VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

BE/B.TECH Scheme of Teaching and Examinations
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
(Effective from the Academic Year 2018-2019)

III- SEMESTER

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES
(Common to all Programmes)

Course Code	**18MAT31**	CIE Marks	40
Teaching Hours/Week (L: T:P)	(2:2:0)	SEE Marks	60
Credits	**3**	Exam Hours	03

Course Learning Objectives:

- To have an insight into Fourier series, Fourier transforms, Laplace transforms, Difference equations and Z-transforms.
- To develop the proficiency in variational calculus and solving ODE's arising in engineering applications, using numerical methods.

Module-1

Laplace Transform: Definition and Laplace transforms of elementary functions (statements only). Laplace transforms of Periodic functions (statement only) and unit-step function – problems.
Inverse Laplace Transform: Definition and problems, Convolution theorem to find the inverse Laplace transforms (without Proof) and problems. Solution of linear differential equations using Laplace transforms.

Module-2

Fourier Series: Periodic functions, Dirichlet's condition. Fourier series of periodic functions period 2π and arbitrary period. Half range Fourier series. Practical harmonic analysis.

Module-3

Fourier Transforms: Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. Problems.
Difference Equations and Z-Transforms: Difference equations, basic definition, z-transform-definition, Standard z-transforms, Damping and shifting rules, initial value and final value theorems (without proof) and problems, Inverse z-transform and applications to solve difference equations.

Module-4

Numerical Solutions of Ordinary Differential Equations(ODE's):
Numerical solution of ODE's of first order and first degree- Taylor's series method, Modified Euler's method. Runge -Kutta method of fourth order, Milne's and Adam-Bash forth predictor and corrector method (No derivations of formulae)-Problems.

Module-5

Numerical Solution of Second Order ODE's: Runge-Kutta method and Milne's predictor and corrector method. (No derivations of formulae).
Calculus of Variations: Variation of function and functional, variational problems, Euler's equation, Geodesics, hanging chain, problems.

Course outcomes:
At the end of the course the student will be able to:

- CO1: Use Laplace transform and inverse Laplace transform in solving differential/ integral equation arising in network analysis, control systems and other fields of engineering.
- CO2: Demonstrate Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
- CO3: Make use of Fourier transform and Z-transform to illustrate discrete/continuous function arising in wave and heat propagation, signals and systems.
- CO4: Solve first and second order ordinary differential equations arising in engineering problems using single step and multistep numerical methods.
- CO5:Determine the externals of functionals using calculus of variations and solve problems arising in dynamics of rigid bodies and vibrational analysis.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition, 2016
2	Higher Engineering Mathematics	B. S. Grewal	Khanna Publishers	44th Edition, 2017
3	Engineering Mathematics	Srimanta Pal et al	Oxford University Press	3rd Edition, 2016
Reference Books				
1	Advanced Engineering Mathematics	C. Ray Wylie, Louis C. Barrett	McGraw-Hill Book Co	6th Edition, 1995
2	Introductory Methods of Numerical Analysis	S.S.Sastry	Prentice Hall of India	4th Edition 2010
3	Higher Engineering Mathematics	B.V. Ramana	McGraw-Hill	11th Edition,2010
4	A Textbook of Engineering Mathematics	N. P. Bali and Manish Goyal	Laxmi Publications	6th Edition, 2014
5	Advanced Engineering Mathematics	Chandrika Prasad and Reena Garg	Khanna Publishing,	2018

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. VTU EDUSAT PROGRAMME - 20

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SEMESTER – III

CHEMICAL PROCESS CALCULATIONS

Course Code	**18CH32**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:2:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives: The students will

1. Learn basic laws about the behavior of gases, liquids and solids and some basic mathematical tools.
2. Understand systematic problem solving skills, enhance confidence, and generate careful work habits.
3. Learn what material balances are, how to formulate and apply them, how to solve them.
4. Learn what energy balances are, and how to apply them and finally, to learn how to deal with the complexity of big problems.

Module-1

UNITS AND DIMENSIONS:
Fundamental and derived units, Conversion, Dimensional consistency of equations, Dimensionless groups and constants, conversions of equations.

BASIC CHEMICAL CALCULATIONS:
Concept of mole, mole fraction, Compositions of mixtures of solids, liquids and gases, Concept of Normality, Molarity, Molality, ppm, Ideal gas law calculations.

Module-2

MATERIAL BALANCE WITHOUT REACTION:
General material balance equation for steady and unsteady state, Typical steady state material balances in distillation, absorption, extraction.

Module-3

MATERIAL BALANCE WITHOUT REACTION:
Drying, mixing and evaporation, Elementary treatment of material balances involving bypass, recycle and purging.

Module-4

STEADY STATE MATERIAL BALANCE WITH REACTION:
Principles of Stoichiometry, Concept of limiting, excess reactants and inerts, fractional and percentage conversion, fractional yield and percentage yield, selectivity, related problems, Ultimate and proximate analysis of fuels, Calculations involving burning of solid, liquid and gaseous fuels, excess air, air-fuel ratio calculations.

Module-5

ENERGY BALANCE:
General steady state energy balance equation, Thermo physics, Thermo chemistry and laws, Heat capacity, Enthalpy, Heat of formation, Heat of reaction, Heat of combustion and Calorific values. Heat of solution, Heat of mixing, Heat of crystallization, determination of ΔH_R at standard and elevated temperatures, Theoretical flame temperature and adiabatic flame temperature.

Course Outcomes: On completion of this course the student will have

- Comprehend the basic theories in stoichiometry and perform unit conversions and calculations.
- Discuss material balance of steady state processes like distillation, absorption, extraction and crystallization.
- Solve material balance problems like drying, mixing, evaporation, bypass, recycle and humidification.
- Discuss concepts of material balance problems with chemical reactions. Combustions and air fuel calculations.
- Explain the concepts of thermo physics and thermo chemistry and solve steady state enthalpy balance problems.
- Develop mathematical solutions for mass and energy balance for any processes.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

- The students will have to answer 5 full questions, selecting one full question from each module.

Note: Question Paper to contain at least 30% Theory

TEXT BOOKS:

1. Bhatt B.I. and Vora S.M., **"Stoichiometry (SI Units)"**, 3rd edn, 1996, Tata McGraw Hill Publishing Ltd., New Delhi, 1996
2. Hougen O.A., Watson K.M. and Ragatz R.A., **"Chemical Process Principles-Part I"**
3. **"Material and Energy balances"**, 2nd Edn, CBS publishers and distributors, New Delhi, 1995

REFERENCE BOOK:

1. Himmelblau D.M., **"Basic principle and Calculations in Chemical Engineering"**, 6thedn, Prentice Hall of India, New Delhi,1997.

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Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – III

MOMENTUM TRANSFER

Course Code	**18CH33**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will

1. Understand concepts on nature of fluids, pressure concepts and measurement of pressure by various experimental methods and by mathematical relations and enhancement of problem solving skills.
2. Learn detailed explanation on types of fluids, stress and velocity relations, type of fluid flow and boundary layer relations.
3. Understand relationship between kinetic energy, potential energy, internal energy and work complex flow systems using Bernoulli's equation with application to industrial problems.
4. Understand clear concepts on Flow of incompressible fluids in conduits and thin layers and friction factor variations with velocity and friction losses using Bernoulli's Equations and they will be demonstrated experimentally.
5. Study Flow of compressible fluids, Dimensional analysis, Dimensional homogeneity and various dimensionless numbers and their applications.
6. Understand principles and working of various types of pumps, transportation and metering of fluids using various experimental techniques and applications to industry.

Module-1

FLUID STATICS AND ITS APPLICATIONS:
Concept of unit operations, Concept of momentum transfer, Nature of fluids and pressure concept, variation of pressure with height – hydrostatic equilibrium, Barometric equation, Measurement of fluid pressure – manometers, Continuous gravity decanter, Centrifugal decanter.

FLUID FLOW PHENOMENA:
Type of fluids – shear stress and velocity gradient relation, Newtonian and Non- Newtonian fluids, Viscosity of gases and liquids. Types of flow – laminar and turbulent flow, Reynolds stress, Eddy viscosity. Flow in boundary layers, Reynolds number, and Boundary layer separation and wake formation.

Module-2

BASIC EQUATIONS OF FLUID FLOW:

Average velocity, Mass velocity, Continuity equation, Euler and Bernoulli equations Modified equations for real fluids with correction factors, Pump work in Bernoulli equation, Angular momentum equation.

FLOW OF INCOMPRESSIBLE FLUIDS IN CONDUITS AND THIN LAYERS:
Laminar flow through circular and non-circular conduits, Hagen Poiseuille equation, Laminar flow of Non-Newtonian liquids, Turbulent flow in pipes and closed channels.

Module-3

FLOW OF INCOMPRESSIBLE FLUIDS IN CONDUITS AND THIN LAYERS:
Friction factor chart, friction from changes in velocity or direction, Form friction losses in Bernoulli equation, Flow of fluids in thin layers.

FLOW OF COMPRESSIBLE FLUIDS:
Continuity equation, Concept of Mach number, Total energy balance, Velocity of sound, Ideal gas equations, Flow through variable-area conduits, Adiabatic frictional flow, Isothermal frictional flow (elementary treatment only).

Module-4

TRANSPORTATION AND METERING OF FLUIDS:
Pipes, Fittings and valves, Measurement of fluid and gas flow rates by orifice meter, rotameter and pitot tube, Elementary concept of target meter, vortex-shedding meters, turbine meters, positive displacement meters, magnetic meters, coriolis meters and thermal meters, Flow through open channel-weirs and notches.

Module-5

PUMPS:
Performance and Characteristics of pumps-positive displacement and centrifugal pumps, Fans, compressors, and blowers.

DIMENSIONAL ANALYSIS:
Dimensional homogeneity, Rayleigh's and Buckingham Π- methods, Significance of different dimensionless

numbers, Elementary treatment of similitude between model and prototype.

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

- Recall the concepts of fluid statics and dynamics and able to measure pressure difference.
- Explain the fundamental equations of fluid flow.
- Understand the various equations for incompressible and compressible fluids in conduits.
- Demonstrate the knowledge of fluid flow principles in various types of flow measurements, transportation and metering equipment of fluids using experimental techniques and applications to industry.
- Develop functional relationships using dimensional analysis and similitude to solve technical problems.
- Design appropriate flow systems and flow measuring instruments.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. McCabe, W.L., *et.al.,* **"Unit Operations in Chemical Engineering"**, 5thedn., McGraw Hill, New York 1993
2. Kumar K.L., **"Engineering Fluid Mechanics"**, Eurasia Publishing House (p) Ltd., New Delhi, 3rdedn. 1984
3. Dr R K Bansal., "**A Text Book of Fluid Mechanics**" 1stedn., Laxmi Publications (P) Ltd., New Delhi. 2005.

REFERENCE BOOKS:

1. Coulson J.H. and Richardson J.F., **"Chemical Engineering"**, Vol-I, 5thedn., Asian Books (p) Ltd., New Delhi, 1998
2. Badger W.L. and Banchero J.T., **"Introduction to Chemical Engineering"**, Tata McGraw Hill, New York, 1997

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SEMESTER - III

MECHANICAL OPERATIONS

Course Code	**18CH34**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will

1. Study different properties of particulate solids, handling and mixing of solid particles.
2. Study principles of comminution and different types of equipment for size reduction like crushers, grinders etc.
3. Understand mechanical separation aspect such as screening, filtration, sedimentation, transportation of solids etc.
4. Understand energy requirements in solids handling, agitation and mixing, solid conveying and storage.
5. Hands on experience of working by conducting experiments on some of the basic unit operations such as separation and size reduction.
6. Present seminar on current separation techniques and submit the report on the same.

Module-1

PARTICLE TECHNOLOGY:

Particle shape, particle size, different ways of expression of particle size, shape factor, sphericity, particle size analysis, screens – ideal and actual screens, Differential and cumulative size analysis, effectiveness of screen, Specific surface of a mixture of particles, Number of particles in a mixture, standard screens, Industrial screening equipment, Motion of screen, Grizzly, Gyratory screen, Vibrating screen, Trommels.

Module-2

SIZE REDUCTION:

Introduction – types of forces used for comminution, Criteria for comminution, Characteristics of comminuted products, Laws of size reduction, Work Index, Energy utilization, methods of operating crushers – Free crushing, choke feeding, open circuit grinding, Closed circuit grinding, wet and dry grinding, Equipment for size reduction – Classification of size reduction equipment, equipment – Blake jaw crusher, Gyratory crusher, Smooth roll crusher, Toothed roll crusher, impactor, Ball mill, Critical speed of ball mill, Cutters – Knife cutter.

Module-3

FLOW OF FLUID PAST IMMERSED BODIES:

Drag, Drag coefficient, Pressure drop – Kozeny-Carman equation, Blake-Plummer, Ergun equation, Fluidization, conditions for fluidization, Minimum fluidization velocity, Pneumatic conveying.

MOTION OF PARTICLES THROUGH FLUIDS:

Mechanics of particle motion, Equation for one dimensional motion of particles through a fluid in gravitational and centrifugal field, Terminal velocity, Drag coefficient, Motion of spherical particles in Stoke's region, Newton's region, and Intermediate region, Criterion for settling regime, Hindered settling, Modification of equation for hindered settling, Centrifugal separators, Cyclones and Hydro cyclones.

Module-4

SEDIMENTATION:

Batch settling test, Coe and Clevenger theory, Kynch theory, thickener design.

FILTRATION:

Introduction, Classification of filtration, Cake filtration, Clarification, batch and continuous filtration, Pressure and vacuum filtration, Constant rate filtration and cake filtration, Characteristics of filter media, Industrial filters, Sand filter, Filter press, Leaf filter, Rotary drum filter, Centrifugal filtration – Suspended batch centrifuge, Filter aids, Application of filter aids, Principles of cake filtration.

Module-5

AGITATION AND MIXING:

Application of agitation, Agitation equipment, Types of impellers – Propellers, Paddles and Turbines, Flow patterns in agitated vessels, Prevention of swirling, Standard turbine design, Power correlation and power calculation, Mixing of solids, Types of mixers –, Muller mixers, Mixing index, Ribbon blender, Internal screw mixer.

SAMPLING, STORAGE AND CONVEYING OF SOLIDS:

Sampling of solids, Storage of solids, Open and closed storage, Bulk and bin storage, Conveyors – Belt

conveyers, Chain conveyor, Apron conveyor, Bucket conveyor, Screw conveyor.

MISCELLANEOUS SEPARATION:

Magnetic separation, Electrostatic separation, Jigging, Heavy media separation, Froth floatation process.

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

- Apply principles of screen analysis, equivalent diameters to samples. Comprehend applications of Standard Sieve Series, concepts of ideal and actual screens and Screening equipment.
- Comprehend the forces and laws of size reduction and explain the working principle of size reduction equipment.
- Comprehend flow of fluids through solid beds and apply the same to filtration.
- Deduce expression for power requirements in agitation and mixing and compare different mixing devices.
- Comprehend different sampling techniques and solids conveying machinery.
- Explain principle of size separation in Magnetic, Electrostatic, Froth Floatation techniques and size enlargement techniques.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. McCabe, W.L., *et.al.,* **"Unit Operations in Chemical Engineering"**, 5th edn., McGraw Hill International, Singapore, 2000
2. Badger W.L. and Banchero J.T., **"Introduction to Chemical Engineering"**, 3rd edn. Tata McGraw Hill International Edition, Singapore , 1999
3. Coulson J.H. and Richardson J.F., **"**Coulson and Richardson's **Chemical Engineering"**, Vol-II Particle Technology and Separation Process, 6th edn., Asian Books (p) Ltd., New Delhi, 1998

REFERENCE BOOKS:

1. Brown G.G., *et.al.,* "Unit Operations", 1st edn., CBS Publisher, New Delhi, 1995
2. Foust A.S., *et.al.,* "Principles of Unit Operations", 3rd edn., John Wiley and Sons, New York, 1997

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SEMESTER - III

CHEMICAL TECHNOLOGY-I

Course Code	**18CH35**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will

1. Understand industrial scale operations and processes employed at inorganic chemical industries.
2. Be exposed to various types of reactions and reactor types involved.
3. Understand various types of engineering problems encountered at these industries.
4. Be exposed to National importance and major plant locations of these industries.
5. Understand safety and environmental concerns of these industries.

Note: Unit processes and unit operations involved, main/side reactions, raw materials / utility required, material and energy balances, flow sheet of the process, equipment used, major and minor engineering problems, uses, examples of such industries in India, reasons for their locations of the above industries are to be discussed.

Module-1

Water and Air:

Water:

Introduction, impurities in water, soft water-hard water, causes of hardness, disadvantages of hard water, measurement of hardness, methods of softening of water, purification of water, treatment of boiler feed water.

Air:

Introduction, constituents, compressed air, blower air, fan air, types of compressors.

Module-2

Industrial Gases and Acids:

Industrial Gases: CO_2, H_2, O_2, N_2, SO_2, SO_3, Water Gas, Shift Gas**.**

Industrial Acids: Sulfuric, Nitric, Hydrochloric and Phosphoric Acids.

Module-3

Chlor-alkali and Cement industries:

Alkali industries: Sodium chloride, Soda ash, Caustic soda, Chlorine.

Cement industries: Classification, manufacture, reactions, flow diagrams, major and minor engineering problems, applications.

Module-4

Inorganic Fertilizers: Ammonia, urea, ammonium phosphate, ammonium nitrate, ammonium sulphate, DAP, phosphorous pentoxide, super phosphate and triple super phosphate.

Module-5

Miscellaneous Industries: Paints, pigments, varnishes, hydrogen peroxide, silicon carbide, glass.

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

- Get insight of sources, impurities and treatment methods of water and air.
- Explain the production of different industrial gases and acids.
- Develop flowchart for industrial scale operations and processes employed at chlor-alkali and cement industries.
- Identify various types of reactions and reactor types involved in the production of fertilizers.
- Develop flow charts and explain industrial scale operations/processes employed in inorganic chemical industries.
- Identify the major and minor engineering problems in different inorganic industries.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. **Shreve's Chemical Process Industries,** 4th edn, McGraw Hill.
2. **Dryden – Outlines of Chemical Technology for 21st Century,** Gopal Rao & Marshall Sittig, 3rd Edn., EWP.
3. **Unit Processes in Organic Chemical Industries**, Desikan and Sivakumar (Eds.), CEDC, IITM, 1982.

REFERENCE BOOK:

1. **Encyclopedia of Chemical Technology**, Kirk and Othmer, 27th volume, 5th Edn, Wiley, 2004.

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Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

TECHNICAL CHEMISTRY

Course Code	**18CH36**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will

1. Study the basic of bond formation, Types of bonding, Anti bonding.
2. Study of Colligative properties; determine the effects of solutes on boiling point, freezing point, and osmotic pressure and to calculate the molecular weight of the unknown solute using freezing point depression.
3. Study of isomerism nomenclature properties of isomers.
4. Study of Coordinate compounds.
5. Study of Heterocyclic compounds.
6. Study of reactions & mechanisms.

Module-1

BONDING: Atomic and Molecular orbital theory:

Theory of bonding, Types of bonds, Hydrogen bond with discussion on interaction between two atoms such as exchange of electron, screen effect of electrons, ionic character of H-OH bond. Anti-bonding, Bond theory of metals, Theory of resonance, Structural stability, structure of carbonate ion and benzene, Importance of resonance compounds.

Module-2

COLLIGATIVE PROPERTIES:

Colligative properties - meaning and types, Lowering of vapor pressure - Raoult's law - statement, limitation, Determination of molecular weight by lowering of vapor pressure. Problems, Ostwald's and Walker's method, Elevation in boiling point of a solvent – derivation, Experimental determination of molecular weight by ebullioscopy method, problems, Isotonic solutions - abnormal molecular weight. Osmosis and osmotic pressure – explanation of the terms, effect of temperature and concentration and simultaneous effect of both, Determination of molecular weight, Berkeley and Hartley's method.

Module-3

ISOMERISM:

Definition, Types, Conformational isomerism in alkanes, free rotation about carbon- carbon single bond, conformation of ethane, propane n, butane , relative stability of different conformations. Optical isomers – Isomer number & tetrahedral carbon atom chirality, optical isomerism with one asymmetric carbon atom, Polarimeter, Specific rotation, Enantiomerism R & S Nomenclature. Geometrical isomerism – Definition, conditions for geometrical isomerism, cis-trans & E-Z nomenclature, physical & chemical properties of geometrical isomerism.

COORDINATION CHEMISTRY:

Werner's theory, Nomenclature, effective atomic number, stability of complex ions, factors affecting the stability, stereochemistry of co-ordination compounds. Isomerism of co-ordination compounds. Importance of coordination compounds.

Module-4

HETEROCYCLIC COMPOUNDS:

Nomenclature, Classification, Structure, Preparation, Properties & Reactions of Heterocyclic, Analogues of Cyclopropane, Cyclo butane Cyclopentadiene, Heterocyclic's one or more hetero atoms, Azetidenes, Furans, Pyratidine, Pyroles, diazines, Fused heterocyclics, Heterocyclics in Dyes, Medicines, Natural products.

Module-5

REACTIONS & MECHANISMS:

Concept of Steady states, reactive intermediates, Carbanions, Carbocations, Inductive and resonance effects. Mechanism of nucleophilic substitution (SN1 and s2) in alkyl halides. Mechanism of elimination reactions (E1 and E2). Mechanism of electrophilic substitution in benzene, nitration, sulphonation, halogenation. Friedel-crafts alkyl and acylation reactions. Electronic interpretation of orienting influence of substituents in aromatic electrophilic of toluene, chlorobenzene, phenol and nitrobenzene. Solvents effects.

Course Outcomes: On successful completion of this course students will be able to

- Explain the bond theory Resonance theory H-OH Bonds.

- Understand the Colligative properties.
- Explain the effects of solutes on boiling point, freezing point, and osmotic pressure.
- Calculate the molecular weight of the unknown solute using freezing point depression.
- Explain the structure and bonding of coordination compounds with proper reason of deviation, isomerism prevailing.
- Write reaction mechanisms in various types of reactions.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. ArunBahl and Bahl B.S., **"A text book of Organic Chemistry"**, 15th edn., Chand S. and Company, New Delhi, 1998
2. Morrison B.R. and Boyd L.L., **"Organic Chemistry"**, 6th edn, ELBS, New Delhi, 1998
3. Tiwari Melhotra and Vishnoi, **"Organic Chemistry"**, 7th edn., Chand S. and Company, New Delhi, 1996

REFERENCE BOOKS:

1. Puri L.R. and Sharma B.R., **"Physical Chemistry"**, 14th edn., Chand S. and Company, New Delhi, 1998
2. James Huheey, **"Inorganic Chemistry"**, 19th edn. Wiley Publishers, New Delhi, 1997.
3. Dhone D. B., A Text Book of Plant Utilities, Nirali Publications.

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MOMENTUM TRANSFER LAB

Course Code	**18CHL37**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

Sl. No.	Experiments
1	Friction in circular pipes.
2	Friction in non-circular pipes.
3	Friction in helical/spiral coils.
4	Flow measurement using venturi/orifice meters (incompressible fluid).
5	Local velocity measurement using Pitot tube.
6	Flow over notches.
7	Hydraulic coefficients – open orifice.
8	Packed bed.
9	Fluidized bed.
10	Study of characteristics for centrifugal , Positive displacement pump
11	Study of various pipe fittings and their equivalent lengths.
12	Compressible fluid flow.
13	Reynolds apparatus.
14	Unsteady flows - Emptying of Tank
15	Bernoulli's Experiment.

Note: Minimum 10 experiments are to be conducted

Course Outcomes: On successful completion of this course students will be able.

- Identify, name, and characterize flow patterns and regimes.
- Write basic units of measurement, convert units, and appreciate their magnitudes.
- Measure fluid pressure and relate it to flow velocity.
- Demonstrate practical understanding of friction losses, coefficient of discharge and efficiency in internal flows and pumps.
- Explain fluid flow in channels and application of flow meters and notches.
- Demonstrate the ability to write clear lab reports.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

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Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

TECHNICAL CHEMISTRY LAB

Course Code	**18CHL38**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

Sl. No.	Experiments
1	Critical Solution Temperature- Water – Phenol System.
2	Distribution Coefficients - Iodine in Water Chloroform.
3	Boiling Point Elevation -Water acetic acid solution.
4	Estimation of dissolved oxygen in given sample of water by Winkler's method.
5	Estimation of Iodine & Saponification number of vegetable oil .
6	Analysis of alloy- Stainless steel/ Brass.
7	Analysis of Bleaching Powder -Available chlorine.
8	Molecular weight determination -Victor Mayers Method
9	Freezing point depression- Ice-salt system.
10	Refractometric Estimation - Sugar content of solution.
11	Heats of mixing -Water –HCl system.
12	Conductometric estimation- Water hardness estimation.
13	Calorimetric Estimation – Potassium dichromate Estimation
14	Analysis of coal- Moisture Volatile matter & Ash content.
15	Study of kinetics of reaction between K2S2O8 and KI.
16	Study of kinetics of hydrolysis of ester.
17	Conductometric determination of equivalent conductance of acetic acid at infinite.
18	Dilution (using Kohlrausch Law).
19	Estimation of phenol by iodometric method.
20	Preparation of p-bromo acetanilide from acetanilide.
21	Colorimetric estimation of fluoride in water using SPADNS reagent.

Note: Minimum 10 experiments are to be conducted

Course Outcomes: On successful completion of this course students will be able.

- Explain and perform analytics of quantitative estimation by volumetric method of metal and alloys, oil and proximate analysis of coal.
- Determine disinfectant and water quality parameter analysis to assess the quality of water.
- Analyze kinetics, partition co-efficient, transition temperature, percentage composition of binary mixture, critical solution temperature and molecular weight of chemical components.
- Predict the organic reaction mechanism and to estimate functional groups employing different techniques.
- Have knowledge of handling instruments for precise analysis.
- Perform physico-chemical experiments.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

B. E. (Common to all Programmes)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER –II / III / IV

Aadalitha Kannada

Course Code	**18KAK28/39/49**	CIE Marks	100
Teaching Hours/Week (L:T:P)	(0:2:0)		
Credits	01		

ಆಡಳಿತ ಕನ್ನಡ ಕಲಿಕೆಯ ಉದ್ದೇಶಗಳು:

- ಪದವಿ ವಿದ್ಯಾರ್ಥಿಳಾಗಿರುವುದರಿಂದ ಆಡಳಿತ ಕನ್ನಡದ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.
- ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾ ಬರಹದಲ್ಲಿ ಕಂಡುಬರುವ ದೋಷಗಳು ಹಾಗೂ ಅವುಗಳ ನಿವಾರಣೆ. ಮತ್ತು ಲೇಖನ ಚಿಹ್ನೆಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
- ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆ ಸರ್ಕಾರಿ ಪತ್ರವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
- ಭಾಷಾಂತರ ಮತ್ತು ಪ್ರಬಂಧ ರಚನೆ ಬಗ್ಗೆ ಅಸಕ್ತಿ ಮೂಡಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ ಮತ್ತು ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.

ಪರಿವಿಡಿ (ಪಠ್ಯಪುಸ್ತಕದಲ್ಲಿರುವ ವಿಷಯಗಳ ಪಟ್ಟಿ)

ಅಧ್ಯಾಯ – 1 ಕನ್ನಡಭಾಷೆ – ಸಂಕ್ಷಿಪ್ತ ವಿವರಣೆ.
ಅಧ್ಯಾಯ – 2 ಭಾಷಾ ಪ್ರಯೋಗದಲ್ಲಾಗುವ ಲೋಪದೋಷಗಳು ಮತ್ತು ಅವುಗಳ ನಿವಾರಣೆ.
ಅಧ್ಯಾಯ – 3 ಲೇಖನ ಚಿಹ್ನೆಗಳು ಮತ್ತು ಅವುಗಳ ಉಪಯೋಗ.
ಅಧ್ಯಾಯ – 4 ಪತ್ರ ವ್ಯವಹಾರ.
ಅಧ್ಯಾಯ – 5 ಆಡಳಿತ ಪತ್ರಗಳು.
ಅಧ್ಯಾಯ – 6 ಸರ್ಕಾರದ ಆದೇಶ ಪತ್ರಗಳು.
ಅಧ್ಯಾಯ – 7 ಸಂಕ್ಷಿಪ್ತ ಪ್ರಬಂಧ ರಚನೆ (ಪ್ರಿಸೈಸ್ ರೈಟಿಂಗ್), ಪ್ರಬಂಧ ಮತ್ತು ಭಾಷಾಂತರ.
ಅಧ್ಯಾಯ – 8 ಕನ್ನಡ ಶಬ್ದಸಂಗ್ರಹ.
ಅಧ್ಯಾಯ – 9 ಕಂಪ್ಯೂಟರ್ ಹಾಗೂ ಮಾಹಿತಿ ತಂತ್ರಜ್ಞಾನ.
ಅಧ್ಯಾಯ – 10 ಪಾರಿಭಾಷಿಕ ಆಡಳಿತ ಕನ್ನಡ ಪದಗಳು ಮತ್ತು ತಾಂತ್ರಿಕ/ ಕಂಪ್ಯೂಟರ್ ಪಾರಿಭಾಷಿಕ ಪದಗಳು.

ಆಡಳಿತ ಕನ್ನಡ ಕಲಿಕೆಯ ಫಲಿತಾಂಶಗಳು:

- ಆಡಳಿತ ಭಾಷೆ ಕನ್ನಡದ ಪರಿಚಯವಾಗುತ್ತದೆ.
- ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡುತ್ತದೆ.
- ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳು ಮತ್ತು ಲೇಖನ ಚಿಹ್ನೆಗಳು ಪರಿಚಯಿಸಲ್ಪಡುತ್ತವೆ.
- ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆ ಸರ್ಕಾರಿ ಪತ್ರವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡುತ್ತದೆ.
- ಭಾಷಾಂತರ ಮತ್ತು ಪ್ರಬಂಧ ರಚನೆ ಬಗ್ಗೆ ಅಸಕ್ತಿ ಮೂಡುತ್ತದೆ.
- ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ ಮತ್ತು ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳು ಪರಿಚಯಿಸಲ್ಪಡುತ್ತವೆ.

ಪರೀಕ್ಷೆಯ ವಿಧಾನ : ನಿರಂತರ ಆಂತರಿಕ ಮೌಲ್ಯಮಾಪನ – ಅಖಇ **(ಅಡಟಿಣಟಿಣಜಾ ಐಟಿಣಜಡಿಟಿಬಿಟ ಇತಟಿಟಣಟಿಣಟಿಟಿ):**
ಕಾಲೇಜು ಮಟ್ಟದಲ್ಲಿಯೆ ಆಂತರಿಕ ಪರೀಕ್ಷೆಯನ್ನು 100 ಅಂಕಗಳಿಗೆ ವಿಶ್ವವಿದ್ಯಾಲಯದ ನಿಯಮಗಳು ಮತ್ತು ನಿರ್ದೇಶನದಂತೆ ನಡೆಸತಕ್ಕದ್ದು.

ಪಠ್ಯಪುಸ್ತಕ : ಆಡಳಿತ ಕನ್ನಡ ಪಠ್ಯ ಪುಸ್ತಕ (ಏಬಿಟಿಟಿಬಿಜಬಿ ಜಿಡಿಡಿ ಂಜಟಟಿಟಿಡಿಬಿಣಟಿಟಿ)
ಸಂಪಾದಕರು
ಡಾ. ಎಲ್. ತಿಮ್ಮೇಶ
ಪ್ರೊ. ವಿ. ಕೇಶವಮೂರ್ತಿ
ಪ್ರಕಟಣೆ : ಪ್ರಸಾರಾಂಗ, ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಬೆಳಗಾವಿ.

B. E. (Common to all Programmes)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER –II & III/IV

Vyavaharika Kannada

Course Code	**18KVK28/39/49**	CIE Marks	100
Teaching Hours/Week (L:T:P)	(0:2:0)		
Credits	01		

Course Learning Objectives:

The course will enable the students to understand Kannada and communicate in Kannada language.

Table of Contents:

Chapter - 1: Vyavaharika kannada – Parichaya (Introduction to Vyavaharika Kannada).
Chapter - 2: Kannada Aksharamale haagu uchcharane (Kannada Alpabets and Pronunciation).
Chapter - 3: Sambhashanegaagi Kannada Padagalu (Kannada Vocabulary for Communication).
Chapter - 4: Kannada Grammar in Conversations (Sambhashaneyalli Kannada Vyakarana).
Chapter - 5: Activities in Kannada.

Course Outcomes:

At the end of the course, the student will be able to understand Kannada and communicate in Kannada language.

ಪರೀಕ್ಷೆಯ ವಿಧಾನ : ನಿರಂತರ ಆಂತರಿಕ ಮೌಲ್ಯಮಾಪನ – ಅಖಇ **(ಅಟಿಣಟಿಣಠಿ ಖಟಿಣಜಡಿಟಿಚಿಟ ಇಠಚಿಟಣಚಿಣಟಿ):**

ಕಾಲೇಜು ಮಟ್ಟದಲ್ಲಿಯೆ ಆಂತರಿಕ ಪರೀಕ್ಷೆಯನ್ನು 100 ಅಂಕಗಳಿಗೆ ವಿಶ್ವವಿದ್ಯಾಲಯದ ನಿಯಮಗಳು ಮತ್ತು ನಿರ್ದೇಶನದಂತೆ ನಡೆಸತಕ್ಕದ್ದು.

ಖಿಷಣಛಣಠಣ (ಪಠ್ಯಪುಸ್ತಕ): ವ್ಯಾವಹಾರಿಕ ಕನ್ನಡ ಪಠ್ಯ ಪುಸ್ತಕ (ಗಿಥಿಚಿತಚಿಟಿಚಿಡಿಟಿಣಚಿ ಏಚಿಟಿಟಿಚಿಜಚಿ ಖಿಷಣಠ ಃಡಣಗ)

ಸಂಪಾದಕರು

ಡಾ. ಎಲ್. ತಿಮ್ಮೇಶ

ಪ್ರೊ. ವಿ. ಕೇಶವಮೂರ್ತಿ

ಪ್ರಕಟಣೆ : ಪ್ರಸಾರಾಂಗ, ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಬೆಳಗಾವಿ.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW (CPC)
(Mandatory Learning Course: Common to All Programmes)

Course Code	**18CPC39/49**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(1:0:0)	SEE Marks	60
Credits	01	Exam Hours	02

Course Learning Objectives: To

- know the fundamental political codes, structure, procedures, powers, and duties of Indian government institutions, fundamental rights, directive principles, and the duties of citizens
- Understand engineering ethics and their responsibilities; identify their individual roles and ethical responsibilities towards society.
- Know about the cybercrimes and cyber laws for cyber safety measures.

Module-1

Introduction to Indian Constitution:
The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian constitution, The Making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and significance in Nation building.

Module-2

Union Executive and State Executive:
Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Articles 370.371,371J) for some States.

Module-3

Elections, Amendments and Emergency Provisions:
Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44, 61, 73,74, ,75, 86, and 91,94,95,100,101,118 and some important Case Studies. Emergency Provisions, types of Emergencies and its consequences.

Constitutional special provisions:
Special Provisions for SC and ST, OBC, Women, Children and Backward Classes.

Module-4

Professional / Engineering Ethics:
Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India): Profession, Professionalism, and Professional Responsibility. Clash of Ethics, Conflicts of Interest. Responsibilities in Engineering Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.

Module-5

Internet Laws, Cyber Crimes and Cyber Laws:
Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship. Cybercrimes and enforcement agencies.

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

CO 1: Have constitutional knowledge and legal literacy.
CO 2: Understand Engineering and Professional ethics and responsibilities of Engineers.
CO 3: Understand the the cybercrimes and cyber laws for cyber safety measures.

Question paper pattern for SEE and CIE:

- The SEE question paper will be set for 100 marks and the marks scored by the students will proportionately be reduced to 60. The pattern of the question paper will be objective type (MCQ).
- For the award of 40 CIE marks, refer the University regulations 2018.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Constitution of India, Professional Ethics and Human Rights	Shubham Singles, Charles E. Haries, and et al	Cengage Learning India	2018
2	Cyber Security and Cyber Laws	Alfred Basta and et al	Cengage Learning India	2018
Reference Books				
3	Introduction to the Constitution of India	Durga Das Basu	Prentice –Hall,	2008.
4	Engineering Ethics	M. Govindarajan, S. Natarajan, V. S. Senthilkumar	Prentice –Hall,	2004

B. E. CHEMICAL ENGINEERING
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

ADDITIONAL MATHEMATICS – I
(Mandatory Learning Course: Common to All Programmes)
(A Bridge course for Lateral Entry students under Diploma quota to BE/B. Tech. programmes)

Course Code	**18MATDIP31**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:1:0)	SEE Marks	60
Credits	0	Exam Hours	03

Course Learning Objectives:

- To provide basic concepts of complex trigonometry, vector algebra, differential and integral calculus.
- To provide an insight into vector differentiation and first order ODE's.

Module-1

Complex Trigonometry: Complex Numbers: Definitions and properties. Modulus and amplitude of a complex number, Argand's diagram, De-Moivre's theorem (without proof).
Vector Algebra: Scalar and vectors. Addition and subtraction and multiplication of vectors- Dot and Cross products, problems.

Module-2

Differential Calculus: Review of elementary differential calculus. Polar curves –angle between the radius vector and the tangent pedal equation- Problems. Maclaurin's series expansions, problems.
Partial Differentiation: Euler's theorem for homogeneous functions of two variables. Total derivatives - differentiation of composite function. Application to Jacobians of order two.

Module-3

Vector Differentiation: Differentiation of vector functions. Velocity and acceleration of a particle moving on a space curve. Scalar and vector point functions. Gradient, Divergence, Curl and Laplacian (Definitions only). Solenoidal and irrotational vector fields-Problems.

Module-4

Integral Calculus: Review of elementary integral calculus. Statement of reduction formulae for $\sin^n x, \cos^n x, and \sin^m x \times \cos^n x$and evaluation of these with standard limits-Examples. Double and triple integrals, problems.

Module-5

Ordinary differential equations (ODE's): Introduction-solutions of first order and first degree differential equations: Variable Separable methods, exact and linear differential equations of order one. Application to Newton's law of cooling.

Course Outcomes: At the end of the course the student will be able to:

- CO1: Apply concepts of complex numbers and vector algebra to analyze the problems arising in related area.
- CO2: Use derivatives and partial derivatives to calculate rate of change of multivariate functions.
- CO3: Analyze position, velocity and acceleration in two and three dimensions of vector valued functions. CO4: Learn techniques of integration including the evaluation of double and triple integrals.
- CO5: Identify and solve first order ordinary differential equations.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook				
1	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	43rd Edition, 2015
Reference Books				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition, 2015

2	Engineering Mathematics Vol.I	RohitKhurana	Cengage Learning	2015

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

COMPLEX ANALYSIS, PROBABILITY AND STATISTICAL METHODS
(Common to all programmes)
[As per Choice Based Credit System (CBCS) scheme]

Course Code	**18MAT41**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To provide an insight into applications of complex variables, conformal mapping and special functions arising in potential theory, quantum mechanics, heat conduction and field theory.
- To develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, design engineering and microwave engineering.

Module-1

Calculus of complex functions: Review of function of a complex variable, limits, continuity, and differentiability. Analytic functions: Cauchy-Riemann equations in Cartesian and polar forms and consequences.
Construction of analytic functions: Milne-Thomson method-Problems.

Module-2

Conformal transformations: Introduction. Discussion of transformations: $w = Z^2, w = e^z, w = z + \frac{1}{z}, (z \neq 0)$. Bilinear transformations- Problems.
Complex integration: Line integral of a complex function-Cauchy's theorem and Cauchy's integral formula and problems.

Module-3

Probability Distributions: Review of basic probability theory. Random variables (discrete and continuous), probability mass/density functions. Binomial, Poisson, exponential and normal distributions- problems (No derivation for mean and standard deviation)-Illustrative examples.

Module-4

Statistical Methods: Correlation and regression-Karl Pearson's coefficient of correlation and rank correlation -problems. Regression analysis- lines of regression –problems.
Curve Fitting: Curve fitting by the method of least squares- fitting the curves of the form-
$y = ax + b, y = ax^b$ *and* $y = ax^2 + bx + c$.

Module-5

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation and covariance.
Sampling Theory: Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means, student's t-distribution, Chi-square distribution as a test of goodness of fit.

Course Outcomes: At the end of the course the student will be able to:

- Use the concepts of analytic function and complex potentials to solve the problems arising in electromagnetic field theory.
- Utilize conformal transformation and complex integral arising in aerofoil theory, fluid flow visualization and image processing.
- Apply discrete and continuous probability distributions in analyzing the probability models arising in engineering field.
- Make use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.
- Construct joint probability distributions and demonstrate the validity of testing the hypothesis.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year

Textbooks				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition,2016
2	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	44th Edition, 2017
3	Engineering Mathematics	Srimanta Pal et al	Oxford University Press	3rd Edition,2016
Reference Books				
1	Advanced Engineering Mathematics	C.Ray Wylie, Louis C.Barrett	McGraw-Hill	6th Edition 1995
2	Introductory Methods of Numerical Analysis	S.S.Sastry	Prentice Hall of India	4th Edition 2010
3	Higher Engineering Mathematics	B.V.Ramana	McGraw-Hill	11th Edition,2010
4	A Text Book of Engineering Mathematics	N.P.Bali and Manish Goyal	Laxmi Publications	2014
5	Advanced Engineering Mathematics	Chandrika Prasad and Reena Garg	Khanna Publishing,	2018

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. VTU EDUSAT PROGRAMME - 20

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

CHEMICAL ENGINEERING THERMODYNAMICS

Course Code	**18CH42**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:2:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives: The students will

1. Learn fundamentals of thermodynamics such as types of properties, processes and laws of thermodynamics for flow and non-flow process.
2. Understand the clear concepts on P-V-T behavior, Equations of state, thermodynamic diagrams and compressibility charts, entropy, irreversibility and problem solving skills.
3. Learn the thermodynamic properties of pure fluids, energy relations and fugacity concepts.
4. Study the estimation of partial molar properties, property changes of mixing, and ideal and non ideal solutions.
5. Learn the fundamentals of phase equilibrium, concept of chemical potential and generation and consistency check for VLE data.
6. Understand fundamentals of chemical reaction equilibrium to find feasibility and extent of conversion for the industrial reactions.

Module-1

BASIC CONCEPTS:
System, Surrounding and processes, Closed and Open systems, state and Properties, Intensive and Extensive Properties, State and Path functions, equilibrium state and Phase rule, Zeroth law of thermodynamics, Heat reservoir and Heat engines, Reversible and Irreversible processes.
FIRST LAW OF THERMODYNAMICS: General statement of First law of thermodynamics, First law for cyclic process and non-flow processes, Heat capacity.

Module-2

P-V-T BEHAVIOUR:P-V-T behavior of pure fluids, Equations of state and ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic and polytropic processes. Equation of state for real gases: vander Waals equation, Redlich – Kwong equation, Peng – Robinson equation, Virial equation, Compressibility charts: Principles of corresponding states, generalized compressibility charts.
SECOND LAW OF THERMODYNAMICS: General statements of the Second law, Concept of Entropy, The Carnot Principle, calculation of entropy changes, Clausius Inequality, Entropy and Irreversibility, Third law of Thermodynamics.

Module-3

THERMODYNAMIC PROPERTIES OF PURE FLUIDS: Reference Properties, Energy Properties, Derived Properties, Work function, Gibbs free energy, Relationships among thermodynamic properties, Exact differential equations, Fundamental property relations, Maxwell's equations, Clapeyron equations, Entropy heat capacity relations, Modified equations for U & H, Effect of temperature on U, H & S, Relationships between C_P & C_V, Gibbs- Helmholtz equation, Fugacity, Fugacity coefficient, Effect of temperature and pressure on Fugacity, Determination of Fugacity of pure gases, Fugacities of solids and liquids, Activity, Effect of temperature and pressure on activity.

Module-4

PROPERTIES OF SOLUTIONS:
Partial molar properties, Chemical potential, Fugacity in solutions, Henry's law and dilute solutions, activity in solutions, Activity coefficients, Gibbs – Duhem's equation, Property changes of mixing, excess properties.

Module-5

PHASE EQUILIBRIA: Criteria of phase Equilibria, Criterion of stability, Duhem's theorem, Vapor – Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions, VLE at low pressures, VLE at high pressures, consistency test for VLE data, Calculation of Activity coefficients using Gibbs – Duhem's equation.
CHEMICAL REACTION EQUILIBRIUM: Reaction Stoichiometry, Criteria of chemical reaction equilibrium, Equilibrium constant and standard free energy change, Effect of temperature, Pressure on equilibrium constants and other factors affecting equilibrium conversion, Liquid phase reactions, heterogeneous reaction equilibrium, phase rule for reacting systems.

Course Outcomes: On successful completion of this course students will be able to

- Calculate the heat and work requirements for the given flow or non-flow processes.
- Analyze and find properties such as Pressure, Volume and temperature for equations of states and from the fundamentals of first law of thermodynamics.
- Calculate entropy for the processes, and various types of energies such as internal energy, enthalpy, Helmholtz free energy and Gibbs free energy.
- Differentiate between ideal and non-ideal solution and estimate partial molar properties.
- Generate Vapor Liquid Equilibrium data for ideal and non-ideal solutions and check for their consistency by various methods.
- Learn the thermodynamic properties of pure fluids, energy relations and fugacity concepts.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Note: Use of steam tables permitted in examination and internal assessment test.

TEXT BOOKS:

1. Smith J.M. and Vanness H.C., "Introduction to Chemical Engineering Thermodynamics", 5thedn., McGraw Hill, New York, 1996
2. Rao Y.V.C., "Chemical Engineering Thermodynamics", New age International Publication, Nagpur, 2000

REFERENCE BOOK:

1. Narayanan K.V., "Text book of Chemical Engineering Thermodynamics", Prentice Hall of India Private Limited, New Delhi, 2001.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

CHEMICAL TECHNOLOGY-II

Course Code	**18CH43**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: Students will be able to

1. Understand the basic concepts of Industrial Processes practiced in different Organic Chemical Industries.
2. Get insight in to the safety and environmental management schemes practiced.
3. Assess different engineering problems of individual processes.
4. Understand the plant layout and equipment used in the processes

Module-1

OILS, FATS, WAXES, SOAPS AND DETERGENTS: Vegetable and animal oils and fats. Extraction of vegetable oils, refining of edible oils. Hydrogenation of oils, waxes and their applications. Soaps and detergents, theory of detergency. Miscellaneous concentrations.

Module-2

SUGAR, STARCH AND ALLIED INDUSTRIES: Production of cane sugar. Chemistry of starch. Manufacturing of industrial starch and its applications. Fermentation industries: Production of alcohol, Manufacture of beer, wines and liquors.

Module-3

PETROLEUM INDUSTRIES AND PETROCHEMICALS: Origin and classification. Petroleum refining and processing. LPG, CNG, LNG technologies, methane, benzenes.

Module-4

COAL: Formation and Classification of coal, mining of coal, destructive distillation of coal, coking of coal, coal tar distillation, chemicals from coal.
PULP AND PAPER INDUSTRIES: Raw materials, manufacture of pulp, paper and structural boards.

Module-5

POLYMERS AND RUBBER: Macromolecules. Polymerization. PVC, LDPE. Polypropylene. Cross-linked polymers. UF and MF. Natural rubber.

Course Outcomes: On successful completion of this course students will be able to

- Explain the basic concepts of industrial processes practiced in the manufacture of Oils, Fats, Waxes, Soaps and Detergents.
- Get insight of sugar, starch manufacture and fermentation products.
- Explain refining of petroleum and production of different petrochemicals.
- Explain the formation, classification of coal, destructive distillation of coal and manufacture of pulp and paper.
- Learn industrial scale operations and processes employed in manufacture of polymers and rubber.
- Identify the major and minor engineering problems in different industries.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. **Shreve's Chemical Process Industries,** 4th edn, McGraw Hill.
2. **Dryden – Outlines of Chemical Technology for 21st Century,** Gopal Rao & Marshall Sittig, 3rd edn. EWP.
3. **Unit Processes in Organic Chemical Industries**, Desikan and Sivakumar (Eds.), CEDC, IITM, 1982.

REFERENCE BOOK:

1. **Encyclopedia of Chemical Technology**, Kirk and Othmer, 27th volume, 5th edn, Wiley, 2004

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SEMESTER - IV

MATERIAL SCIENCE

Course Code	**18CH44**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will be able

1. Understand concepts on properties and selection of metals, ceramics, and polymers for design and manufacturing
2. .Study variety of engineering applications through knowledge of atomic structure, electronic structure, chemical bonding, crystal structure, X-rays and X-ray diffraction, defect structure.
3. 3.Study Microstructure and structure-property relationships, Phase diagrams, heat treatment of steels
4. Study detailed information on types of corrosion and its prevention.
5. Learn information on selection of materials for design and manufacturing.

Module-1

INTRODUCTION: Introduction to material science, Classification of engineering materials, Level of structure, Structure property relationships in materials.

CRYSTAL GEOMETRY AND STRUCTURE DETERMINATION: Geometry of crystals – the Bravais lattices, Crystal directions and planes – the miller indices, Structure determination – X –Ray diffraction – Bragg law, The powder method.

ATOMIC STRUCTURE, CHEMICAL BONDING AND STRUCTURE OF SOLIDS: Structure of atom, Periodic table, Ionization potential, Electron affinity and Electro-negativity, Primary and secondary bonds, variation of bonding character and properties, Covalent solids, Metals and alloys.

Module-2

CRYSTAL IMPERFECTIONS: Point Imperfections, Line imperfections – edge and screw dislocations, the Burgers vector, line energy of dislocations, Surface imperfections.

PHASE DIAGRAM AND PHASE TRANSFORMATIONS: Phase rule, Single component systems, Binary phase diagrams, Lever rule, Typical phase diagrams for Magnesia-Alumina, Copper – Zinc, iron – carbon systems, Nucleation and growth, Solidification, Allotropic transformation.

Module-3

DEFORMATION OF MATERIALS AND FRACTURE: Elastic deformation, Plastic deformation, Creep, Visco-elastic deformation, Different types of fracture.

HEAT TREATMENT: Annealing, normalizing, Hardening, Martempering, Austempering, Hardenability, Quenching, Tempering.

Module-4 CORROSION AND ITS PREVENTION: Direct corrosion, Electro-chemical corrosion, Galvanic cells, High temperature corrosion, Passivity, factors influencing corrosion rate, Control and prevention of corrosion-modification of corrosive environment, Inhibitors Protective coatings.

Module-5

TYPICAL ENGINEERING MATERIALS: Ferrous metals, Non ferrous metals and alloys – Aluminum and its alloys, Copper and its alloys, Lead and its alloys, Tin, Zinc and its alloys, Alloys for high temperature service, Ceramic materials – Structure of ceramics, Polymorphism, Mechanical, electrical and thermal properties of ceramic phases, Refractories, Glasses, abrasives, Plastics, fibres and elastomers, Organic protective coatings.

Course Outcomes: On successful completion of this course students will be able to

- Capable of applying core concepts in Materials Science to solve Engineering problems
- Comprehend Importance of ceramics, polymers and composites, its types and applications
- Study crystal imperfections, its characteristics and corrosion prevention methods.
- Identify the phase transformation due to temperature in alloys and properties of metals and non-metals.
- Apply the knowledge of visco-elastic behaviour in material science and engineering.
- Categorize various heat treatment methods employed in the industry and its effect on the mechanical properties.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks

- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Raghavan V., "Materials Science and Engineering – A First Course", 3rd edn., Prentice Hall of India Pvt. Ltd., New Delhi, 1996
2. Hajra Choudhury S.K., "Materials Science and Processes", Indian book distributing Co., 1982

REFERENCES:

1. Van Vlack H.L., "Elements of Material Science", 2nd edn., Addison – Wesly Publishing Company, New York, 1964.

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Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

PROCESS HEAT TRANSFER

Course Code	**18CH45**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will be able

1. Study various modes of Heat transfer and their fundamental relations
2. Study conduction heat transfer and develop mathematical relations for various solid geometries.
3. Understand properties of insulation and critical thickness of insulation
4. Understand different types of heat transfer coefficients and their estimations in various types of flows in different geometries.
5. Study the Boiling phenomenon and to generate pool boiling curve
6. Understand the working of Heat exchangers and to learn design of double pipe, shell and tube heat exchangers and design of evaporators and conduct experiments and to submit the report
7. Understand the phenomenon of radiation, radiation shields and estimation of emissivity.

Module-1

INTRODUCTION: Various modes of heat transfer Viz. Conduction, Convection and Radiation.
CONDUCTION: Fourier's law, Steady state unidirectional heat flow through single and multiphase layers slabs, cylinders and spheres for constant and variable thermal conductivity.
INSULATION: Properties of insulation materials, Types of insulation, Critical and Optimum thickness.

Module-2

EXTENDED SURFACES: Fins – Types of fins, Derivation of fin efficiency for longitudinal fins, Fin effectiveness, Elementary treatment of unsteady state heat conduction.
CONVECTION: Individual and overall heat transfer coefficient, LMTD, LMTD correction factor, Dimensionless numbers, Dimensional analysis, Empirical correlation for forced and natural convection.

Module-3

ANALOGY: Analogy between momentum and heat transfer- Reynolds, Colburn and Prandtl analogies.
HEAT TRANSFER WITH PHASE CHANGE: Boiling phenomena, Nucleate and Film boiling, Condensation - Film and Drop wise condensation, Nusselts equations.
HEAT TRANSFER EQUIPMENT: Double pipe heat exchangers, Shell and tube heat exchangers – Types of shell and tube heat exchangers, Construction details, Condenser, types of condensers

Module-4.

DESIGN OF HEAT TRANSFER EQUIPMENT: Elementary design of double pipe heat exchanger, shell and tube heat exchangers and condensers. Numerical Problems.

Module-5

EVAPORATORS: Types of evaporators, performance of tubular evaporator – Evaporator capacity, Evaporator economy, Multiple effect evaporator – Methods of feeding, effect of liquid head and boiling point elevation.
RADIATION: Properties and definitions, Absorptivity, Reflectivity, Emissive power and intensity of radiation, Black body radiation, Gray body radiation, Stefen – Boltzmann law, Wein's displacement law, Kirchhoff's law.

Course Outcomes: On successful completion of this course students will be able to

- Comprehend basic laws of HT and derive steady state expression for determination of temperature distribution and heat conduction in different geometries
- Determine critical thickness of insulation and efficiency of extended surfaces
- Derive and determine LMTD, overall heat transfer coefficient & temperature distribution under unsteady-state heat conduction
- Establish the analogy between momentum and heat transfer and describe pool boiling regimes
- Explain construction and working principle of heat exchangers and concepts of radiation
- Comprehend significance of Dimensionless numbers in heat transfer coefficient calculation, HT equipment design and explain working principle of evaporators and apply principles of dimensional analysis

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks

- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Kern D.Q., **"Process Heat Transfer"**, McGraw Hill., New York, 1965
2. McCabe W.L., *et.al*., **"Unit Operations of Chemical Engineering"**, 5th edn., McGraw Hill, New York, 2000
3. Coulson J.M. and Richardson J.F., **"Unit Operations of Chemical Engineering"**, Vol-I, 5th edn., Chemical Engg, Pergamon & ELBS, McGraw Hill, New York, 2000

REFERENCES:

1. Rao Y.V.C., "Heat Transfer", 1st edn. Universities Press (India) Ltd., New Delhi, 2001.
2. Dutta, Binay K., "Heat Transfer: Principles and Applications", PHI Learning. 2000

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Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

INSTRUMENTAL ANALYSIS

Course Code	**18CH46**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The course is designed to impart the knowledge in the field of Instrumental Analysis. The various modern analytical techniques like UV-Visible, IR, NMR, Mass, GC, HPLC, different chromatographic methods and other important topics are taught to enable the students to understand and apply the principles involved in the determination of different bulk drugs and their formulation. In addition to the theoretical aspects, the basic practical knowledge relevant to the analysis is also imparted.

Module-1

CHROMATOGRAPHY:
Classification of chromatographic methods based on the mechanism of separation. Column Chromatography: Adsorption and partition, theory, preparation, procedure and methods of detection. Thin Layer Chromatography: Theory, preparation, procedures, detection of compounds. Paper Chromatography: Theory, different techniques employed, filter papers used, qualitative and quantitative detection .Counter – current extraction, solid phase extraction techniques, gel filtration.

Module-2.

GAS CHROMATOGRAPHY: Introduction, fundamentals, instrumentation, columns: preparation and operation, detection, dramatization. . HPLC: Principles and instrumentation, solvents and columns, detection and applications, HPTLC: Theory and principle, instrumentation, elution techniques.

Module-3

Introduction, electromagnetic spectrum, absorbance laws and limitations, instrumentation-design and working principle, chromophore concept, auxochromes, Wood-Fisher rules for calculating absorption maximum, applications of UV-Visible spectroscopy . IR spectroscopy: Basic principles-Molecular vibrations, vibrational frequency, factors influencing vibrational frequencies, sampling techniques, instrumentation, interpretation of spectra, FT-IR, theory and applications.

Module-4.

MASS SPECTROSCOPY: Theory, ionization techniques: electron impact ionization, chemical ionization, field ionization, fast atom bombardment, plasma desorption, fragmentation process: types of fission, resolution, GC/MS, interpretation of spectra and applications for identification and structure determination.

Module-5

NMR: Theory, instrumentation, chemical shift, shielding and de-shielding effects, splitting of signals, spin-spin coupling, proton exchange reactions, coupling constant (J), nuclear over Hauser effect (NOE), 13CNMR spectra and its applications, 2D-NMR, COSY and applications.

Course Outcomes: On successful completion of this course students will be able to

- Discuss types of spectroscopy, instrumentation and applications of UV Spectroscopy
- Explain theory, instrumentation and applications of IR spectroscopy
- Explain theory, instrumentation and applications of NMR spectroscopy
- Discuss principle, instrumentation and applications of Mass Spectroscopy, Flame Emission Spectroscopy (FES) and Atomic Absorption Spectroscopy (AAS)
- Discuss principle, instrumentation and applications of polarography
- Discuss classification of chromatography and explain Thin Layer, Gas Chromatography and High Performance Liquid Chromatographic methods.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

TEXT BOOKS:

1. Instrumental Methods of Chemical Analysis by B.K Sharma
2. Organic Spectroscopy by Y.R Sharma.

REFERENCES:

1. Text book of Quantitative Chemical Analysis by Vogel's A.I.

2. Organic Spectroscopy by William Kemp

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SEMESTER - IV

CHEMICAL ENGINEERING DRAWING LAB

Course Code	**18CHL47**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

SECTIONAL VIEWS:
Representation of the sectional planes, Sectional lines and hatching, selection of section planes and types of sectional views.

PROPRTIONATE DRAWINGS
Equipment and piping symbols, Vessels components: Vessel openings, Manholes, Vessel enclosures, Vessel support, Jackets, Shell and tube heat exchanger, Reaction vessel and different types of Evaporators. P & I Diagrams

ASSEMBLY DRAWINGS:
Joints: Cotter joint with sleeve, Socket and Spigot joint, Flanged pipe joint, Union joint, Stuffing box and Expansion joint (Screw type or flanged type)

COURSE OUTCOMES: On successful completion of this course students will be able to

- Analyze the general projections of given object.
- Represent two-dimensional proportionate drawings of process symbols of various pipes and fittings.
- Demonstrate the proportionate drawings of reaction vessel, jacked vessels, evaporator, STHE and DPHE
- Identify the parts of industrial used equipment.
- Draw the assembly drawings of socket and spigot, flanged pipe and union joints showing sectional, front, top, and side views.
- Demonstrate the usage of solid edge software tool for engineering drawing.

Note:

- Assignments to be given to students to practice all the drawings and weightage shall be given to these assignments while awarding IA marks.
- Minimum of Ten drawings are to be conducted.
- Examination consists of one question on proportionate drawing (30 marks) and one question on Assembly drawing (70 marks).
- **Examination to be conducted like other lab exams. Question paper should be prepared jointly by Internal and External examiners.**
- Computer Aided drawing Software: Solid Edge or Equivalent Software.

TEXT BOOKS:

1.Gopal Krishna K.R., "Machine Drawing", 2nd revised edn., Sudhas stores, Bangalore, 1998
2.Bhat N.D., "Machine Drawing", 22nd edn., Charoter Publishing House, Anand, 1987
3. Joshi M.V., "Process Equipment Design", 3rd edn., Macmillan India publication", New Delhi, 1999

REFERENCE BOOKS:

1.Walas S.M., "Chemical Process Equipment", Butterworth Heinemann Pub., 1999
2. Ludwig E.E., "Applied Process Design", 3rd edn., Gulf Professional Publishing, New Delhi, 1994

Note: Minimum 10 experiments are to be conducted

B. E. CHEMICAL ENGINEERING
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SEMESTER - IV

MECHANICAL OPEARATIONS LAB

Course Code	**18CHL48**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

Sl. No.	Experiments based on the following topics,
1	Ball mill
2	Batch sedimentation
3	Free settling
4	Drop weight crusher
5	Screen effectiveness
6	Sieve analysis
7	Jaw crusher
8	Leaf filter
9	Air elutriation
10	Grindability index
11	Gyratory crusher
12	Froth floatation
13	Plate and frame filter press
14	Cyclone separator
15	Beaker Decantation

Note: Minimum 10 experiments are to be conducted

Course Outcomes: On successful completion of this course students will be able to

- Explain properties of particulate solids, handling and mixing of solid particles.
- Analyze principles and different types of size reduction equipment like crushers, grinders etc.
- Explain mechanical separation aspect such as screening, filtration, sedimentation, transportation of solids etc.
- Evaluate energy requirements in solids handling, agitation and mixing, solid conveying and storage.
- Conduct experiments on some of the basic unit operations such as separation and size reduction.
- Develop the ability to write clear lab reports.

TEXT BOOKS:

REFERENCE BOOKS:

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SEMESTER - IV

ADDITIONAL MATHEMATICS – II
(Mandatory Learning Course: Common to All Branches)
(A Bridge course for Lateral Entry students under Diploma quota to BE/B. Tech programmes)

Course Code	**18MATDIP41**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:1:0)	SEE Marks	60
Credits	00	Exam Hours	03

Course Learning Objectives:

- To provide essential concepts of linear algebra, second & higher order differential equations along with methods to solve them.
- To provide an insight into elementary probability theory and numerical methods.

Module-1

Linear Algebra: Introduction - rank of matrix by elementary row operations - Echelon form. Consistency of system of linear equations - Gauss elimination method. Eigen values and eigen vectors of a square matrix. Problems.

Module-2

Numerical Methods: Finite differences. Interpolation/extrapolation using Newton's forward and backward difference formulae (Statements only)-problems. Solution of polynomial and transcendental equations – Newton-Raphson and Regula-Falsi methods (only formulae)- Illustrative examples. Numerical integration: Simpson's one third rule and Weddle's rule (without proof) Problems.

Module-3

Higher order ODE's: Linear differential equations of second and higher order equations with constant coefficients. Homogeneous /non-homogeneous equations. Inverse differential operators.[Particular Integral restricted to $R(x) = e^{ax}, \frac{sinax}{cosax}, x^n \; for \; f(D)y = R(x)$.

Module-4

Partial Differential Equations (PDE's): Formation of PDE's by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only.

Module-5

Probability: Introduction. Sample space and events. Axioms of probability. Addition & multiplication theorems. Conditional probability, Bayes's theorem, problems.

Course Outcomes: At the end of the course the student will be able to:

- Solve systems of linear equations using matrix algebra.
- Apply the knowledge of numerical methods in modelling and solving of engineering problems.
- Apply the knowledge of numerical methods in modelling and solving of engineering problems.
- Classify partial differential equations and solve them by exact methods.
- Apply elementary probability theory and solve related problems.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook				
1	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	43rd Edition, 2015
Reference Books				

1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10^{th} Edition, 2015
2	Engineering Mathematics Vol.I	RohitKhurana	Cengage Learning	2015.

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SEMESTER - V

MANAGEMENT AND ENTREPRENEURSHIP

Course Code	**18CH51**	CIE Marks	40
Teaching Hours/Week (L:T:P)	2:2:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will.

1. Understand the roles of managers and historical evolution of various approaches to the study of management.
2. Demonstrate the process of planning which can be used as a tool for decision-making in organizations.
3. Create logical relationships between various organizational structures and designs.
4. Implement leadership practices towards the management and development of people within organizations.

Module-1

Organization and Management: Forms of Business Organization, Basic concepts of management-classification, characteristics, objectives, Functions of management-planning, organizing, staffing, directing, Organization Structure-linear, functional, line and staff, staff and functional, Management by objectives, Management information system.

Module-2.

Personnel (Human Resource) Management: Acquisition of manpower-functions and objectives of personnel management, manpower planning, Job analysis and evaluation, Induction, Orientation, Training and development, Maintenance of human resource. Industrial relations, Trade Unionism.

Module-3

Entrepreneurship and Project Management: Entrepreneurship- Types, Growth, functions, qualities, Project Planning-project implementation, monitoring and control, evaluation strategies, Gantt charts, Critical path method, Performance evaluation and review technique, application of network techniques.

Module-4.

Operation Research: Introduction, phases, scope, methodology, O R Models, techniques, applications of O R, Linear Programming, graphic method, simplex method, waiting line theory, game theory, Monte Carlo technique. Dynamic programming.

Module-5

Materials Management: Purchasing, make or buy decision, stores management, inventory control, spare parts management, value engineering.
Marketing: Marketing research, marketing management, consumer behavior and market promotion.

Course Outcomes: On successful completion of this course students will be able to

1. Understand the principles of management theory & recognize the characteristics of an organization.
2. Demonstrate the importance of key performance areas in strategic management & decision-making process.
3. Design appropriate organizational structures and possess an ability to conceive organizational dynamics.
4. Evaluate attitudes and personality traits for inter personal effectiveness and development within organizations.
5. Implement the right leadership practices in organizations that would enable systems orientation.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. T R Banga S C Sharma Industrial Organization and Engineering Economics Khanna Publications 24th Edition ISBN No. 81-7409-078-9
2. Dr. Vilas Kulkarni & Hardik Bavishi Engineering Economics & Management: Vikas Publishing.

REFERENCES:

1. Stephen Robbins, Mary Coulter & Neharika Vohra, Management, Pearson Education Publications, 10th edn, ISBN: 978-81-317-2720-1.
2. James Stoner, Edward Freeman & Daniel Gilbert Jr, Management, PHI, 6th Edition, ISBN: 81-203-0981-2.

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Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

MASS TRANSFER OPERATIONS-I

Course Code	**18CH52**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives: The students will

1. Be able to formulate equations for estimation of diffusivities in fluids & solids using first principles of engineering sciences.
2. Be able to apply mass transfer fundamentals to calculate mass transfer rates and design the mass transfer equipment.

Module-1

Types of diffusion in fluids. Types of diffusion in solid. Measurement and calculations of diffusivities. Mass transfer coefficients and their correlations. Theories of mass Transfer. Interphase mass transfer. M**a**terial balance for co-current, cross-current and counter-current operations. Concept of stages, cascades operation, NTU and HTU concepts.

Module-2.

Humidification: General theory, Psychrometric chart. Concepts in humidification, dehumidification. Design of cooling towers.

Module-3

Drying: Introduction, Equilibria, Drying rate curves. Mechanism of drying, types of dryers. Design of batch and continuous dryers.

Module-4.

Adsorption: Theories of adsorption. Isotherms, Industrial adsorbents. Equipment, Batch & continuous multistage adsorption.

Module-5

Crystallization: Factors governing nucleation and crystal growth rates. Controlled growth of crystals. Incorporation of principles into design of equipment. Different types of crystallizer equipment.
Introduction to Novel Separations: Ion exchange**,** Membrane processes-Reverse Osmosis, Dialysis, Ultra and Micro-filtrations, Super-critical fluid extraction.(Working principle and operations only)

Course Outcomes: On successful completion of this course students will be able to

- Estimate mass transfer co-efficient and provide valid conclusions on suitability of the operation.
- Explain concepts, application of humidification, dehumidification and design of cooling towers.
- Comprehend operation, concepts and types of dryers.
- Explain operation, types of adsorbers and design of packed bed adsorbers
- Apply the mechanism of crystallization and various separation techniques.
- Apply the analogies in transport processes for validating and reaching substantiated conclusions

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

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TEXT BOOKS:

1

REFERENCES:

3.

B. E. CHEMICAL ENGINEERING
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SEMESTER - V

CHEMICAL REACTION ENGINEERING-I

Course Code	**18CH53**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives: The students will be able to

- Analyze and interpret the data to determine rate equation and estimate the performance equation of ideal systems
- Formulate and analyze the rate equations for various reactions using suitable mechanisms

Module-1

Introduction: Scope of Chemical Reaction Engineering. Classification of reactions. Rate equation and rate of reaction. Factors affecting rate of reaction. Chemical kinetics and Thermodynamics Equilibrium. Temperature dependency of rate constant from Arrhenius, Collision and Transition state theories. Molecularity and order of reaction.

Non-Elementary Reactions: Difference between elementary and non-elementary reactions. Kinetic models and mechanisms for non-elementary reactions. Types of reactors.

Module-2.

Homogeneous Reactions: Interpretation of batch reactor data. Constant & Variable Volume batch reactor. Analysis: Differential method, Integral method, half-life method. Method of excess and method of isolation (For Reversible and Irreversible reactions up to second order). Autocatalytic reactions.

Module-3

Design of Ideal Reactors: Concept of ideality. Development of design equations for batch, tubular and stirred tank reactors for both constant and variable volume reactions. Evaluation of rate equations from data obtained in these reactors. Numerical Problems.

Module-4.

Comparison of Ideal Reactors: General graphical comparison.

Multiple Reactor Systems: Plug flow and/or Mixed flow reactors in Series, parallel and series parallel. Reactors of different types and sizes in series.

Design of Reactors for Multiple Reactions: Design of Batch reactor, Plug and Mixed flow reactors for Parallel, Series and Series-Parallel reactions (Only irreversible reactions must be considered.

Module-5

Non-Isothermal Reactors: Introduction, effect of temperature on equilibrium constant and heat of reaction, Material and Energy balances, conversions in adiabatic and non-adiabatic reactors.

Analysis of Non Isothermal Reactor: Design procedure (For single/ simple reactions only). Optimum temperature Progression.

Course Outcomes: On successful completion of this course students will be able to

- Discuss types of reactions, order, molecularity and fundamentals of rate.
- Analyze and interpret the kinetic data to determine suitable rate equation
- Formulate and analyze the rate equations for various reactions using suitable mechanisms.
- Develop design/performance equations for ideal reactors and for multiple reactors
- Explain basics of non-isothermal reactions, material and energy balances involved.
- Explain design procedures of non-isothermal reactors

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

TEXT BOOKS:

1. **Chemical Reaction Engineering,** Octave Levenspiel, 3rd edn, John Wiley & Sons, 2001.
2. **Elements of Chemical Reaction Engineering,** H. Scott Fogler, 3rd edn, Prentice Hall 2001.

REFERENCES:

1. **Chemical Engineering Kinetics,** J.M. Smith, 3rd edn, McGraw Hill, 1984

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

CHEMICAL EQUIPMENT DESIGN

Course Code	**18CH54**	CIE Marks	40
Teaching Hours/Week (L: T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: Students will
Understand types in the design of Chemical equipment and its accessories.

Module-1

Introduction: Basic considerations in design. General design procedure. Equipment classification. Various components of process equipment. Design parameters.
Design Considerations: Material selection. Factors affecting design. Stresses due to static and dynamic loads (Internal & External).
Design of Pressure Vessels: Design parameters, conditions & stresses. Design of shell, and other vessel components. Vessel at low & high operating temperatures. Design problems using given process parameters.

Module-2.

Vessel Component Design: Design of supports for vessels- Bracket, Leg, Saddle and Skirt supports. Classification of flanges. Flange thickness calculation, Gasket selection, Bolt selection, Nozzle Selection. Design of vessel closures- Flat plates, Formed heads, Elliptical & Hemispherical heads**.**

Module-3

Storage Vessels: Process conditions and design parameters for storage of volatile, non-volatile fluids & gases. Design of cylindrical tanks with fixed roofs. Design of partially filled spherical tanks, Numerical problems.

Module-4.

Reaction Vessels: Design of reaction tanks with agitation and jacket. Types of agitators, baffles. Power requirement calculations. Design of tank dimensions and agitation system components. Drive calculations & selection of accessories. Design of jackets. Numerical problems**.**

Module-5

Tall Vertical Vessels: Vessels subjected to various loads, Multi shell constructions. Determination of shell thickness. Supports for columns.
Pipe Line Design: Pipe line sizing, Condensate and steam pipe design **.**

Course Outcomes: On successful completion of this course students will be able to

- Explain the basic considerations, factors, parameters involved in the design, and the types of codes available for the design
- Explain mechanical properties of materials and MOC, and apply the knowledge of static and dynamic loads in equipment designing
- Design the pressure vessel and storage vessel in detail
- Design the various types of accessories or components used for the different equipment.
- Design the tall vertical vessel and reaction vessel with various jackets.
- Solve the problems related to pipe line and designing the same

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. **Process Equipment Design -** M. V. Joshi, 3rd edn., Macmillan & Co. India, Delhi, 1998.
2. **Process Equipment Design – Vessel Design,** Brownell & Young, John Willey, 1959
3. **Process Design of Equipment – Vol 1,** S. D. Dawande, 3rd edn, Central Techno Publications. 2003

REFERENCES:

1. **Chemical Engineers Handbook,** Perry & Green, 7th edn, McGraw Hill, 1997
2. **Pressure Vessel Code – IS 2825,** IS Code, B.I.S., New Delhi, 1969
3. **Flow of Fluids through Valves, Fittings & Pipes**, Crane Amazon, 2006

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

INDUSTRIAL POLLUTION CONTROL

Course Code	**18CH55**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will be able to
1.Understand about source, sampling and waste water analysis
2.Understand the causes of water pollution and treatment
3.Understand various concepts of water usage and importance
4.Understand about air, soil and noise pollution and its control.
5. Comprehend the concepts of 3 R's and its importance in sustainable development.

Module-1

Introduction: Importance of environment for mankind. Biosphere and layers of atmosphere. Hydrological cycle and nutrient cycles. Types of pollution. Damages from environmental pollution. Need of environmental legislations and environmental Acts in India. Functions of central and state pollution control boards.
Sources, Sampling and Analysis of Wastewater: Water resources. Origin of wastewater. Evaluation, classification and characterization of wastewater. Physical and chemical characteristics. BOD, COD and their importance. Types of water pollutants and their effects.

Module-2.

Wastewater Treatment: Preliminary, primary, secondary and tertiary treatments of wastewater. Sludge treatment and disposal. Advanced wastewater treatment. Recovery of materials from process effluents.
Applications to Industries: Norms and standards of treated water. Origin, characteristics, and treatment methods in typical industries – petroleum refinery, pulp and paper, distillery, and textile processing.

Module-3

Air Pollution Aspects: Nature of air pollution. Classification of air pollutants. Sources of air pollutants. Air quality criteria and standards. Plume behavior and dispersion of air pollutants. Effects of air pollution on health and vegetation.

Module-4.

Air Pollution Control: Sampling of pollutants. Methods of estimation of air pollutants. Automobile pollution. Control methods for particulates and gaseous pollutants. Origin, control methods, and equipment used in typical industries- metallurgical industries, and cement industries.

Module-5

Solid Waste Treatment: Origin, Classification and microbiology. Properties and their variation. Engineered systems for solid waste management – generation, onsite handling, storage, collection, transfer and transport, composting, sanitary land filling.
Noise Control: Sources and definitions. Determination of noise levels. Noise control criteria and noise exposure index. Acoustic absorptive materials.

Course Outcomes: On successful completion of this course students will be able to

- Explain the fundamentals of environmental pollution and legal aspects
- Apply the principles of mathematics, science and environmental engineering for industrial pollution control.
- Identify and characterize the pollution parameters of Air and waste water
- Discuss the fundamentals of waste water treatment and Air pollution control
- Formulate the basic design of Air pollution control systems and waste water treatment
- Explain fundamentals and illustrate the basic design of Solid waste treatment and Noise control systems

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

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TEXT BOOKS:

1. Environmental Pollution Control Engg, C.S. Rao, 2nd edn, New Age International Reprint, 2002.

2. **Pollution Control in Process Industries,** S.P. Mahajan, Tata Mc Graw Hill, 22nd Reprint, 1999.

REFERENCES:

1. **Principles and Practices of Air Pollution Control and Analysis,** J.R. Mudakavi, I.K. International Publishing, Home Pvt. Ltd., New Delhi, 2010.
2. **Air Pollution,** H.C. Perkins, McGraw Hill, 1974.
3. **Solid Waste Management,** D.J. Hagery *et.al*., Van Nostrand Reinhold, 1973.
4. **Industrial Pollution Control Handbook,** Lund, H.F., 6th edn, Vol.1, McGraw Hill, 1971.
5. **Noise Abatement,** Duerden, Buttreworth, 1970.
6. **Introduction to Environmental Engg,** Davis., 3rd edn, McGraw Hill, 1998.
7. **Waste Water Engineering Treatment Disposal Reuse,** Metcalf and Eddy, 4th edn, Tata McGraw Hill, 2003.
8. **Environmental Engineering, G.N**. Pandey and G.C. Carney, Tata McGraw Hill, 11th Reprint, 2002.
9. **Integrated Solid Waste Management,** George Tchobanoglous *et al*, 2nd edn, McGraw Hill & Co, 1993.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

BIOCHEMICAL ENGINEERING

Course Code	**18CH56**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To enhance knowledge and skills in the areas of biochemical processes to provide the fundamental background of biological systems, bio molecules, micro-organisms, fermentation processes, Bioreactors and kinetics.

Module-1

Introduction: Bioprocess engineering and technology. Role of a Chemical engineer in bioprocess industry. Microbiology: Structure of cells: Prokaryotes and Eukaryotes. Classification of micro-organisms. Taxonomy, control of microorganisms – physical and chemical methods.

Module-2.

Biochemistry: Chemicals of Life: Lipids, Sugars, Polysaccharides, Amino acids. Vitamins, Biopolymers, Nucleic Acids: RNA, DNA and their derivatives (Structure, Biological function and Importance for life only to be studied).

Enzymes and Proteins: Detailed structure of proteins and enzymes. Functions. Methods of Production and purification of Enzymes. Nomenclature and Classification of enzymes. Kinetics and mechanism of Enzyme action: Michaelis–Menten, Briggs-Haldane approach. Derivation.

Module-3

Kinetics of Enzyme Action: Reversible Enzyme. Two-substrate. Multi-complexes enzyme kinetics (Derivation of rate equations). Experimental determination of rate parameters: Batch and continuous flow experiments. Line weaver–Burk, Eadie-Hofstee and Hanes-Woolf Plots. Batch Kinetics (Integral and Differential methods).

Enzyme Inhibition: Effect of Inhibitors (Competitive, noncompetitive, uncompetitive, substrate and product inhibitions), Temperature and pH on the rates enzyme catalyzed reactions. Determination of kinetic parameters for various types of inhibitions. Dixon method. Enzyme immobilization: Uses.

Module-4.

Fermentation Technology: Ideal reactors: A review of Batch and Continuous flow reactors for bio kinetic measurements. Microbiological reactors: Operation and maintenance of typical aseptic aerobic fermentation processes. Formulation of medium: Sources of nutrients. Introduction to sterilization of bioprocess equipment.

Growth Kinetics of Microorganisms: Transient growth kinetics (Different phases of batch cultivation). Quantification of growth kinetics: Substrate limited growth, Models with growth inhibitors, Logistic equation, Filamentous cell growth model. Continuous culture: Optimum Dilution rate and washout condition in Ideal Chemostat.

Module-5

Downstream Processing: Strategies and steps involved in product purification. Methods of cell disruption, Filtration, Centrifugation, Sedimentation, Chromatography, Freeze drying / lyophilization. Membrane separation Technology: Reverse Osmosis, Ultra filtration, Micro filtration, Dialysis.

Course Outcomes: On successful completion of this course students will be able to

- Explain structure of cells, nucleic acids, nomenclature, classification and production of enzymes; derive the rate equation by M-M and Brigs-Haldane approach
- Derive rate equation for given enzyme mechanisms and estimate the kinetic rate parameters
- Describe the effects of pH, temperature and inhibitors on enzyme catalysed reactions and explain the methods of enzyme immobilization
- Describe the growth cycle phases for batch cultivation and fed-batch reactors and, derive an expression to determine optimum dilution rate.
- Explain medium formulation, operation & maintenance of fermentation process and strategies and steps involved in product purification.
- Explain Heat & mass transfer considerations and scale up of bioprocesses

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.

- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

.

TEXT BOOKS:

1. Biochemical Engineering Fundamentals, Bailey and Ollis, 2nd edn, McGraw Hill, 1976.
2. Bioprocess Engineering, Shuler M. L. and Kargi F., 2nd edn, Prentice Hall, 2002.

REFERENCES:

1. **Biochemical Engineering,** James Lee, Prentice Hall, 1992.
2. **Biochemical Reactors,** Atkinson B, Pion Ltd., London, 1974.
3. **Industrial Microbiology,** Casida, wiley, New York, 1968
4. **Principles of Fermentation Technology,** Stanbury and Whitekar, 2nd edn, Butterworth-Heinemann An Imprint of Elsevier

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

HEAT TRANSFER LAB

Course Code	**18CHL57**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives: Students will

1. Experimentally verify the Heat Exchanger concepts studied in theory.
2. Carry out experiment and make observations for various heat transfer equipment.
3. Study the effect of U, hi and ho in design of equipment.
4. Evaluate the performance characteristic for different heat transfer cases.

Sl. No.	Experiments
1	Natural Convection in Bare tube
2	Vertical Shell and tube Heat exchanger (Condenser)
3	Horizontal Shell and tube Heat exchanger (Condenser)
4	Helical Coil Heat exchanger
5	Emissivity Determination
6	Effect of Geometry on Natural convection/Lagged pipe
7	Heat Transfer in Packed Beds
8	Double Pipe Heat Exchanger
9	Heat Transfer in Jacketed Vessel
10	Determination of Insulation Thickness
11	Transient Heat Conduction
12	Heat Transfer in Fluidized Beds
13	Evaporator
14	Solar Heater
15	Spiral Plate Heat Exchanger
16	Cross Flow Heat Exchanger
17	Natural Convection in Finned tube
18	Determination of thermal conductivity of a metal rod
19	Heat transfer through composite wall.
20	Stefan-Boltzman constant evaluation

Note: Minimum 10 experiments are to be conducted

Course Outcomes: On successful completion of this course students will be able to

- Experimentally verify the heat transfer concepts studied in theory.
- Evaluate Thermal conductivity of a given metal Rod and composite wall.
- Determine the Heat transfer coefficient for Fin, Forced convection, Natural Convection, and parallel and counter flow heat exchanger.
- Test Emissivity, Stefan Boltzmann Constant and Critical Heat flux.
- Asses the performance of different heat transfer equipment.
- Develop the ability to write laboratory reports.

Conduct of Practical Examination:

1. Minimum of 10 experiments are to be conducted and all 10experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

TEXT BOOKS:

1. **Process Heat Transfer**, Kern D.Q. McGraw Hill., New York, 1965
2. **Unit Operations of Chemical Engineering,** McCabe W.L., et.al., 5th edn., McGraw Hill, New York, 2000.

Unit Operations of Chemical Engineering, Coulson J.M. and Richardson J.F., Vol-I, 5th edn. Chemical Engg, Pergamon & ELBS, McGraw Hill, New York, 2000

REFERENCE BOOKS:

1. Heat Transfer, Rao Y.V.C., 1st edn., Universities Press (India) Ltd., New Delhi, 2001.
2. **Heat Transfer: Principles and Applications**, Dutta, Binay K., PHI Learning. 2000.

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Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

POLLUTION CONTROL & INSTRUMENTAL ANALYSIS LAB

Course Code	**18CHL58**	CIE Marks	40
Teaching Hours/Week (L:T:P)	**0:2:2**	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives: Students will

1. Experimentally verify the principles and working of instruments studied in theory.
2. Carry out experiment and make observations for various parameters.
3. Study and use various analytical instruments for analysis of various parameters.
4. Evaluate the data and compare with reported literature.

Sl. No.	Experiments
1	Analysis of effluents for pH, alkalinity and turbidity
2	Determination of COD and BOD
3	Volatile, Fixed, Filterable and Dissolved solid analysis
4	Analysis by ion selective electrode (any two anions)
5	Measurement of particulate matter in Air
6	Measurement of SO2 in air
7	Analysis of exhaust by Orsat apparatus
8	Analysis of flue gases by Gas chromatograph
9	UV Spectrophotometer
10	KF Auto titrator
11	Flame photometer
12	Turbidometer
13	Dissolved Oxygen measurement
14	Bomb calorimeter
15	Viscometer
16	Polarograph
17	Potentiometer titration

Note: Minimum 10 experiments are to be conducted

Course Outcomes: On successful completion of this course students will be able to

- Experimentally verify the principles and working of instruments studied in theory.
- Know the use of skills in handling various analytical instruments.
- Study and use various analytical instruments for analysis of various parameters.
- Evaluate the data and compare with reported literature.
- Apply theoretical knowledge of various Analytical Instruments.
- Acquire practical knowledge and able to handle analytical instruments to determine pollution parameters and thereby in control of pollutants to help environment and society.

Conduct of Practical Examination:

- Minimum of 10 experiments are to be conducted and all 10experiments are to be included for practical examination.
- Students are allowed to pick one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Graduate Attributes

1. Critical thinking
2. Usages of modern tools
3. Collaborative and multidisciplinary work
4. Lifelong learning
5. Independent and reflective learning

TEXT BOOKS:

1. **Air Pollution Engineering Manual**, Wayne T. Davis, John Wiley & Sons, Inc., 2000.

REFERENCE BOOKS:

1. **Practical Waste Treatment and Disposal**, Dickinson, Applied Science publication, London.
2. **Pollution control in Process industries,** Mahajan, TMH, New Delhi.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS)and Outcome Based Education (OBE)
SEMESTER – V
Common to all programmes

ENVIRONMENTAL STUDIES

Course Code	**18CIV59**	CIE Marks	40
Teaching Hours / Week (L:T:P)	(1:0:0)	SEE Marks	60
Credits	01	Exam Hours	02

Module - 1

Ecosystems (Structure and Function): Forest, Desert, Wetlands, Riverine, Oceanic and Lake. 02 Hrs
Biodiversity: Types, Value; Hot-spots; Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.

Module - 2

Advances in Energy Systems (Merits, Demerits, Global Status and Applications)**:** Hydrogen, Solar, OTEC, Tidal and Wind.
Natural Resource Management (Concept and case-studies): Disaster Management, Sustainable Mining, Cloud Seeding, and Carbon Trading.

Module - 3

Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies)**:** Surface and Ground Water Pollution; Noise pollution; Soil Pollution and Air Pollution.
Waste Management & Public Health Aspects: Bio-medical Wastes; Solid waste; Hazardous wastes; E-wastes; Industrial and Municipal Sludge.

Module - 4

Global Environmental Concerns (Concept, policies and case-studies):Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.

Module - 5

Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship- NGOs.
Field work: Visit to an Environmental Engineering Laboratory or Green Building or Water Treatment Plant or Waste water treatment Plant; ought to be Followed by understanding of process and its brief documentation.

Course outcomes: At the end of the course, students will be able to:

- CO1: Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale,
- CO2: Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment.
- CO3: Demonstrate ecology knowledge of a complex relationship between biotic and a biotic components.
- CO4: Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues.

Question paper pattern:

- The Question paper will have 100 objective questions.
- Each question will be for 01 marks
- Student will have to answer all the questions in an OMR Sheet.
- The Duration of Exam will be 2 hours.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Environmental Studies	Benny Joseph	Tata Mc Graw – Hill.	2nd Edition, 2012
2.	Environmental Studies	S M Prakash	Pristine Publishing House, Mangalore	3rd Edition, 2018

3	Environmental Studies – From Crisis to Cure	R Rajagopalan	Oxford Publisher	2005
Reference Books				
1	Principals of Environmental Science and Engineering	Raman Sivakumar	Cengage learning, Singapur.	2nd Edition, 2005
2	Environmental Science – working with the Earth	G.Tyler Miller Jr.	Thomson Brooks /Cole,	11th Edition, 2006
3	Text Book of Environmental and Ecology	Pratiba Sing, AnoopSingh& PiyushMalaviya	Acme Learning Pvt. Ltd. New Delhi.	1st Edition

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

CHEMICAL REACTION ENGINEERING-II

Course Code	**18CH61**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Credits	4	Exam Hours	03

Course Learning Objectives: The students will be able to

1. Understand and apply the principles of non-ideal flow in the design of reactor
2. Develop rate laws for heterogeneous reactions

Module-1

Basics of Non Ideal Flow: Importance & interpretation of RTD, C, E & F curves & Statistical interpretation. Dispersion model. Tanks in series model. Conversion in non- ideal flow reactors for simple systems.
08 Hr

Module-2.

Introduction to Heterogeneous Systems: Rate equations, contacting patterns, fluid-particle non catalytic reactions, URC model, Spherical particles of unchanging size, shrinking spherical particles, determination of rate controlling steps.
Fluid-Fluid Non Catalytic Reactions: Kinetic regimes for mass transfer and reaction; rate equations.

Module-3

Catalysis: Introduction to catalysis. Properties of catalysts. Estimation methods for catalytic properties. Promoters, inhibitors etc, Mechanism of catalysis. Rate equations for different rate controlling step.
Deactivation: Deactivating catalyst. Mechanism, rate & performance equation.

Module-4.

Solid Catalyzed Reactions: Heterogeneous reactions- Introduction, Kinetic regimes. Rate equation for surface kinetics. Pore diffusion resistance combined with surface kinetics. Thiele modulus and enhancement factor, Porous catalyst particles. Heat effects during reaction.

Module-5

Solid Catalyzed Reactions (Contd.): Performance equations for reactors containing porous catalyst particles. Experimental methods for finding rates. Packed bed catalytic reactor & reactors with suspended solid catalyst. Fluidized reactors of various types.
Gas-Liquid Reactors: Trickle bed, slurry reactors. 3-phase fluidized bed.

Course Outcomes: On successful completion of this course students will be able to

- Apply theoretical knowledge to distinguish between various RTD curves and predict the conversion from a non-ideal reactor using tracer information
- Explain the basics and kinetics of fluid-fluid non catalytic systems.
- Explain the basics and kinetics of fluid-Solid non catalytic systems.
- Explain the basics and kinetics of heterogeneous catalytic reactions and Catalytic deactivation.
- Analyze different steps in reaction mechanisms on solid catalytic surfaces and identify the factors affecting rate.
- Explain design procedure of reactors for heterogeneous catalytic reactions

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

TEXT BOOKS:

1. **Chemical Reaction Engineering,** Octave Levenspiel, 3rd edn, John Wiley & Sons, 2001.
2. **Chemical Engineering Kinetics,** J.M. Smith, 3rd edn, McGraw Hill.
3. **Elements of Chemical Reaction Engineering,** H. Scott Foggler, 3rd edn, Prentice Hall, 2001

REFERENCES:

1. **Chemical & Catalytic Reaction Engineering,** James J. Carberry, McGraw Hill, 1976

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

MASS TRANSFER OPERATIONS-II

Course Code	**18CH62**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Credits	4	Exam Hours	03

Course Learning Objectives: The students will be able to

1. Be able to understand different separation techniques.
2. Be able to design distillation column, absorber and calculations involved in liquid extraction.

Module-1

Gas Liquid Contacting Systems: Types, construction and working of plate and packed columns, types and properties of industrial packing's, plate efficiencies, HETP and HTU concepts.

Absorption: Absorption. Solvent selection for absorption. Material balance and concept of driving force and minimum solvent rates. Multistage absorption columns. Design of Plate columns. Absorption and desorption factors.

Module-2.

Packed Tower Absorption: Liquid phase hold up and pressure drop in absorption towers. Design of packed towers (process design-height and diameter). Multi-component absorption. Absorption with chemical reaction.

Distillation: Introduction. Vapour liquid equilibria (T-x,y, P-x,y. H-x,y and x-y diagrams for binary mixtures). Relative volatility. Prediction of VLE from vapour pressure data using Raoult's law. VLE for multi-component systems. Non-ideal systems. Azeotropes. Immiscible systems. Atmospheric distillation**,** Flash and simple distillation.

Module-3

Distillation (Contd.):.Multi-stage rectification column. Design using McCabe Thiele and Lewis-Sorel methods for binary mixtures.

Distillation (Contd.): Ponchon-Savarit method. Introduction to Multicomponent distillation, Vacuum, molecular, extractive and azeotropic distillations .

Module-4.

Liquid-Liquid Extraction: Ternary equilibrium. Solvent selection. Single stage. Multi-stage cross-current, counter-current extraction. Equipment for liquid-liquid extraction.

Module-5

Leaching Operation: Equipment for leaching. Preparation of solids for leaching. Equilibrium diagrams. Calculation of single stage and multi-stage leaching operation.

Course Outcomes: On successful completion of this course students will be able to

- Comprehend the gas – liquid operation and apply the knowledge of gas-liquid operations in distillation and absorption.
- Study the absorption process and apply to a wide variety of process such as recovery of vapors from dilute mixture with gases, solute recovery.
- Apply the knowledge of distillation in separation of liquid mixtures.
- Evaluate the number of plates required in distillation by McCabe and Thiele method and Ponchon and Savarit method.
- Solve problems associated with leaching and extraction operations.
- Differentiate various separation techniques.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1.Mass Transfer Operations - Robert E Treybal, 3rd edn, McGraw Hill, 1981.

2.Unit Operations in Chemical Engineering - McCabe & Smith, 6th edn McGraw Hill, 2001.

REFERENCES BOOKS:

1.Chemical Engineering Vol I, II, IV and V - Coulson and Richardson, 4th edn, Pergamon Press, 1998.

2. Introduction to Chemical Engineering - Badger & Banchero, TMH 6th Reprint 1998

3. Principles of Unit Operation - Foust *et.al*., 2nd edn, John Wiley, 1994

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

MASS TRANSFER OPERATIONS-II

Course Code	**18CH62**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Credits	4	Exam Hours	03

Course Learning Objectives: The students will be able to

3. Be able to understand different separation techniques.
4. Be able to design distillation column, absorber and calculations involved in liquid extraction.

Module-1

Gas Liquid Contacting Systems: Types, construction and working of plate and packed columns, types and properties of industrial packing's, plate efficiencies, HETP and HTU concepts.

Absorption: Absorption. Solvent selection for absorption. Material balance and concept of driving force and minimum solvent rates. Multistage absorption columns. Design of Plate columns. Absorption and desorption factors.

Module-2.

Packed Tower Absorption: Liquid phase hold up and pressure drop in absorption towers. Design of packed towers (process design-height and diameter). Multi-component absorption. Absorption with chemical reaction.

Distillation: Introduction. Vapour liquid equilibria (T-x,y, P-x,y. H-x,y and x-y diagrams for binary mixtures). Relative volatility. Prediction of VLE from vapour pressure data using Raoult's law. VLE for multi-component systems. Non-ideal systems. Azeotropes. Immiscible systems. Atmospheric distillation**,** Flash and simple distillation.

Module-3

Distillation (Contd.):.Multi-stage rectification column. Design using McCabe Thiele and Lewis-Sorel methods for binary mixtures.

Distillation (Contd.): Ponchon-Savarit method. Introduction to Multicomponent distillation, Vacuum, molecular, extractive and azeotropic distillations.

Module-4.

Liquid-Liquid Extraction: Ternary equilibrium. Solvent selection. Single stage. Multi-stage cross-current, counter-current extraction. Equipment for liquid-liquid extraction.

Module-5

Leaching Operation: Equipment for leaching. Preparation of solids for leaching. Equilibrium diagrams. Calculation of single stage and multi-stage leaching operation.

Course Outcomes: On successful completion of this course students will be able to

- Comprehend the gas – liquid operation and apply the knowledge of gas-liquid operations in distillation and absorption.
- Study the absorption process and apply to a wide variety of process such as recovery of vapors from dilute mixture with gases, solute recovery.
- Apply the knowledge of distillation in separation of liquid mixtures.
- Evaluate the number of plates required in distillation by McCabe and Thiele method and Ponchon and Savarit method.
- Solve problems associated with leaching and extraction operations.
- Differentiate various separation techniques.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Mass Transfer Operations - Robert E Treybal, 3rd edn, McGraw Hill, 1981.

2.Unit Operations in Chemical Engineering - McCabe & Smith, 6th edn McGraw Hill, 2001.

REFERENCES BOOKS:

1.Chemical Engineering Vol I, II, IV and V - Coulson and Richardson, 4th edn, Pergamon Press, 1998.

2. Introduction to Chemical Engineering - Badger & Banchero, TMH 6th Reprint 1998

3. Principles of Unit Operation - Foust *et.al*., 2nd edn, John Wiley, 1994.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

PROCESS EQUIPMENT DESIGN AND DRAWING

Subject Code	**18CH63**	CIE Marks	40
Hours /Week	3:2:0	SEE Marks	60
Credits	04	Exam Hours	04

Course Objectives:
The students will be able to
1. Understand advances and types in the design of heat and mass transfer equipment and its accessories.
2. Develop modifications based on design.

Detailed chemical engineering process design of the following equipment should be studied. Standard code books are to be used. The detailed proportionate drawings shall include sectional front view, full top/side view depending on equipment and major components.
1. **Class work:** Students are to design the equipment. They shall also be trained to draw free hand proportionate sketches.
2. **Final Examination:** Students have to answer any one of the two questions given in the examination. After completing the design, free hand proportionate sketches are to be drawn as required.

Content

1. Shell and Tube Heat exchanger
2. Condenser – Horizontal
3. Condenser – Vertical
4. Evaporator – Single effect
5. Sieve Tray Distillation Column
6. Packed Bed Absorption Column
7. Rotary Drier

Course Outcomes: On successful completion of this course students will be able to
- Design (both process & mechanical) shell & tube heat exchanger and draw proportionate sketches.
- Design (both process & mechanical) horizontal & vertical condensers and draw proportionate sketches.
- Design and draw single effect evaporator for given system and able to draw sectional views.
- Design sieve tray distillation column and to draw sketches.
- Design packed bed absorber and draw sketches.
- Design rotary dryer and draw sectional views and to solve any heat and mass transfer equipment designs.

QUESTION PAPER PATTERN:
- The question paper will have two questions.
- Each full Question consisting of 100 marks. Students have to answer any one full question.
- Use of **Chemical Engineers Handbook,** Perry & Green, Is Code book: 2825, 4503 are permitted in the Examination and Internal test.

TEXT BOOKS:

1. **Process Equipment Design** - M. V. Joshi, 3rd edn., Macmillan & Co. India, Delhi, 1998.
2. **Process Equipment Design – Vessel Design,** Brownell & Young, John Wiley, 1959.
3. **Process Design of Equipment – Vol 1,** S. D. Dawande, 3rd edn, Central Techno Publications. 2003.

REFERENCE BOOKS:

1. **Chemical Engineers Handbook,** Perry & Green, 8th edn, McGraw Hill, 1997.
2. **Pressure Vessel Code – IS 2825, 4503,** IS Code, B.I.S., New Delhi, 1969.
3. **Flow of Fluids through Valves, Fittings & Pipes**, Crane Amazon, 2006.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

OILS AND FATS TECHNOLOGY

Course Code	**18CH641**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	3	Exam Hours	03

Course Learning Objectives: The students will be able to

1.Understand Structure of fats and oils, Sources and classification of fats and oils, Chemical and physical characteristics

2. Know its importance in industry and nutrition.

3. Process of fats and oils, Pre-extraction operations, extraction/processing, filtering and refining. Quality and nutritive values of processed products.

Module-1

Introduction: Classification of fats and oil. Characteristic of oils. Utilization of fat and oils. Composition of oils (general).

Obtaining Oils and Fats from Source Materials: Mechanical pretreatment. Mechanical expression. Solvent extraction (two types of extractors).

Module-2.

Process Techniques: Refining and hydrogenation (H_2 production and catalyst).

Process Techniques (contd.): Degumming. Alkali refining and bleaching.

Module-3

Deodorization: Theoretical consideration and operation of commercial deodorizer.

Vegetable Oils: Composition. Extraction. Refining processes and uses of coconut oil, cottonseed oil.

Module-4.

Vegetable Oils: Composition. Extraction. Refining processes and uses of coconut oil, cottonseed oil.

Vegetable Oils: Refining processes and uses of palm oil, Soya bean oil, peanut oil, sunflower oil.

Module-5

Marine Oils: Composition. Extraction. Refining processes and uses of fish oils.

Course Outcomes: On successful completion of this course students will be able to

- Work on isolation and purification of fats and oils.
- Develop new skills in fat and oil products development.
- Experiment on physical and chemical changes occurring in fat and oil products
- Know its importance in industry and nutrition.
- Process of fats and oils, Pre-extraction operations, extraction/processing, filtering and refining.
- Quality and nutritive values of processed products.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Bailey's Industrial Oil and Fat Products – Vol I to V, Y .H. Hery John Wiley International, 2nd edn, 1976.

REFERENCES BOOKS:

1. **Chemistry and Technology of Oil and Fats,** Devine J and Williams P.N, 1961.
2. **Chemical process Industries,** Austin G. T., Shreve's 5th edn, McGraw-Hill international Book Company, Singapore, 1984
3. **Outlines of Chemical Technology,** Dryden C. E., Edited by Gopala Rao. M and M. Sittig, 2nd edn, Affiliated East West Press, 1993.
4. **Hand Book of Industrial Chemistry**, Kent J.A (Ed) Riegel's Van Nostrand Reinhold, 1974

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

PETROLEUM REFINERY ENGINEERING

Course Code	**18CH642**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	3	Exam Hours	03

Course Learning Objectives:

1.Understand history, classification of petroleum crudes.

2.Understand the extraction and production of oil and gas to meet energy needs, as well as refining of crude oil for a wide spectrum of useful products such as petrochemicals, Chemicals, Plastics.

Module-1

Indian Petroleum Industry: Prospects & Future. Major companies. World production, Markets, Offshore and onshore, Oil well technology.

Composition of Crude: Classification. Evaluation of petroleum. UOP-k factor. TBP analysis. EFV analysis. Average boiling point. ASTM curves. Thermal properties of petroleum fractions.

Product Properties and Test Methods: Gas. Various types of gas and LPG. Reid vapor pressure analysis. Gasoline and naptha. Octane No. Oxidation stability. Additives for gasoline. Kerosene. Characterization for flash point or fire point, volatility, burning qualities etc, Diesel, octane testing, viscosity etc. Grades of diesels e.g. HSD, LDO. Diesel additives. Lube oils: Types, tests-carbon residue and viscosity index.

Module-2.

Crude Pretreatment: Pumping of crude oils. Dehydration of crude by chemical, gravity, centrifugal, electrical de-salter and comparison of each. Heating of crude- heater, different types of pipe still heaters including box type, cylindrical etc. Crude distillation, arrangement of towers for various types of reflux. Design aspects for atmospheric and vacuum column. Atmospheric distillation distillation unit: internals and operational.

Module-3

Treatment Techniques: Types of impurities present and various desulfurisation processes. Production and treatment of LPG. LNG technology. Sweetening operations for gases including merox, ethanolamine, copper chloride, stertford etc. Catalytic de sulphonisation. Treatment of kerosene, De-aromatisation and merox. Treatment of diesel, naptha: desulpurisation by hydrogen and catalysts. Treatment of lubes: sulphuric acid, clay treatment, solvent treatment- phenol, furfural**.**

Module-4.

Thermal Processes: Thermal cracking reactions- theory of thermal cracking. Properties of cracked materials and factors influencing the properties of cracked materials. Vis breaking, dubbs two coil cracking process.

Catalytic Reforming: Theory of reforming. Factors influencing reforming, reforming catalysts, feedstock requirements. Plat-forming, hondi forming, flexi forming etc.

Module-5

Catalytic Cracking: Comparison of thermal and catalytic cracking. Carbonium ion chemistry. Feedback requirements. Cracking conditions. Commercial cracking analysis. Various catalytic cracking processes. Fixed bed crackers. Moving bed crackers. Fluid catalytic cracking-flexi cracking-ortho-flow reactor. Theory of coking: various types of coking processes. Delayed coking, fluid coking, contact coking, flexi coking. Naptha cracking, naptha cracking for ethylene as feed selection and gas yield. Hydro cracking. Theory of hydro cracking. Catalysts for hydro cracking.

Course Outcomes: On successful completion of this course students will be able to

- Get insight scenario, prospects and classification of petroleum crudes.
- Explain the refining of crude oil for the production of wide spectrum of useful products
- Classify the various treatment techniques employed in petroleum refining
- Discuss various cracking and reforming methods employed in petroleum refining.
- Discuss catalytic cracking methods employed in petroleum refining.
- Identify suitable refining technology for maximizing the product yield.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.

- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Petroleum Refinery Engineering, Nelson, 4th edn McGraw Hill, 14th Reprint, 1982.

2. **Modern Petroleum Refining Processes,** Bhaskara Rao, 3rd edn, Oxford & IBH Publication, Reprint, 1999.

REFERENCES BOOKS:

1.Petroleum Refining Technology, Ram Prasad, 1st edn, Khanna Publishers, 2000

2.Challenges in Crude Oil Evaluation, Nagnal J.M., Gate, McGraw Hill, 1996.

3. **Petroleum Processing,** Bland W.F. and Davidson R.L. McGraw Hill, 1967.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

CHEMICAL PLANT UTILITIES AND SAFETY

Course Code	**18CH643**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	**4**	Exam Hours	03

Course Learning Objectives: The students will be able to

1. Understand various utilities required for a process industry
2. Analyze the safety factors in a typical process unit.
3. Be able to select different safety devices required

Module-1

Introduction: Different utilities. Role of utilities in process plant operations and criteria for selection and estimation of suitable utilities.

Water: Water resources. Process water, Cooling water, drinking water and boiler feed water Quality Standards. Water treatment processes for drinking, process and boiler feed. Storage and handling of water. Types and selection of pumps, piping and accessories. Water pretreatment.

Module-2.

Air: Compressed air, blower air, fan air. Types of compressor and vacuum pumps and selection. Power requirements, performance and related calculations. Booster and receivers. Quality of compressed air for instruments and processes. Compressed air distribution system- piping and accessories. Air-water vapor system: humidification/ dehumidification and evaporative cooling-related calculations. Insulation: Insulation Materials & Selection- Economics of insulation. Insulating factors. Properties & Classification.

Module-3

Steam and Power: Steam generation in chemical plants. Types of boilers and waste heat boilers. Fuels-types, emissions and global warming, green fuels. Calorific value. Proximate and ultimate analysis. HHV, LHV and related calculations. Cogeneration power plants. CHPs and Boiler performance. Related calculations. Economy of steam generation with different fuels, related calculation. Steam storage and handling-piping and accessories. Boiler performance. Economy of steam generation with different fuels, related calculation. Steam storage and handling-piping and accessories.

Module-4.

Refrigeration: Different refrigeration systems and their characteristics. Air-conditioning systems. Coefficient of performance. Power requirements and refrigeration effect- related calculations for each type of refrigeration system. Refrigerant properties and selection. Some commonly used refrigerants and secondary refrigerants. Cold insulation and cryogenic insulation**.**

Module-5

Process Safety: Intrinsic & Extrinsic Safety. The Hazards- Toxicity, Flammability, Fire, Explosions. Sources of ignition, Pressure. Hazard and risk assessment methods. MSDS.

Safety Devices: Pressure relief valves. Rupture discs. Blow down systems. Flare systems. Flame arrestors. Deflagration arrestors and explosion suppression. Personal safety devices. Process Safety Analysis: HAZAN and HAZOP comparison. Risk analysis and estimation. Safety check list. Computer based quantitative risk analysis.

Course Outcomes: On successful completion of this course students will be able to

- Summarize various utilities used in process industries
- Examine the processes for proper usage of utilities.
- Calculate performance of different types of boiler.
- Select commonly used refrigerants for cold and cryogenic applications.
- Examine process safety and risk analysis.
- Explain role of utilities in process plant operation, criteria for selection, estimation of suitable utilities and safety aspects in a chemical industry.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1.Thermal Engineering, B.K. Sarkar, Tata Mc Graw Hill, 8th Reprint, 1998.
2.Water and Waste water engineering- Vol 2, Gordon M Fair, John C. Geyer and Daniel A Okun, Jhon Hutey, 1996.

REFERENCES BOOKS:

1. Chemical Engineers Handbook, Perry, 8th edn, 2007.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

PROCESS WASTE WATER MANAGEMENT

Course Code	**18CH651**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	3	Exam Hours	03

Course Learning Objectives: The students will be able to

1. Understand the mechanisms and processes used to treat waters that have been contaminated in some way by anthropogenic, industrial or commercial activities prior to its release into the environment or its re-use
2. Understand various terms used in industrial wastewater treatment and to acquaint with different steps involved in treatment of industrial wastewater.

Module-1

Effects of Industrial Wastes on sewerage system and sewage treatment plants and receiving water bodies. Effects of waste additions on physical and chemical properties of soil.
Effluent standards and receiving water quality standards. Different aspects and choices of various disposal alternatives.

Module-2.

Industrial Wastes survey-Process flow charts, condition of waste stream. Material balance, Sampling – Grab, Composite and integrated samples. Continuous monitoring – pH, Conductivity, Bio monitoring.

Module-3

Pretreatment of Industrial Wastewater – Volume reduction, Strength reduction, Neutralization, Equalization and Proportion, Removal of Organic and inorganic dissolved solids. Wastewater Treatment in specific industries: Distillery, Sugar, Pulp and paper, Cement, Textile, Dairy, Fertilizer, Pesticides, Pharmaceutical.

Module-4.

Design of complete treatment systems & disposal for industries: Distillery, diary, textile, paper and pulp mill to meet P.C.B. norms. Radioactive wastes treatment- Low activity and high activity radiation, application of radioactive techniques for wastewater treatment. Bio-Remediation of contaminated soils.

Module-5

Environmental Auditing: Cost of Pollution, Environmental audit solutions, Financial and Managerial opportunities. Criminal and Regulatory liabilities. **.**

Course Outcomes: On successful completion of this course students will be able to

- Explain the importance of process waste water management and effects of Industrial wastes on receiving water bodies and soil.
- Discuss material balance, sampling and bio monitoring of industrial waste water.
- Formulate pretreatment methods of Industrial wastewater.
- Outline environmental auditing and regulatory liabilities.
- Explain environmental concern to be adopted at professional practice.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module..

TEXT BOOKS:

1. **Liquid Waste of industry theories, Practices and Treatment,** Nemerow N.N., Addison, Wiley New York.
2. Industrial Wastewater Management Hand Book, Azad N. S., McGraw Hill book Co., New York
3. **Industrial Waste Disposal**, Ross R.D. Reinhold Environmental Series – New York.

REFERENCES BOOKS:

1.Practical Waste Treatment and Disposal, Dickinson, Applied Science publication, London.
2.Pollution control in Process industries, Mahajan S P, TMH, New Delhi.
3.Industrial Water pollution Control, Eckenfelder, - McGraw hill Company, New Delhi American Chemical Society, Washington D.C. USA.

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Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

PROCESS AIR POLLUTION & CONTROL

Course Code	**18CH652**	CIE Marks	40
Teaching Hours/Week (L:T:P)	03	SEE Marks	60
Credits	**3**	Exam Hours	03

Course Learning Objectives: The students will be able to

1. Understand knowledge on the principles and design of control of indoor/ particulate / gaseous air pollutant and its emerging trends.

Module-1

INTRODUCTION: Structure and composition of Atmosphere – History of Air pollution and episodes, Causes of air pollution and types, Introduction to meteorology toxicology and transport of air pollution, Sources and classification of air pollutants - Effects of air pollutants on human health, vegetation & animals, Materials & Structures – Effects of air Pollutants on the atmosphere, Soil & Water bodies – Long- term effects on the planet – Global Climate Change, Ozone Holes – Ambient Air Quality and Emission Standards – Air Pollution Indices – Emission Inventories.

Module-2.

AIR POLLUTION MONITORING AND MODELING: Physicochemical processes governing the spread of pollutants from point, non-point, line, and area sources; Generation, transport and decay of air pollutants; Mathematical Modeling of dynamics of pollutants, Ambient and Stack Sampling and Analysis of Particulate and Gaseous Pollutants - Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Transport & Dispersion of Air Pollutants - Modeling Techniques – Air Sampling and monitoring methods.

Module-3

CONTROL OF PARTICULATE CONTAMINANTS: Factors affecting Selection of Control Equipment - Gas Particle Interaction, Working principle, Design and performance equations of Gravity Separators, cyclones, Fabric filters, Particulate Scrubbers, Electrostatic Precipitators - Operational Considerations - Process Control and Monitoring - Costing of APC equipment - Case studies for stationary and mobile sources .

Module-4.

CONTROL OF GASEOUS CONTAMINANTS: Control Equipment, Factors affecting Selection of Control Equipment - Working principle, Design operation and performance of absorption, Adsorption, condensation, Incineration, Bio scrubbers, Bio filters - Process control and Monitoring - Operational Considerations - Costing of APC Equipment - Case studies for stationary and mobile sources.

Module-5

AUTOMOBILE AND NOISE POLLUTION: Vehicular Pollution: Automobile emission - Types of emissions - Exhaust emissions, evaporative emissions, crank-case emissions- Prevention and control of vehicular pollution. Noise Pollution: Sources and Effects of Noise Pollution - Measurement - Standards - Control and Preventive measures. Sources types and control of indoor air pollutants, sick building syndrome types - Radon Pollution and its control. Air pollution legislation and regulations. Case studies of a few industrial pollution control systems.

Course Outcomes: On successful completion of this course students will be able to

- Explain the fundamentals of Atmospheric pollution and discuss the effects of Process Air Pollution.
- Discuss Air pollution monitoring and Mathematical modeling of dynamics of pollutants.
- Suggest measures and methods for control of particulate and gaseous contaminants.
- Determine noise levels and suggest suitable practice for control of Noise pollution.
- Discuss vehicular pollution and its control.
- Explain environmental and social concerns to be adopted at professional practice.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. **Air Pollution Control Engineering,** Lawrence K. Wang, Norman C. Parelra, Yung Tse Hung, Tokyo, 2004.
2. Air Pollution Control Engg, Noel de Nevers, Mc.Graw Hill, New York, 1995.
3. Air Pollution, David H.F. Liu, Bela G. Liptak, Lewis Publishers, 2000.

REFERENCES BOOKS:

1. Air Pollution & Control Technologies, Anjaneyulu. Y, Allied Publishers (P) Ltd. India, 2002.
2.Air Pollution (Vol.I – Vol.VIII), Arthur C.Stern, Academic Press, 2006
3. Air Pollution Engineering Manual, Wayne T. Davis, John Wiley & Sons, Inc., 2000.
4. Fundamentals of Air Pollution, Daniel Vallero, Fourth Edition, 2008.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

SOLID WASTE MANAGEMENT IN PROCESS INDUSTRIES

Course Code	**18CH653**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	3	Exam Hours	03

Course Learning Objectives: The students will be able to

1. Understand solid waste management from an environmental public health perspective.
2. Identify and discuss the public health, regulatory, planning, technical, and economic principles that influence the solid waste management system.

Module-1

Introduction: Definition, characteristics and perspectives of solid waste. Types of solid waste. Physical and chemical characteristics. Variation of composition and characteristics. Municipal, industrial, special and hazardous wastes.

General Aspects: Overview of material flow in society. Reduction in raw material usage. Reduction in solid waste generation. Reuse and material recovery. General effects on health and environment. Legislations.

Module-2.

Engineered Systems: Typical generation rates. Estimation and factors affecting generation rates. On site handling. Storage and processing. Collection systems and devices. Transfer and transport.

Module-3

Processing Techniques: Mechanical volume reduction. Thermal volume reduction. Component separation. Land filling and land forming. Deep well injection.

Module-4.

Material Recovery: Mechanical size alteration. Electromagnetic separation. Drying and dewatering. Other material recovery systems. Recovery of biological conversion products. Recovery of thermal conversion products.

Energy Recovery: Energy recovery systems and efficiency factors. Determination of output and efficiency. Details of energy recovery systems. Combustion incineration and heat recovery. Gasification and pyrolysis. Refuse derived fuels (RDF).

Module-5

Hazardous Wastes: Classification. Origin and reduction at source. Collection and handling. Management issues and planning methods. Environmental Acts.

Case Studies: Major industries and management methods used in typical industries – Coal fired power stations, textile industry, oil refinery, distillery, sugar industry, and radioactive waste generation units.

Course Outcomes: On successful completion of this course students will be able to

- Identify and discuss the public health, regulatory, planning, technical, and economic principles that influence the solid waste management system
- Select appropriate engineered methods for handling, collection and transportation of solid waste.
- Explain various processing techniques employed in solid waste management
- Assess various material and energy recovery methods employed in solid waste management
- Identify and discuss the different hazardous wastes handling associated with solid waste
- Justify solid waste management from an environmental, public health perspective

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1.Integrated Solid Waste Management, George Tchobanoglous *et al*., 2nd edn, McGraw Hill & Co, 1993.

2.Industrial Solid Waste Management and Land Filling Practice, Dutta *et al.,* Narosa Publishing House, 1999.

REFERENCES BOOKS:

1. Waste Treatment Plants, Sastry C.A. *et al*, Narosa Publishing House, 1995.

2. Hazardous Waste Management, Lagrega, McGraw Hill, 1994.

B. E. CHEMICAL ENGINEERING
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SEMESTER - VI

CHEMICAL REACTION ENGINEERING LAB

Course Code	**18CHL66**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:2: 2	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives: Students will

1. Experimentally verify the principles and working of reactors studied in theory.
2. Carry out experiment and make observations for various parameters.
3. Study and use various reactors for determining rate constant and conversion.
4. Evaluate the data and compare with reported literature.

Sl. No.	Experiments
1	Batch Reactor
2	Isothermal plug flow reactor
3	Mixed flow reactor
4	Semi batch reactor
5	Heterogeneous catalytic Reactor
6	Segregated flow reactor
7	Adiabatic Reactor
8	Packed bed Reactor
9	RTD Studies in Tubular Reactor
10	Effect of temperature on Rate of reaction
11	Bio Chemical Reaction (Batch)
12	Enzyme catalyzed reactions in batch reactor
13	RTD Studies in mixed flow reactor
14	CSTR in series
15	Catalyst Properties

Note: Minimum 10 experiments are to be conducted

Course Outcomes: On successful completion of this course students will be able to

- Experimentally verify the principles and working of reactors studied in theory.
- Carry out experiment and make observations for various parameters.
- Study and use various reactors for determining rate constant and conversion.
- Evaluate the data and compare with reported literature.
- Apply theoretical knowledge of various types of reactors.
- Apply the use of skills in handling various reactors.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

TEXT BOOKS:

1. **Chemical Reaction Engineering,** Octave Levenspiel, 3rd edn, John Wiley & Sons, 2001.
2. **Chemical Engineering Kinetics,** J.M. Smith, 3rd edn, McGraw Hill.
3. **Elements of Chemical Reaction Engineering,** H. Scott Foggler, 3rd edn, Prentice Hall, 2001.

REFERENCE BOOKS:

1. **Chemical & Catalytic Reaction Engineering,** James J. Carberry, McGraw Hill, 1976.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

MASS TRANSFER OPERATIONS LAB

Course Code	**18CHL67**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives: Students will

5. Experimentally verify the mass transfer concepts studied in theory.
6. Carry out experiment and make observations for various mass transfer equipment.
7. Study the effect of mass transfer coefficients in design of equipment.
8. Evaluate the performance characteristic for different mass transfer cases.

Sl. No.	Experiments
1	Diffusion of organic vapours in air
2	Simple Distillation
3	Packed column/ plate column distillation
4	Steam distillation
5	Solid – liquid leaching
6	Surface evaporation
7	Tray dryer
8	Adsorption studies
9	Liquid-liquid/Vapour –liquid equilibrium
10	Liquid extraction – (cross current: 1 and 2 or 3 stage)
11	Hold up studies in packed columns
12	Rotary/ vacuum dryers
13	Wetted wall column
14	Cooling tower
15	Solid dissolution
16	Gel-electrophoresis

Note: Minimum 10 experiments are to be conducted

Course Outcomes: On successful completion of this course students will be able to

- Experimentally verify the mass transfer concepts studied in theory.
- Conduct experiment and make observations for mass transfer equipment.
- Discuss the effect of mass transfer coefficients in design of equipment.
- Explain the handling of Mass transfer operations.
- Apply theoretical knowledge of mass transfer equipment.
- Acquire practical knowledge of mass Transfer Equipment.

Conduct of Practical Examination:

5. Minimum of 10 experiments are to be conducted and all 10experiments are to be included for practical examination.
6. Students are allowed to pick one experiment from the lot.
7. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
8. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

TEXT BOOKS:

1. Mass Transfer Operations - Robert E Treybal, 3rd edn, McGraw Hill, 1981.
2. **Unit Operations in Chemical Engineering** - McCabe & Smith, 6th edn, McGraw Hill,2001.

REFERENCE BOOKS:

1. Chemical Engineering Vol I, II, IV and V - Coulson and Richardson, 4th edn, Pergamon Press, 1998.
2. **Transport Processes and Unit Operation -** Geankoplis C J, Prentice Hall (I), 2000.

B. E. CHEMICAL ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - VI			
MINI-PROJECT			
Course Code	**18CHMP68**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	60
Credits	02	Exam Hours	03
Mini-project work: Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.			
i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the Mini-project work, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates. **(ii) Interdisciplinary:** Continuous Internal Evaluation shall be group wise at the college level with the participation of all the guides of the college. The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.			
SEE for Mini-project: **(i) Single discipline:** Contribution to the Mini-project and the performance of each group member shall be assessed individually in the semester end examination (SEE) conducted at the department. **(ii) Interdisciplinary:** Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belongs to.			

B. E. CHEMICAL ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - VI			
INTERNSHIP			
Course Code		CIE Marks	
Teaching Hours/Week (L:T:P)		SEE Marks	
Credits		Exam Hours	
Internship: All the students admitted to III year of BE/B.Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.			

VII- SEMESTER

B. E. CHEMICAL ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - VII			
PROCESS CONTROL AND INSTRUMENTATION			
Course Code	**18CH72**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: To gain the knowledge of different process instruments, To understand dynamic modeling of a physical process using first principles, To design various control schemes, To apply the control system in various processes.

Module-1

Instrumentation: Fundamentals Static and dynamic characteristics. Indicators and recorders. Pressure measurement- Bourdon, diaphragm and bellow type gages. Vacuum measurements. Temperature measurement- Bimetal and resistance thermometers, thermocouples and pyrometers.

Module-2.

First Order Systems: Thermometer, level, mixing tank, STR, Linearisation, I order systems in series. Response for various input forcing functions. **Second Order Systems**: Characteristics of manometer and damped vibrator. Transfer functions. Response for various input forcing functions, response for step input for under damped case – Terms associated with it. Transportation lag.

Module-3

Closed Loop System: Basic components. Servo and regulator control. Controllers – P, I, D and On –Off mo combinations - Final control elements - Valves, actuators and valve positioners. **Closed Loop Response:** Closed loop transfer function, Transient response of servo and regulator control systems with various controller characteristics.

Module-4.

Stability: Stability of linear control systems. Routh Test. Frequency Response – Bode diagrams.

Module-5

Control System Design By Frequency Response: Bode criterion. Gain and Phase margins, Ziegler – Nichols controller tuning, Cohen-Coon controller tuning. **Root Locus:** Rules for plotting and problems.

Course Outcomes: On successful completion of this course students will be able to

- Comprehend basic techniques, devices for temperature and pressure measurements and characteristics of measuring devices.
- Discuss fundamental laws and apply to summarise behaviour of thermometer and manometers.
- Comprehend servo, regulatory control systems and final control elements.
- Arrange basic control components and summarise and represent in block diagram.
- Determine stability of system by Routh Hurwitz and Root Locus techniques.
- Comprehend basics of controller tuning.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

TEXT BOOKS:

1. **Process System Analysis and Control,** Coughner & Koppel, 2nd edn, McGraw Hill, NewDelhi, 1991.

REFERENCES BOOKS:

1. **Process Modeling, Simulation & Control for Chemical Engineers,** Luyben, 2nd edn, McGraw Hill, 1990.
2. **Chemical Engineering Vol. III, III Edition,** Coulson & Richardson, Pergamon Press,1998.
3. **Chemical Process Control-**An Introduction to Theory & Practical, George Stephanopoules,Vol.3, Prentice Hall, New Delhi, 1998.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

ELECTRO CHEMICAL TECHNOLOGY

Course Code	**18CH731**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will be able to
1. Understand the operation of various types of electrochemical systems.
2. Understand electrochemical corrosion of metals and corrosion protection methods.

Module-1

Introduction To Theoretical Aspects: Faradays laws, mechanism of conduction in solids, liquids and gases and in ionic melts. Conduction in metals and semiconductors.
Reversible electrodes and potentials, electrode processes and electrode kinetics. .

Module-2.

Various types of over potentials. Polarisation. Butler-volmer for one electron and mute electron steps. Models of electrical Double layer.

Module-3

Applied aspects: Potentiometry and ion-selective electrodes. Polarography.

Module-4.

Electrode deposition of metals and alloys. Primary and Secondary Fuel Cells.

Module-5

Corrosion and its Prevention: Electro winning. Electro organic and inorganic synthesis (and some typical examples). Environmental electrochemistry. Bio-electro chemistry**.**

Course Outcomes: On successful completion of this course students will be able to

- Explain Faradays laws and mechanism of conduction in solids, liquids and gases
- Classify reversible electrodes and explain electrochemical cells, models of electrical double layer and Bulter-Volmer equation
- Explain over potential, polarization and deposition of metals & alloys
- Discuss potentiometry, polarography and ion-selective electrodes
- Explain various types of primary and secondary batteries and fuel cells
- Discuss corrosion of metals & their prevention; explain electro-winning, electro-organic and inorganic synthesis and environmental impact

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

TEXT BOOKS:

1. **Modern Electrochemistry,** J.O.M., Bockris & A.K.N. Reddy, Vol.1 & 2, Plenum, New York 2002.
2. **Industrial Electrochemical Processes,** A. Kuhn, Elsevier, Amsterdam, 1971.

REFERENCES BOOKS:

1. **Electro Analytical Chemistry,** J.J. Lingane, Wiley, New York, 1958.
2. **Electrochemistry, Principles and Applications,** E.C. Potter, Cleaverhume Press, London 1956.
3.**Organic Electrochemistry,** M.M. Baizer, Marcel Dekker, 3rd Edition, New York, 1991.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

PETROCHEMICALS

Course Code	**18CH732**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will be able to
1. Understand the various types of Carbon compounds and their properties.
2. Understand preparation of petrochemical compounds from different sources.

Module-1

Definition of Petrochemicals: Petrochemical industries in India. Principal raw materials. Introduction to chemicals from C_1, C_2, C_3 and C_4 compounds.
Chemicals from C_1 Compounds: Manufacture of methanol and chloro methanes. Manufacture of perchloro ethylene.

Module-2.

Chemicals from C_2 Compounds: Feed stock, technology, engineering problems and usage of Ethylene and acetylene, ethanol, polyethylene, acetaldehyde, ethanol amines, acetic acid.

Module-3

Chemical from C_3 Compounds: Isopropanol, acetone, acrylonitrile, polypropylene, propylene oxide.

Module-4.

Chemical from C_4 Compounds: Butadiene dehydrogenation of butane (Houdry). Dehydrogenation of butylenes. Dehydrogenation-dehydration of ethanol. Steam cracking of hydrocarbons.
Chemicals from Aromatics: Primary raw material. Hydroalkylation.

Module-5

Manufacture of phenol – 2 methods. Styrene – 2 methods. Phthalic anhydride maleic anhydride, nitrobenzene, aniline. Manufacture of industrial dyes based on petroleum feed stocks.

Course Outcomes: On successful completion of this course students will be able to
- Explain the scenario of petrochemical industry in India.
- Discuss the sources, composition and characterization of petrochemicals.
- Differentiate various types of hydrocarbons and their properties
- Explain production of primary and secondary petrochemicals
- Discuss the types of chemical processes involved in production of petrochemicals.
- Identify the major engineering problems of petrochemical production processes.

QUESTION PAPER PATTERN:
- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

TEXT BOOKS:
1. **Petrochemicals,** B.K. Bhaskar Rao, CRC Press, 1990.
2. **Chemicals from Petroleum,** A.L. Waddams, 2nd edn, ELBS, London, 1970.

REFERENCES BOOKS:
1. **Dryden's Outlines of Chemical Technology,** Gopal Rao M and Marshall Sittig, 3rd edn, East-West Press, 1997.
2. **Chemical Process Industries,** 5th edn, Shreve and Austin, McGraw Hill, 1984.
3. **Chemical Technology,** G.N. Pandey, 3rd edn, Vikas Publishing House Pvt. Ltd., 1977.
4. **Chemical Technology,** Mukhlyonov, Mir Publications, 1982.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

COMPUTER APPLICATIONS AND MODELING

Course Code	**18CH71**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will be able to
To make the students understand physical systems in chemical engineering and to develop their mathematical models and solutions for these models. The students will also learn to use the commercial process simulators.

Module-1

Review of Computational Methods: Simultaneous linear algebraic equation – Gauss Jordan., Non-linear algebraic equation-Newton Raphson. Ordinary Differential Equation- R-K Method. Numerical Integration-Simpson's 1/3 Rule. Curve Fitting-Least Squares. .

Module-2.

Applications: Vapor- Liquid equilibria for binary mixtures. Calculation of Bubble Pressure and Bubble Point. Dew Pressure and Dew point for Ideal Binary and multi-component system.
Flash Vaporization: for multi-component system. Design of Adiabatic Batch Reactor. Design of Adiabatic PFR, Adiabatic CSTR and Combinations.

Module-3

Design of Adiabatic PFR, Adiabatic CSTR and Combinations.
Design: Double Pipe Heat Exchanger (Area, Length and Pressure drop). Shell & Tube Heat Exchanger (Area, Number of tubes, Pressure drop.

Module-4.

Absorption & Distillation Columns: Calculations for Plate and Packed Columns.

Module-5

Modeling: Models and model building, principles of model formulations, precautions in model building, Fundamental laws: Review of shell balance approach, continuity equation, energy equation, equation of motion, transport equation of state equilibrium and Kinetics, classification of mathematical models. **Mathematical Modeling and Solutions to the Following:** Basic tank model – Level V/s time. Batch Distillation – Vapor composition with CSTRs in series time.

Course Outcomes: On successful completion of this course students will be able to

- Identify numerical techniques for solving chemical engineering problems
- Analyze specific problems and develop algorithms.
- Write C-programs for design of chemical engineering equipment.
- Explain the fundamentals of modeling.
- Use mathematical modeling and solve specific chemical engineering models.
- Summarise concepts of Models, fundamental laws of model building, apply to Distillation and CSTR.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. **Computer based Numerical Analysis,** M. Shantha Kumar, 1st edn, KPS Publisher,1987.
2. **Introduction to Chemical Engineering and Computer Calculations,** Myers, A.L and Seider W.D, Prentice Hall, 1976.
3. **Process Modeling Simulation and Control for Chemical Engineering,** William. L Luyben, 2nd edn., McGraw Hill, 1990.

REFERENCES BOOKS:

1.Elements of Chemical Reaction Engineering, H. Scott Fogler, 2nd edn, Prentice Hall, 2001.
2.Introduction to Chemical Engineering Thermodynamics, Smith J. M. and H. C. Vanness, 5th edn, McGraw Hill, 1996.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

FERMENTATION TECHNOLOGY

Course Code	**18CH733**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will be able to

1. Be able to understand role of microorganisms in fermentation.
2. Be able to understand the various fermentation technologies used.
3. Be able to learn the production of important products through fermentation.

Module-1

Introduction to fermentation & Microbial Growth Kinetics: History and development of fermentation, general requirements of the fermentation, range of fermentation processes, parts of a fermentation process-upstream and downstream processing, aerobic and anaerobic fermentation, solid state and submerged fermentation. Batch culture (Quantifying cell concentration, Growth patterns and Kinetics), Continuous culture, Comparison of batch and continuous cultures in industrial processes, Fed batch culture, Examples of use of fed batch cultures.

Module-2.

Isolation, preservation Pathways and improvement of industrial Microbes: Isolation, preservation Improvement of industrially important microorganisms, DNA techniques Induction, carbon catabolite repression, crab tree effect, feedback Inhibition and repression

Module-3

Media, Sterilization inoculum for industrial fermentations: Introduction, Typical media, Energy sources, Carbon sources, Nitrogen sources, Buffers, Oxygen requirements, Antifoams, Medium optimization, Medium sterilization: The design of batch sterilization processes, The design of continuous sterilization processes, Sterilization of the fermenter, feeds and air, Filter sterilization The development of inocula for yeast , bacterial and fungal processes, The aseptic inoculation of plant fermenters.

Module-4.

Aeration agitation & Design of fermenter: The oxygen requirements and supply of industrial fermentations, Determination of K_{La}, Factors affecting K_{La} values, balance between oxygen supply and demand, Basic function of a fermenter for microbial or animal cell culture, body construction, and various parts of a fermenter.

Module-5

Important products through Fermentation: Organic acids: citric and acetic acid; enzymes: amylase, protease, lipase; antibiotics: penicillin; vitamins: vitB12; amino acids: lysine, Glutamic acid; organic solvents: ethanol, acetone butanol alcoholic beverages: wine, beer; biomass: baker's yeast ; bio fertilizers; bio pesticides; bio surfactant; steroid transformation; biopolymers.

Course Outcomes: On successful completion of this course students will be able to

- Comprehend role of microorganisms in fermentation.
- Explain the various fermentation technologies used.
- Explain production of important products through fermentation.
- Discuss instrumentation and operation of fermenter for aerobic and anaerobic.
- Integrate biological and engineering principles involved in the production and recovery of commercial products.
- Develop critical thinking skills and learn to employ a quantitative, scientific approach towards conversion of biological materials to value added products.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

TEXTBOOKS:

1. **Biochemical Engineering,** Bailey & Ollis, McGraw Hill.
REFERENCES BOOKS: **1. Principles of Fermentation Technology** – Stan bury P.F., Whitaker A, Hall S. J. **2. Bioprocess Engineering: Basic concepts** – Shuler M.L., Kargi F. (PHI)

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

NOVEL SEPARATION TECHNIQUES

Course Code	**18CH741**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will be able to

1. To identify the multiple factors influencing the choice of separation techniques.
2. To be able to qualitatively and quantitatively address the fundamental aspects of specialty separation processes.

Module-1

Adsorptive Separations: Review of fundamentals. Mathematical modeling of column factors. Pressure swing & thermal swing adsorption. Counter current separations. **Chromatography:** Chromatography fundamentals. Different types, Gradient & affinity chromatography, Design Calculations for chromatographic columns.

Module-2.

Membrane Separation Processes: Types, Thermodynamic considerations. Mass transfer considerations. Design of RO &UF. Ion selective membranes. Micro filtration. Electro dialysis. Pervaporation. Gaseous separations. **External Field Induced Separations:** Electric & magnetic field separations. Centrifugal separations and calculations.

Module-3

Surfactant Based Separations: Fundamentals. Surfactants at inter phases and in bulk. Liquid membrane permeation. Foam separations. Micellar separations.

Module-4.

Super Critical Fluid Extraction: Thermodynamics and physico chemical principles. Process description. Application. Case Study.

Module-5

Mechanical–Physical Separation Process: Introduction, Classification, Filtration in solid liquid separation. Settling & sedimentation in particle fluid separation.
Other Separations: Separation by thermal diffusion, Electrophoresis, crystallization.

Course Outcomes: On successful completion of this course students will be able to

- Explain fundamentals of various types of advanced separation techniques.
- Analyze a given industrial separation/problem and apply concepts of advanced separation techniques.
- Explore usage of alternative separation techniques to the existing ones.
- Analyze and design pervaporation, chromatography and dialysis based separation processes.
- Analyze merits and limitations of novel eparation techniques.
- Identify the multiple factors influencing the choice of separation techniques.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

TEXT BOOKS:

1.Marcel Mulder, "Basic Principles of Membrane Technology",2nd edn.,Springer Publications, 2007
Handbook of Separation Process Technology ,R. W. Rousseu, John Wiley & Sons,1987.
2.Handbook of Separation Process Technology ,R. W. Rousseu, John Wiley & Sons,1987

REFERENCES BOOKS:

1. Encyclopedia of Chemical Technology, Kirk-Othmer, John Wiley & Sons,2001.
2. Rate Controlled Separations, Phillip C Wankat, Kluwer Academic Pub, 1990.
3. Transportation and Separation Process, Gaenkopolis, Printice Hall, 2003.
4. Large Scale Adsorption Chromatography, P C Wankat, CRC Press, 1986.
5. Reverse Osmosis and Ultra Filtration Process Principle, S. Sourirajan & T. Matsura, NRC Publication, Ottawa, 1985.
6. Surfactant Based Separation, T.O. Hatton, Vol 23.

7. Supercritical Fluid Extraction, M A McHugh & V. J. Krukonis, Butterworth, 1987.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

CHEMICAL PROCESS INTEGRATION

:	**18CH742**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:
Process integration involves considering holistic view of chemical process. To understand process synthesis and analysis. Heat and mass integration techniques are studied to minimize the losses and to make the process more economical.

Module-1

Introduction to Process Integration: Graphical Techniques. Overall mass targeting, Synthesis of Mass Exchange Network: Graphical approach. Direct recycle strategies.

Module-2.

Visualization Strategies: for development of mass integrated system. Algebraic approach to targeting direct recycles.

Module-3

Algebraic Approach: to targeting mass exchange, network. Recycle strategies using property integration.

Module-4.

Heat Integration: Combined heat and power integration. Optimization: Mathematical approach to direct recycle, Graphical method, simplex method, single variable optimization, multivariable optimization.

Module-5

Mathematical Techniques: for synthesis of mass & heat exchange excluding Lingo optimization techniques, for mass integration. Initiatives and applications. Case studies.

Course Outcomes: On successful completion of this course students will be able to

- Solve process integration and direct recycle problems using analytical and graphical techniques and MEN with pinch analysis.
- Solve direct recycle problems using algebraic techniques and to solve problems using visualization tools.
- Synthesize MEN using algebraic techniques and to solve problems using property integration.
- Find the minimum heating and cooling utilities for a process and to find solutions using optimization techniques.
- Synthesize MEN and HEN problems using mathematical equations.
- Discuss the integration methods to reduce the material and energy recovery and reuse.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

TEXT BOOKS: 1. Process Integration - Mahmoud. M., El – Hawalgi, Vol. 7, Academic Press, 2006.

REFERENCES BOOKS:
1. Chemical Process Design & Integration, Robin Smith, 2nd edn, Wiley, 2005.
2. Pinch Analysis and Process Integration - A user guide on process integration for efficient use of energy, Kemp I.C, 2nd edn, Butterworth, Heinneman, 2006.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

PILOT PLANT AND SCALE UP STUDIES

Course Code	**18CH743**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:
To understand different scale up methods in chemical engineering and applying the knowledge to scale up the reactors for industrial scale operations.

Module-1

Pilot Plants: Evolution of process system. Need of pilot plants. Concept of prototypes, models, scale ratios, element. Principles of similarity: Geometric similarity, Distorted similarity, Static, dynamic, kinematic, thermal and chemical similarity with examples**.** .

Module-2.

Dimensional Analysis: (Review of Rayleigh's, Buckingham-∏methods), Differential equation for static systems, flow systems, thermal systems, mass transfer processes, chemical processes-homogeneous and heterogeneous.

Module-3

Regime Concept: Static regime. Dynamic regime. Mixed regime concepts. Criteria to decide the regimes. Equations for scale criteria of static, dynamic processes, Extrapolation. Boundary effects.

Module-4.

Scale up of mixing process, agitated vessel, Scale up of chemical reactor systems-Homogeneous reaction systems. Reactor for fluid phase processes catalyzed by solids. Fluid-fluid reactors.

Module-5

Stagewise mass transfer processes. Continuous mass transfer processes. Scale up of momentum and heat transfer systems. Environmental challenges of scale up.

Course Outcomes: On successful completion of this course students will be able to

- Differentiate between pilot plant and model and able to develop a prototype based on studies.
- Advantages and disadvantages of dimensional analysis technique over differential equation technique.
- Designing of equipment by successive approximation method (Extrapolation).
- Apply the principles of scale-up for pilot plant.
- Scale up equipment for momentum and heat transfer systems.
- Able to eliminate boundary effects in various chemical systems.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

TEXT BOOKS:

1. **Scale up of Chemical Processes**, Attilio Bisio, Robert L. Kabel, John Wiley & Sons, 1985
2. **Pilot Plants Models and scale up method in Chemical Engineering,** John stone and Thring, McGraw Hill, 1957.

REFERENCES BOOKS:

1 .Pilot Plants and Scale up Studies, Ibrahim and Kuloor.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

FOOD TECHNOLOGY

Course Code	**18CH751**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will be able to

1. Impart knowledge to the students about food processing and various unit operations involved in it, packaging, storing and preservation, food poisoning, food related hazards and safety.

Module-1

Introduction and Quality Attributes of Food: Function of foods. Food in relation to health. Aim of food science and technology. Quality attributes – Appearance factors, Textural factors, Flavor factors. Visual and objectively measurable attributes. Aroma of foods – introductory ideas, formation, chemistry and analysis. Taste – introductory ideas, formation and chemistry. Additional quality; quality standards, quality control. Introduction to sensory evaluation of foods and beverages.

Modern Trends In Food Science: Biotechnology in food. Biofortification, Nutraceuticals. Organic foods. Low cost nutrient supplements. Packaging of foods and nutrition labeling. Careers in food science and food industries.

Module-2.

Formation and Chemistry of Food: Carbohydrates. Proteins. Lipids. Vitamins. Minerals. Water. Biotin. Choline. Phytochemicals. **Food Processing and Preservation:** Food deterioration – Causes. Aims and objectives of preservation and processing. Unit operations in processing. Different methods of food preservation – low temperature, high temperature, preservatives, osmotic pressure, dehydrations. food irradiation; processing and preservations of milk and dairy, vegetables and fruits, cereals, legumes and nuts, meat and meat products, fats and oils, beverages, sugars, sweeteners, honey and confectionary, salt and spices.

Module-3

Enzymatic and Non-Enzymatic Reactions During Storages: Introduction to enzymes. Nature and function of enzymes. Classification of enzymes. Hydrolases – Esterace, amylases, pectic enzymes. Proteases. Oxidoreductases – phenolases, glucose oxidase, catalose, peroxidase, lipoxygenase, xantine oxidase. Immobilized enzymes. Uses and suggested uses of enzyme in food processing. Non-enzymatic reactions

Module-4.

Food Additives: Introduction and need for food additives. Types of additives – antioxidants, chelating agents, coloring agents, curing agents, emulsions, flavors and flavor enhancers, flavor improvers, humectants and anti choking agents, leavening agents, nutrient supplements, non- nutritive sweeteners, pH control agents. Preservatives – types and applications. Stabilizers and thickeners, other additives. Additives and food safety.

Food Contamination and Adulteration: Types of adulterants and contaminants. Intentional adulterants. Metallic contamination. Incidental adulterants. Nature and effects. Food laws and standards.

Module-5

Environmental Concerns and Food Safety: Water in food production. Properties and requirements of processing water. Environmental concerns – solid waste disposal, wastewater properties, wastewater treatment. Safety hazards and risks. Food related hazards. Processing and handling. Cleaning and sanitizing.

Course Outcomes: On successful completion of this course students will be able to

- Explain the quality attributes and chemistry of foods
- Comprehend about food processing and various unit operations involved in it,
- Apply principles of packaging, storing and preservation, food poisoning, food related hazards and safety
- Explain the various causes of food deterioration and food poisoning.
- Identify appropriate processing, preservation, and packaging method.
- Analyze product quality and effect of processing technique on it.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks

- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Food Science, B. Srilakshmi, 4th edn, New Age International, 2007.

2. **Foods: Facts and Principles,** N. Shakuntala Manay and M. Shadaksharamurthy, New Age Publishers, 2005.

REFERENCES BOOKS:

1. **Introduction to Food Science,** Rick Parker, Thomsan Detmer, 2001.
2. **Food Processing and Preservation,** G. Subbulakshmi and Shobha A. Udupi, New Age International, 2001.
3. **Food Science,** Norman N. Potter and Joseph H. Hotchkin, 1st edn, Avi Publishing Co, 1968.
4. **Principles of Food Chemistry,** John M DeMan, 3rd edn, Springer,1999

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

PULP AND PAPER TECHNOLOGY

Course Code	**18CH752**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will be able to

1. Understand the wood chemistry, basic pulp and papermaking processes from different raw materials.
2. Acquainted with raw material characteristics, physical and mechanical concepts, nomenclature and procedures related to evaluating paper and paper board product propertie
3. Learn Chemical recovery systems and bleaching of mechanical pulps. Treatment of effluent.

Module-1

Wood Chemistry: Chemical composition- cellulose, hemi cellulose, lignin, wood extractives, raw material. Quality parameters under evaluation. Yield of raw material.

Pulping: General principle of pulping. Types of pulping processes: mechanical, chemical, semi-chemical, sulphate process, Kraft process. Process calculations. Raw material utility requirements. Process flow sheet and description. Washing and bleaching. Common unit operation. Wood treatment, digestion, evaporation, drying with equipment used.

Module-2.

Treatment of Pulp: Screening, washing, refining, thickening of pulp. Bleaching- conventional and non-conventional bleaching techniques.

Paper Making: Preliminary operations on pulp. Beating and refining of pulp. Non-fibrous materials. Fillers and loading material. Internal sizing. Wet and additive surface treatment. Paper coloring. Surface sizing.

Module-3

Paper Drying and Finishing: Types of dryers. Calendaring. Reeling and winding. Paper machine drives, cutting, winding and rewinding. Conversion of papers.

Module-4.

Paper Quality of Grades: Different grades of paper quality. Parameters and their evaluation. Saturation of paper. Special grade papers. Recycling of waste papers..

Module-5

Supportive Operations: Chemical recovery – water balance, oxidation, evaporation of black liquor, lime recovery. Quality control and safety aspects.

Environmental Aspects: Effluent characteristics of pulp and paper industries. Treatment methods.

Course Outcomes: On successful completion of this course students will be able to

- Introduction of raw materials of paper and its yield
- Paper manufacturing processes starting from raw materials, pre-treatment's and equipment used.
- Paper making from wet pulp to papers with suitable additives for quality.
- Paper drying and finishing processes, quality checks and recycling of paper.
- Industrial support systems for paper factory and environmental considerations.
- Explain environmental aspects related to paper industry.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

TEXT BOOKS:

1.Pulp and Paper Chemistry and Technology, Casey, J.P., 2nd edn, Inter Science, 1960

REFERENCES BOOKS:

1 **Handbook of Pulp and Paper Technology**, Britt K.W., Reinhold Publication Corp., 1964
2. **Pulp and Paper Science and Technology**, Libby C.E. Vol 1 to 3, McGraw Hill, 1962.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

PETROCHEMICAL ENGINEERING

Course Code	**18CH753**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will be able to

1. Study the Prospects, Growth, Economy related to Petrochemical Industry.
2. Study various feed stocks employed.
3. Study heat & mass transfer operations related to Petrochemical Industry.
4. Study reactors employed and engineering problems encountered at Petrochemical Industry.

Module-1

Introduction: The growth of petrochemical industry, Global & Indian scenario, Feed stocks for Petrochemicals, Natural gas, Refinery gases, Sources, Composition of natural gas, Properties, Storage Heating value and flammability limits of natural gas. Refinement of Natural Gas: Acid gas removal: Amine process, Carbonate washing process, Sulphur recovery process. Dehydration, Technology of Liquefied Natural Gas **. 08 Hr**

Module-2.

CRACKING: Thermal, Catalytic, Product distribution, Steam cracking, Thermodynamics of Steam cracking of Natural gas, Naphtha and Heavy distillates, Products of steam cracking, Production of Hydrogen, Synthesis gas, Methanol, Reaction features. Reactors for steam cracking. Engineering Problems associated.

Module-3

Thermodynamical and Technological principles involved in Alkylation, Oxidation, Nitration Hydrolysis processes employed at petrochemical industry.

Module-4.

Thermodynamical and Technological principles involved in Sulphonation, Sulfation and Isomerization processes employed at petrochemical industry

Module-5

Petro Chemicals from Aromatics: Feed stocks, Hydro alkylation. Thermodynamics, Kinetic Reactors features Product distribution Engg. problems associated

Course Outcomes: On successful completion of this course students will be able to

- Explain the scenario, prospects and growth related to petrochemical industry in India.
- Discuss various cracking methods employed in petroleum refining.
- Discuss the types of chemical processes employed at petrochemical industry.
- Apply thermodynamical and technological aspects involved in petrochemical industry
- Explain the production of petrochemicals from aromatic hydrocarbons.
- Identify the various engineering problems associated with petrochemical industries.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. Bhaskara Rao, B.K., "A Text on Petrochemicals", Khanna Publishers, 2000.
2. Sukumar Maiti, "Introduction to Petrochemicals", 2nd edn, Oxford and IBH Publishers, 2002.
3. Dryden, C.E., "Outlines of Chemical Technology", 2nd edn, Affiliated East-West press, 1993

REFERENCES BOOKS:

1. Margaret Wells, "Handbook of Petrochemicals and Processes", 2nd edn, Ash Gate Publishing Limited, 2002.
2. Sami Matar, and Lewis F. Hatch., "Chemistry of Petrochemical Processes", 2nd edn, Gulf Publishing Company, 2000.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

COMPUTER APPLICATIONS & SIMULATION LAB

Course Code	**18CHL76**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives: Students will

1. Identify applications of numerical techniques in solving chemical engineering problems
2. Develop algorithm and write program for Bubble point, Dew point, Flash drum and Adiabatic flame temperature
3. Develop algorithm and write program for elementary design of heat exchangers, distillation column
4. Comprehend utilization of simulation software for determination of thermo-physical properties of pure components & generation of VLE data of binary component system
5. Simulate heat exchanger, distillation column and flash drum using simulation software

PREREQUISITES: Students should have pursued the following courses as part of their degree program / have good working knowledge in (i) Fluid mechanics (ii) Chemical Reaction Engineering (iii) Chemical Engineering Thermodynamics (iv) Heat and Mass Transfer (v) Process Equipment Design (vi) Numerical analysis

Experiments: The following experiments are to be carried out; the data are to be analysed based on the theoretical aspects, and recorded with comments.

Sl. No.	**Part – A Numerical Methods And Computer Applications**
1	Non-linear algebraic equation- Newton Raphson (Specific volume of binary mixture)
2	Ordinary Differential Equation- R-K Method ($dCa/dt=kCa^2$)
3	Numerical Integration - Simpson's 1/3 Rule (Batch Reactor to find time)
4	Curve Fitting –Least Square (Nre vs f)
5	Calculation of Bubble Point and Dew Point for Ideal multi-component system
6	Flash Vaporization for multi-component system
7	Design of Adiabatic Batch Reactor, PFR
8	Adiabatic Flame Temperature
9	Double pipe heat exchanger (Area, Length and Pressure drop)
10	Distillation Column (Bubble cap)
The above applications can be solved using Programming Language already learnt at First year or Spread Sheet	
PART – B SIMULATION	
1	Introduction to suggested software available (flow sheeting)
2	Mixing of ideal liquid streams
3	Determination of thermo-physical properties of pure components
4	Generation of VLE data of binary component system
5	Determination of equilibrium conversion of reversible reactions
6	Material balance on reactor based on yield/conversion data
7	Simulation of a flash column
8	Simulation of a distillation column
9	Determination of heat duty
10	Detailed Simulation of heat exchanger
11	Simulation of a CSTR for liquid phase reaction
12	Shortcut Simulation of heat exchanger to determine outlet stream temperature
13	Simulations Studies of pump, compressor, cyclone and heater
14	Process simulation study involving mixing, reactor, distillation, heat exchanger for any of the following: a) Ethylene Glycol from Ethylene oxide b) Atmospheric distillation of crude oil c) Propylene Glycol from Propylene oxide d) Aromatic stripper with recycle stream (Benzene, Toluene, Xylene) Styrene from Ethyl Benzene

Note: Minimum 10 experiments are to be conducted

SOFTWARES SUGGESTED:

- Aspen Plus
- ChemCAD
- COCO simulator
- Design-II
- DWSIM
- Hysys
- Open Modelica
- Prosim

Course Outcomes: On successful completion of this course students will be able to

- Apply theoretical knowledge of numerical methods to solve chemical engineering problems.
- Understand the application of simulation and data processing in chemical engineering.
- Simulate basic equipment used in unit operations.
- Utilize simulation software to verify and analyze different solutions obtained through programming.
- Use simulation software to determine optimal Solutions.
- Apply theoretical knowledge of numerical methods to solve chemical engineering problems.

Conduct of Practical Examination:

Minimum of 10 programs/simulations are to be conducted and all are to be included for practical examination.
Students are allowed to pick one experiment from the lot.
Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

TEXT BOOKS:

1. **Computer based Numerical Analysis,** M. Shanthakumar, 1st edn, KPS Publisher, 1987.
2. **Process Modeling Simulation and Control for Chemical Engineering,** William. LLuyben, 2nd edn., McGraw Hill, 1990.

REFERENCE BOOKS:

1. Andrew Biaglow, Teach Yourself ChemCAD, Wiley-Blackwell, 2020
2. Ghasem, A. and R. Henda. Principles of chemical engineering processes. Boca Raton: CRC Press, 2009.
3. Jana A. K. Process simulation & control using ASPEN, 2/e. New Delhi: PHI Learning Pvt. Ltd., 2012.
4. R. W. Gaikwad, Process Modeling & Simulation, Denett & Co., 2010.
5. S. I. Sandler. Using Aspen Plus in thermodynamics instruction – A step-by-step guide. New Jersey: John Wiley Sons, Inc., 2015.
6. Schefflan, R. Teach yourself – The basics of Aspen Plus. New Jersey: John Wiley & Sons, Inc., 2011.
7. Seider, W. D., J. D. Seader, J. D. and D. R. Lewin, D. R. Product and process design Principles, 2/e. New York: John Wiley and Sons, Inc., 2008
8. Computer based Numerical Analysis, M. Shanthakumar, 1st Edn., KPS Publisher, 1987.
9. Process Modeling Simulation and Control for Chemical Engineering, William. L Luyben, 2nd edn., McGraw Hill, 1990.
10. Elements of Chemical Reaction Engineering, H. Scott Fogler, 2nd edn, Prentice Hall, 2001.
11. Introduction to Chemical Engineering Thermodynamics, Smith J. M. and H. C. Vanness,5th edn, McGraw Hill, 1996.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

PROCESS CONTROL LAB

Course Code	**18CHL77**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives: Students will

1. Experimentally verify the principles and working of instruments studied in theory.
2. Carry out experiment and make observations for various parameters.
3. Study and use of various first order system and controllers.
4. Evaluate the data and compare with reported literature.

Experiments: The following experiments are to be carried out; the data are to be analysed based on the theoretical aspects, and recorded with comments.

Sl. No.	Experiments
1	Thermometer
2	Liquid Level System- Step Response
3	Non Interacting Tanks - Step Response
4	Interacting Tanks - Step Response
5	Pressure Tank
6	U – Tube Manometer
7	Single tank - Impulse Response
8	Non Interacting Tanks - Impulse Response
9	Interacting Tanks - Impulse Response
10	Level/Flow/Pressure/pH/Temperature control – P controller
11	Level/Flow/Pressure/pH/Temperature control – PI controller
12	Level/Flow/Pressure/pH/Temperature control – PD controller
13	Level/Flow/Pressure/pH/Temperature control – PID controller
14	Valve Characteristics
15	Valve Positioner
16	Valve Hysteresis
17	Mixing tank
18	Flapper Nozzle System

Course Outcomes: On successful completion of this course students will be able to

- Demonstrate knowledge and understanding of chemical process systems as well as the operating principles of common instruments, instrumentation networks, sensors and display units.
- To apply and determine time constants for various first order systems.
- Apply acquired engineering knowledge to analyze, assess and solve common process control and instrumentation problems
- Use technical literature and other information sources to treat with industrial control and instrumentation engineering problems
- Utilize appropriate control engineering and instrumentation documentation and standards
- Use control valves and obtain its inherent characteristics..

Conduct of Practical Examination:

1. Minimum of 10 experiments are to be conducted and all 10 experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

TEXT BOOKS:

1. Process System Analysis and Control, Coughner & Koppel, 2nd edn, McGraw Hill, NewDelhi,1991.

REFERENCE BOOKS:

1. **Process Modelling, Simulation & Control for Chemical Engineers,** Luyben, 2nd edn, McGraw Hill, 1990.

2. **Chemical Engineering Vol. III, III Edition,** Coulson & Richardson, Pergamon Press, 1998.
3. **Chemical Process Control-**An Introduction to Theory and Practical, George Stephanopoulos, Vol.3, Prentice Hall, New Delhi, 1998.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

PROJECT WORK PHASE-1

Course Code	**18CHP78**	CIE Marks	100
Teaching Hours/Week (L:T:P)	0:0:2		
Credits	01		

CIE procedure for Project Work Phase - 1: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.
The CIE marks awarded for project work phase -1, shall be based on the evaluation of project work phase -1 Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for the Project report shall be the same for all the batch mates.

Project work:
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or 6.

CIE procedure for Project Work Phase - 1:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.
The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the Project report shall be the same for all the batch mates.
(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.
The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

Course Outcomes: After studying this course, students will be able to:

- Apply fundamentals of science and engineering to identify, formulate and solve chemical engineering problems.
- Conduct experimental investigation, data interpretation and develop solutions for chemical engineering problems.
- Analyze and design solutions for chemical engineering problems through the use of modern engineering and IT tools.
- Assess the impact of chemical engineering solutions on the society and industry and demonstrate the need for sustainable development.
- Develop the ability to communicate effectively in verbal and written forms and prepare project reports and presentations.
- Apply the principles of management in chemical engineering and function effectively as member or leader of a team. Prepare presentation and communicate findings to audience.

B. E. CHEMICAL ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER - VII			
INTERNSHIP			
Course Code		CIE Marks	
Teaching Hours/Week (L:T:P)			
Credits			
Internship: All the students admitted to III year of BE/B.Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and shall have to complete during subsequent University examination after satisfy the internship requirements.			

VIII- SEMESTER

B. E. CHEMICAL ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER VIII			
PROCESS ENGINEERING ECONOMICS AND MANAGEMENT			
Course Code	**18CH81**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives: The students will be able to

1. To study various phases in process design & development.
2. To determine cost involved in various processes.
3. Estimation of capital cost, alternative investments and replacement analysis.
4. To study direct, indirect expenses involved and profitability evaluation methods.
5. To study various financial statements, significance of financial ratios and cash flow diagram.

Module-1

Process Design Development: Overall planning of a plant, Feasibility studies and Material & energy balance, Equipment sizing and selection, Process flow sheet, P & I diagram, Plant layout and location.

Module-2.

Cost Analysis: Factors affecting investment & production cost, Estimation of capital investment, Factors in capital investment, Estimation of working capital, cost index.
Time value of money: Types of interests, Effective and nominal interest rates, present worth and discount.

Module-3

Depreciation & Taxes: Types of Depreciation and calculation methods
Profitability: Theory of profitability and its evaluation methods.

Module-4.

Replacements: Theory of replacements, causes for replacements types of replacements
Alternatives investments: Theory of alternative investments and causes for the same

Module-5

Financial statements and Design report: Introduction to financial statements, Cash flow diagrams, balance sheet and Break-even analysis.
Design report: Introduction to design of reports. Types of reports, Organization of report and purpose of report.

Course Outcomes: On successful completion of this course students will be able to

- Discuss Planning, feasibility of chemical process, carry out material and energy balance, sizing, development of flow sheets & PI diagrams. Select plant location and lay out.
- Evaluate capital investment for chemical plant use of cost indices, discuss types of interest, present worth annuities, perpetuities.
- Discuss depreciation and calculation methods. Profitability and its evaluation.
- Explain theory of replacements and alternative investments.
- Discuss financial statements, breakeven analysis and prepare design reports.
- Manage financially the chemical plant from design stage to commissioning stage and during working

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

TEXT BOOKS:

1.T.R.Banga & S.C.Sharma Industrial Organization & Engineering Economics 22nd edn. Khanna Publishers 1999

REFERENCES BOOKS:

1 Plant design and Economics for Chemical Engineers-Peters& Timmerhaus,4th edn McGraw Hill,1991

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER VIII

PROCESS ENGINEERING ECONOMICS AND MANAGEMENT

Course Code	**18CH821**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will be able to

1. Learn formulations, tablet and capsule making.
2. Learn development, testing of cosmetics.
3. Learn manufacturing technology.
4. Learn patent intellectual property rights and regulatory affairs.

Module-1

Electrophilic Substitution Reaction: Preparation of cyclo alkane. Bayer's strain theory and orbital picture of angle stream.

Electrophilic Substitution Reaction Mechanism & Application: Dehydrogenation of alkyl halides. 1-2 elimination kinetics: E2 and E1mechanisms. Isotope effect. Dehydration of alcohols. Ease of dehydration **08 Hr**

Module-2.

Nucleophilic Addition Reaction: Mechanism. Important chemicals. Oxidation-Reduction reactions. Rheology of Fluids in Mixing and Blending.

Module-3

Preparation: Test for purity and medical uses of Chlorobutal, Dimercopral, Glycerol trinitrate.

Module-4.

Preparation: Test for purity and medical uses of Urea, ethylene diamine dihydrate, vanillin, paraldehyde.
Preparation: Test for purity and medical uses of lactic acid, citric acid, salicylic acid, saccharin sodium.

Module-5

Preparation: Test for purity and medical uses of Ethyl borate, dimethyl phthalate,

Course Outcomes: On successful completion of this course students will be able to

- Explain formulations, tablet and capsule making
- Discuss development, testing of cosmetics.
- Apply manufacturing technology.
- Use patent intellectual property rights and regulatory affairs.
- Develop manufacturing technologies and apply for various cases.
- Practice industrial safety in drug

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. **Organic Chemistry,** T.R. Morisson and R. Boyd, 6th edn, Prentice Hall of India Pvt Ltd., New Delhi, 1992.
2. **The Theory and Practice of Industrial Pharmacy,** Liberman, and Lachman, 3rd edn, Lea & Febiger, Philedelphia, 1986.
3. **Pharmaceutical Product Development,** Jain N.K, CBS Publications and Distributions, New Delhi, 2006

REFERENCES BOOKS:

1. **Organic Chemistry Fundamentals,** I. L. Finar, 2nd edn, ELBS, Pergamon Press, 1965.
2. **Good Manufacturing of Pharmaceuticals,** Sidnay H. Willing, Murray M. Tuckerman, and Williams Hitchings, 3rd edn, Marcell Dekker Inc., NY, 1982.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER VIII

APPLIED MATHEMATICS IN CHEMICAL ENGINEERING

Course Code	**18CH822**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will be able to
To impart the knowledge of mathematics for solving various mathematical equations that need to be solved in several chemical engineering courses such as heat and mass transfer, momentum transfer, reaction engineering, separation processes, thermodynamics, etc.

Module-1

Mathematical Formulation of the Physical Problems: Applications of laws of conservation of mass, energy. Statement of the problem. Modeling. Examples and problems.

Module-2.

Ordinary Differential Equations: Formulations of ordinary differential equations involving chemical engineering problems. Solutions- Equations of first order and first degree. Equations of first order and second degree. Bernoulli equation. Euler equation. Simultaneous linear differential equations.

Module-3

Partial Differential Equations: Formulations of partial differential equations involving chemical engineering problems. Solutions. Fourier series.

Module-4.

Numerical Methods: Solutions of ordinary differential equations for chemical engineering problems. Solutions of partial differential equations for chemical engineering problems.

Module-5

Difference operator, linear difference equations, analysis of stage-wise processes. Laplace transforms and their applications to chemical engineering.

Course Outcomes: On successful completion of this course students will be able to

- Understand the basic algorithms for solution of and be able to solve linear and nonlinear equations.
- Be proficient in manipulation of logarithmic, exponential, and other non-linear functions in order to linearize and to regress non-linear expressions.
- Understand the basic algorithms for solution.
- Solve numerical integration and ordinary differential equations.
- Familiar with a variety of numerical methods for solving partial differential equations.
- Apply the techniques learnt in this subject to the solution of comprehensive design problems in chemical engineering.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

TEXT BOOKS:

1. **Applied Mathematics in Chemical Engineering,** H.S. Mickley, T.K. Sherwood and C.E.Reed, 3rd edn, Tata McGraw Hill, 1999.
2. **Mathematical Methods in Chemical Engineering,** V.G. Jenson & G.V. Jeffreys, Academic Press, London, 1977.
3. **Mathematical Methods in Chemical Engineering,** S. Pushpavanam, Eastern Economy Edition, 2004..

REFERENCES BOOKS:

1. **Applications of Mathematical Modeling to Process Development and Design,** L.M. Rose Applied Science Publishers Ltd., London, 1998.

B. E. CHEMICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER VIII

APPLIED MATHEMATICS IN CHEMICAL ENGINEERING

Course Code	**18CH823**	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: The students will be able to

1. To introduce the students about basic laws of momentum, heat and mass transfer.
2. To determine the heat transfer rate and temperature distribution for different heat transfer situations.
3. To determine the mass transfer rate and concentration distribution for different mass transfer situations.
4. To study the different analogies between mass, momentum and mass transfer

Module-1

Introduction:
Momentum Energy and Mass Transport Newton's law of viscosity (NLV). Newtonian and Non-Newtonian fluids. Fourier's law of heat conduction (FLHC), Fick's law of diffusion (FLD), Effect of temperature and pressure on transport properties of fluids.

Module-2.

Velocity Distribution in Laminar Flow:
Different Flow situations, Steady state Shell momentum balances, Boundary conditions applicable to momentum transport problems, Flow over a flat plate, Flow through a circular tube, Flow through Annulus.
Steady State Shell Energy Balances: General Boundary conditions applicable to energy transport problems of chemical engineering. Heat conduction through compound walls. Overall heat transfer coefficient.

Module-3

Temperature Distribution in Solids and in Laminar Flow:
Different situations of heat transfer: Heat conduction with internal generation by electrical and nuclear energy sources, Heat conduction in a cooling fin: Forced and free convection heat transfer.
Concentration Distributions in Laminar Flow: Steady state Shell mass balances. General Boundary conditions applicable to mass transport problems of chemical engineering. Equimolar counter diffusion. Numerical problems.

Module-4.

Concentration Distributions in Laminar Flow:
Diffusion through stagnant gas and liquid films, Diffusion with homogeneous reaction, Diffusion with heterogeneous reaction Diffusion into falling film – Forced convection mass transfer.

Module-5

Analogies between Momentum, Heat and Mass Transport:
Reynold's, Prandtl's and Chilton & Colburn analogies.
Equations of Change: Equation of continuity, Equation of motion; Navier – Stokes equation**.**

Course Outcomes: On successful completion of this course students will be able to

- Explain types of fluids comprehend effect of temperature and pressure on transport properties of fluids and apply transport laws to solve numerical problems.
- To understand basic laws of momentum, heat and mass transfer.
- Derive overall heat transfer coefficient, Temperature distribution with and without energy sources
- Determine velocity profile and shear stress profiles in different flow situations
- Derive molar flux for stagnant gas, liquid films, homogeneous and heterogeneous reactions and applications to falling film forced convection mass transfer.
- Determine HT & MT coefficient using various analogies.

QUESTION PAPER PATTERN:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module

TEXT BOOKS:

1. **Transport Phenomena,** Bird, Stewart and Lightfoot, Academic Press, 1994.

REFERENCES BOOKS:

1. **Momentum Heat and Mass Transport,** Welty, Wikes and Watson, 4th edn., John Wiley, 2000.
2. **Principles of Unit Operations in Chemical engineering,** Foust *et al.,* 2nd edn, John Wiley, 1990.
3. **Transport Phenomena – A Unified Approach,** Robert S. BrodKey and Henry C. Hershley, Vol.2, Brodkey Publishing, 2003

B. E. CHEMICAL ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER VIII			
PROJECT WORK PHASE-2			
Course Code	**18CHP83**	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	60
Credits	08	Exam Hours	03

Project Work

CIE procedure for Project Work Phase - 2:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

SEE for Project Work Phase - 2:

(i) Single discipline: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.

(ii) Interdisciplinary: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belongs to.

Course Outcomes: On successful completion of this course students will be able to

- Apply fundamentals of science and engineering to identify, formulate and solve chemical engineering problems.
- Conduct experimental investigation, data interpretation and develop solutions for chemical engineering problems.
- Analyze and design solutions for chemical engineering problems through the use of modern engineering and IT tools.
- Assess the impact of chemical engineering solutions on the society and industry and demonstrate the need for sustainable development.
- Develop the ability to communicate effectively in verbal and written forms and prepare project reports and presentations.
- Apply the principles of management in chemical engineering and function effectively as member or leader of a team.

B. E. CHEMICAL ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER VIII			
TECHNICAL SEMINAR			
Course Code	**18CHS84**	CIE Marks	100
Teaching Hours/Week (L:T:P)	0:0:2		
Credits	01	Exam Hours:	03
Course Learning Objectives: Students will Develop skills in searching technical literature, analyzing and evaluating it to compare the various approaches and prepare a written report and also presenting it orally.			
The student has to prepare, submit a seminar report and make a presentation on Seminar topic allotted. The seminar shall be evaluated as internal assessment by a committee constituted by the HOD.			
Course Outcomes: On successful completion of this course students will be able to			
1.	Develop presentation and communication skills both in verbal and written forms.		
2.	Review information about recent developments in Chemical engineering.		
3.	Compare alternate technologies and propose solutions		
4.	Identify new technologies which are feasible and beneficial to society.		
5.	Realise potential technologies to identified problems in Chemical engineering.		
6.	Gain in-depth knowledge in Chemical engineering topics and inculcate a sense of lifelong learning.		

B. E. CHEMICAL ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER VIII			
INTERNSHIP			
Course Code	**18CHI85**	CIE Marks	40
Teaching Hours/Week (L:T:P)		SEE Marks	60
Credits	03	Exam Hours:	03
Internship: Those, who have not pursued /completed the internship shall be declared as fail and have to complete during subsequent University examination after satisfying the internship requirements.			
1.	Identify areas for observational training.		
2.	Describe and summarise different unit operations and unit processes involved.		
3.	Compare theoretical knowledge with industrial practices.		
4.	Integrate various unit operations and draw process flow diagrams.		
5.	Present, summarise collected information in the form of training report.		
6.	Develop presentation and communication skills both in verbal and written forms.		