like dahi powder, srikhand powder, tea complete etc.

Cheese: Different types of cheese; composition and basic processing steps involved in their manufacture; manufacture of cheddar cheese & processed cheddar cheese qualitative line diagram for processing cottage cheese, packaging and storage of cheese.

Ice Cream: Composition of ice cream; assembling of ingredients and processing office cream; hardening and storage; concept of overrun and its significance, batch and continuous process, dried ice cream mixture.

Casein: Different grades of casein; production techniques for casein; composition of casein and its uses.

Lactose: Processing of lactose from why and the process flow diagram; uses of lactose.

Traditional Indian Dairy Products:

1. Khoa - classification, methods of manufacture batch and continous, packaging and preservation, Rabri, Malai, Basundi.

2. Chhan - Product description, methods of manufacture, packaging and preservation, chhana based sweets, nutritive value.

3. Paneer-product description, methods of manufacture, packaging and preservation, nutritive value.

4. Srikhand - product description, methods of manufacture packaging and preservation, nutritive value.