## Chemical Engineering Curriculum

### Second Year  (Third and Fourth Semesters)

<table>
<thead>
<tr>
<th>Sub. Code</th>
<th>Name of Subject</th>
<th>Sub Code</th>
<th>Name of Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT 201</td>
<td>Engineering Mathematics III</td>
<td>MAT 202</td>
<td>Engineering Mathematics IV</td>
</tr>
<tr>
<td>CHE 201</td>
<td>Chemistry II</td>
<td>CHE 202</td>
<td>Mass Transfer I</td>
</tr>
<tr>
<td>CHE 201</td>
<td>Introduction to Chemical Engineering</td>
<td>CHE 202</td>
<td>Chemical Engg. Thermodynamics II</td>
</tr>
<tr>
<td>CHE 203</td>
<td>Momentum Transfer</td>
<td>CHE 204</td>
<td>Heat Transfer Operations</td>
</tr>
<tr>
<td>CHE 205</td>
<td>Mechanical Operations</td>
<td>CHE 206</td>
<td>Object Oriented Computing</td>
</tr>
<tr>
<td>CHE 207</td>
<td>Chemical Engg. Thermodynamics I</td>
<td>CHE 208</td>
<td></td>
</tr>
<tr>
<td>CHE 209</td>
<td>Chem. Engg. Drawing</td>
<td>CHE 210</td>
<td>MT and MO Lab</td>
</tr>
<tr>
<td>CHM 203</td>
<td>Chemistry II Lab</td>
<td>CHE 212</td>
<td>Object Oriented Computing Lab</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHM 204</td>
<td>Chemistry III Lab</td>
</tr>
</tbody>
</table>

### Third Year (Fifth and Sixth Semesters)

<table>
<thead>
<tr>
<th>Sub. Code</th>
<th>Name of Subject</th>
<th>Sub Code</th>
<th>Name of Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM 301</td>
<td>Chemistry IV</td>
<td>CHE 302</td>
<td>Process Design and Drawing of Chemical Equipment</td>
</tr>
<tr>
<td>CHE 301</td>
<td>Simultaneous Heat and Mass Transfer</td>
<td>CHE 304</td>
<td>Pollution Control and safety</td>
</tr>
<tr>
<td>CHE 303</td>
<td>Energy Engineering</td>
<td>CHE 306</td>
<td>Chem. Reaction Engg. II</td>
</tr>
<tr>
<td>CHE 305</td>
<td>Chem. Reaction Engg. I</td>
<td>CHE 308</td>
<td>Transport Phenomena</td>
</tr>
<tr>
<td>CHE 307</td>
<td>Mass Transfer II</td>
<td>CHE 310</td>
<td>Process Dynamics and Control</td>
</tr>
<tr>
<td>CHE 309</td>
<td>Process Plant Materials</td>
<td>CHE 312 E</td>
<td>Elective I</td>
</tr>
<tr>
<td>CHE 311</td>
<td>Heat Transfer Lab</td>
<td>CHE 314</td>
<td>Mass Transfer Lab</td>
</tr>
<tr>
<td>CHM 303</td>
<td>Chemistry IV Lab</td>
<td>CHE 316</td>
<td>Seminar I</td>
</tr>
</tbody>
</table>

### Fourth Year (Seventh and Eighth Semesters)

<table>
<thead>
<tr>
<th>Sub. Code</th>
<th>Name of Subject</th>
<th>Sub Code</th>
<th>Name of Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>HUM 401</td>
<td>Essentials of Management</td>
<td>CHE 402</td>
<td>Industrial Training</td>
</tr>
<tr>
<td>CHE 401</td>
<td>Process Engineering Economics</td>
<td>CHE 404</td>
<td>Seminar II</td>
</tr>
<tr>
<td>CHE 403</td>
<td>Process Modeling and Simulation</td>
<td>CHE 499</td>
<td>Project Work</td>
</tr>
<tr>
<td>CHE 405</td>
<td>Chemical Process Industries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHE 407 E</td>
<td>Elective II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHE 409 E</td>
<td>Elective III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHE 411</td>
<td>Process Modeling and Simulation Lab</td>
<td></td>
<td></td>
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<tr>
<td>CHE 413</td>
<td>Reaction Engg. and Process Dynamics Lab</td>
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</tbody>
</table>
MAT-201 Engineering Mathematics III [ 3 1 0 4]

Fourier Series – Periodic Functions – Euler’s formulae – Fourier series of odd and even functions with arbitrary period – Half range expansions – Fourier sine and cosine transforms and Fourier Integrals

Partial differential equations - Basic concepts – Solutions of equations involving derivatives with respect to one variable only – Solutions by indicated transformations and separation of variables

Derivation of one dimensional wave equation (vibrating string) and its solution by using the method of separation of variables – Simple problems – D’Alembert’s solution of wave equation – Derivation of one dimensional heat equation using Gauss divergence theorem and solution of one dimensional heat equation – Solution by separation of variables

Interpolation and applications – Finite differences – Netwon-Gregory and Lagrange's interpolation formulae – Inverse interpolation – Numerical differentiation

Numerical Integration – Trapezoidal and Simpson's 1/3 and 3/8th rule

Bessel and Legendre's equations – Solution - Orthogonal properties – Data analysis – Curve fitting and regression analysis

Recommended Books:

CHM 201 Chemistry II ( 4 0 0 4)

Primary, Secondary and Tertiary amines – Heterocyclic bases
Grignard Reagents: Preparation and synthetic applications
Active Methylene Group Compounds: Acetoacetic ester – Malonic ester and Diazomethane – Preparation and synthetic applications
Carbohydrates: Classification – Optical activity – Polarimeter – Determination of specific rotation
Monosaccharides: General properties – Mutual conversions (Aldose to ketose and vice versa, Aldo-pentose to Aldo-hexose and vice versa) – Structure of Glucose and Fructose
Disaccharides: Sucrose, Lactose and Maltose – Source – Properties and structure
Polysaccharides: Starch and Cellulose – Source, Properties and structure
Amino acids: Classification – Essential amino acids – Synthesis of amino acids – General physical and chemical properties of amino acids
Peptides and poly-peptides: Classification – Importance in the body system – Methods of synthesis
Proteins: Classification – General Properties – Color tests – Structure of proteins
Enzymes: Co-enzymes – Enzymatic reactions – Specificity of enzymatic reactions – Applications of enzymes
Aromatics: Structure of benzene and theories of aromaticity – Electrophilic substitution reactions of benzene – Effect of substituents in electrophilic substitution
Heterocyclic compounds: Classification – Aromaticity and Basicity of heterocyclic compounds – Preparation and properties of Furans – Thiophene – Pyrrole – Pyridine – Indole – Quinone
Dyes: Theories of dyes – Valence bond and M.O approach to color
Bathochromic and Hypsochromic effects – Classification of dyes according to applications and structures – Azodyes – Methyl orange – Methyl red – Cango red – Triphenyl methane dyes – Melachite green, Rosaniline, Crystal violet – Indigotin – Anthraquinane dyes – Fluorascen brightening agents

Recommended Books:
I.L. Finar, Organic Chemistry, Vol I
M.K.Jain, Modern Organic Chemistry
Morrison and Boyd, Organic Chemistry

CHM 203 Chemistry II Lab ( 0 0 3 1)
1. Preparation of m-Dintrobenzene from Nitrobenzene by nitration
2. Preparation of Acetanilide from aniline by acetylation
3. Preparation of p-Bromo acetonilide from acetonilide by bromination
4. Preparation of Benzoic acid from benzaldehyde by oxidation
5. Preparation of Salicylic acid from methyl salicylate by hydrolysis
6. Determination of percentage purity of Phenol/Aniline by Winkler's method
7. Determination of the amount of Acetone/ETOH by Idoform method
8. Determination of percentage purity of Acetic acid by titration method
9. Determination of the amount of Acetamide by alkali hydrolysis method
10. Determination of (i) Acid value and (ii) Iodine value of the given sample of oil/fat
11. Determination of the saponification value of the given sample of oil/fat

**CHE 201 Introduction to Chemical Engineering**  
(3 1 0 4)


**Recommended Books:**
6. Chemical Engineering Education Development Centre, IIT Madras, Process Calculations for Chemical Engineers, 1975
8. Williams and Johnson, Stoichiometry for Chemical Engineers, McGraw-Hill

**CHE 203 Momentum Transfer**  
(3 1 0 4)


**Recommended Books:**
Coulson and Richardson, Chemical Engineering – Vol 1, Pargamon and ELBS, 3rd Ed., 1977
Foust et al, Principles of Unit Operations, John Wiley and Sons, NY, 2nd Ed., 1980
Badger and Banchero, Introduction to Chemical Engineering, McGraw-Hill, NY
CHE 205 Mechanical Operations  (3 1 0 4)

Recommended Books:
Foust et al, Principles of Unit Operations, John Wiley and Sons, NY, 2nd Ed., 1980
Badger and Banchero, Introduction to Chemical Engineering, McGraw-Hill, NY
Coulson and Richardson, Chemical Engineering – Vol II, Pergamon and ELBS, 3rd Ed., 1970

CHE 207 - Chemical Engineering Thermodynamics - I  (3 1 0 4)

Recommended Books:

CHE 209 Chemical Engineering Drawing  (0 0 3 1)
Assembly drawing of some of the following:
Valves: Globe valve, Ball valve, Non-rising stem gate valve, Three-way stop valve, Needle valve, Gate valve, Diaphragm valve
Pumps: Centrifugal, Rotary, Vane and Gear pumps
Steam traps: Bucket type, Inverted bucket type and Thermodynamic steam traps
Joints: Cotter and Pin joint, Cotter joint with sleeve, Socker and Spigot cotter joint, Strap joint with Gib and Cotter Pipe joints, Flanged pipe joint, Hydraulic pipe joint, Gland and Stuffing box, Expansion joint, Union joint

Recommended Books:
N.D.Bhat, Machine Drawing
Gopal Krishna, Machine Drawing

MAT 202 Engineering Mathematics IV  [3 0 0 3]
Solution of system of linear equations, Gauss Jacobi, Gauss-Seidel and Relaxation methods. Solution of tridiagonal systems
Eigen values and Eigen vectors of matrices and elementary properties computation of largest Eigen value by the power method
Introduction to probability, finite sample spaces, conditional probability and independence, Baye's theorem, one-dimensional random variable, mean, variance, Chebyschev 's inequality
Two and higher dimensional random variables, covariance, correlation coefficient, regression, least squares principles of curve fitting
Distributions: Binomial, Poisson, uniform, normal, gamma Chi-square and exponential, simple problems
Finite element method, Introduction, Simple applications
**Recommended Books:**


**CHM 202 Chemistry II (3 0 0 3)**


**Recommended Books:**

B.R. Puri and L.R. Sharma, Principles of Physical Chemistry

Alkais, Physical Chemistry

Skogg, West and Holler, Fundamentals of Analytical Chemistry

Vogel’s textbook of Quantitative Chemical Analysis, 5th Ed.

**CHE 202 Mass Transfer I (3 1 0 4)**

Introduction to mass transfer operations – Classification with examples gas/gas, gas/liquid, gas/solid, liquid/liquid, liquid/solid solid/solid operations, Steady and unsteady state operations – Stage wise and continuous contact operations

Diffusion through polymers, crystalline and porous solids – Eddy diffusion – Concept of mass transfer coefficient – Relations between different mass transfer coefficients – Mass transfer coefficients in Laminar and Turbulent flow

Theories of mass transfer – Film, surface renewal, penetration combination etc. – Analogies – Interphase mass transfer – Concept of equilibrium – Two resistance concept – Local and overall mass transfer coefficients – Concept of equilibrium curve and Operating line – Material balance approach for cocurrent and countercurrent processes

Absorption and desorption – Equipment for gas-liquid operations – Principles of operation and critical parameters – Two component and multicomponent systems – Ideal and non-ideal solutions – Choice of solvent – Calculations and design of absorption equipment and continuous contact for stage by both coefficient and transfer unit methods – Concept of reflux – Reboiled absorbers – Absorption with chemical reaction


**Recommended Books:**

Foust et al, Principles of Unit Operations, John Wiley and Sons, NY, 2nd Ed., 1980
Badger and Banchero, Introduction to Chemical Engineering, McGraw-Hill, NY
Coulson and Richardson, Chemical Engineering – Vol II, Pergamon and ELBS, 3rd Ed., 1970
Blackables, D.N. and Nedderman, R.M., A Handbook of Unit Operations
Bennet and Myers, Momentum, Heat and Mass Transfer

**CHE 204 Chemical Engineering Thermodynamics - II (3 1 0 4)**


**Recommended Books:**


**CHE 206 Heat Transfer Operations (3 1 0 4)**

Modes of heat transfer – Steady state conduction – Development of equations for conduction through plane and curved surfaces – Compound resistances – Critical thickness of insulation – Heat transfer with internal heat generation – Introduction to transient heat conduction

**Recommended Books:**

Foust et al, Principles of Unit Operations, John Wiley and Sons, NY, 2nd Ed., 1980
Badger and Banchero, Introduction to Chemical Engineering, McGraw-Hill, NY
Coulson and Richardson, Chemical Engineering – Vol I, Pergamon and ELBS, 3rd Ed., 1970

**CHE 208 Object Oriented Computing (3 1 0 4)**
Object oriented programming: Basic concept – Benefits of OOP and C++
Classes and objects: Specifying class – Defining member function and data members – Inline function – Nesting and private member function – Static data and member function – Array of objects – Friendly function
Operator overloading and its rules
Inheritance – Introduction and types – Polymorphism
Numerical Techniques – Approximation and errors.
Interpolation: Lagrange’s and Newton’s formula
Curve fitting: Linear and polynomial – Exponential – Logarithmic
Solution of system of linear algebraic equation: Gauss elimination – Gauss-Jordan – Gauss-Siedal – Jacobi’s iterative methods
Numerical Integration: Trapezoidal – Simpson’s rule
Solution of ordinary differential equations: Euler’s – Modified Euler’s method – Runge-Kutta fourth order method.
Higher order differential equations: Runge – Kutta fourth order method.
Solving of chemical engineering problems using the above techniques.

**Recommended Books:**
H.M.Deitel and P.J.Deitel, C++ - How to Program, 3rd Ed., Pearson Education, Asia

**CHE 210 Momentum Transfer and Mechanical Operations Lab (0 0 3 1)**
Experiments based on Momentum Transfer and Mechanical operations coursework

**CHE 212 Object Oriented Computing Lab (0 0 3 1)**
Ten to twelve experiments based on chemical engineering problems using C++
(MATLAB software wherever possible)

**CHM 204 Chemistry III Lab (0 0 3 1)**
1. Titration of a given mixture of weak and strong acid against a strong base – conductometric method
2. Precipitation titration between lithium sulphate and barium chloride by conductometric method
3. Redox titration of Mohr’s salt against K2Cr2O7 – Potentiometric method
4. Colorimetric determination of Copper/iron
5. Percentage composition of binary mixture using viscometer
6. Bimolecular reaction between K2SO3 and KI
7. Determination of velocity constant for the saponification of ethyl acetate
8. Determination of surface tension of liquid using stalingrometer
9. Kinetics of inversion of sucrose using polarimeter
10. Determination of percentage composition of binary mixture using Abbe’s refractometer

**CHE 301 Analytical Methods and Instrumentation (4 0 0 4)**
1. Spectroscopic methods of Analysis:
   Introduction to spectroscopy
   Microwave spectroscopy: Rotation of molecules, rotational spectra-rigid diatomic
   Molecules, nonrigid diatomic molecules, Techniques and Instrumentation, applications
   Infrared spectroscopy: Vibrating diatomic molecule – simple harmonic oscillator, enharmonic oscillator. Diatomic vibrating rotator. Vibrations of polyatomic molecules. Techniques and Instrumentation, double beam IR Spectrophotometer, FTIR, and applications
   Raman spectroscopy: Quantum theory, molecular polarizability, characteristics of Raman lines, Techniques and Instrumentation, applications
   Ultraviolet spectroscopy: Types of transitions in organic molecules, instrumentation and applications
Visible spectroscopy: Beer – Lambert’s law and its deviations, instrumentation, double beam Spectrophotometer, applications
X-ray spectroscopy: Continuous and line spectra, production of x-rays, principle instrumentation and applications of x-ray absorption method, x-ray emission method, x-ray fluorescence method, x-ray diffraction method
NMR spectroscopy: Classical and Quantum theories. Chemical shift, Spin – spin splitting instrumentation, applications of proton NMR
2. Thermal methods of Analysis:
Thermogravimetry (TG): Introduction, information from TG curve, factors affecting TG curves, instrumentation, applications
Differential Thermal Analysis (DTA): introduction, factors affecting DTA curve, instrumentation, applications
Derivative Thermogravimetry (DTG)
Differential Scanning Calorimetry (DSC)
Solvent extraction: Principle, efficiency of extraction, extraction techniques, applications
3. Chromatography:
General description, classification, migration rates of solutes, Band broadening and column efficiency, column resolution, applications
Paper chromatography: principle, types, applications
Thin layer chromatography: scope, experimental techniques, advantages, applications
Liquid chromatography: HPCL, scope, column efficiency, instrumentation, applications, column chromatography, adsorption chromatography, Ion exchange chromatography, size exclusion chromatography (or Gel chromatography)
Gas chromatography: principle of gas-liquid chromatography, instrumentation, applications, gas-solid chromatography. Electro chromatography

Recommended Books:
3. Fundamentals of Analytical Chemistry, Skoog, West and Holler
4. Principles of Instrumental Analysis, Skoog, Holler and Nieman
6. Instrumental Methods of Chemical Analysis, Ewing

CHE 301 Simultaneous Heat and Mass Transfer

Humidification and dehumidification and water cooling operations – Psychrometric chart – Development and applications – Equipment – Design calculations – Cooling towers – design of cooling towers
Drying – Theory and mechanism of drying operation – Rate curves – Batch and continuous drying – Industrial dryers – Design criteria – Design of rotary dryers – Special methods of drying such as freeze drying and Infra-red drying

Recommended Books:
Coulson and Richardson, Chemical Engineering – Vol 1, Pargamon and ELBS, 3rd Ed., 1977
Foust et al, Principles of Unit Operations, John Wiley and Sons, NY, 2nd Ed., 1980
Badger and Banchero, Introduction to Chemical Engineering, McGraw-Hill, NY

CHE 303 Energy Engineering

Energy scenario in India – Renewable sources of energy – Availability – Generation and utilization of solar, wind, geothermal and tidal energies
Solid fuels: Testing methods – Proximate and ultimate analysis – Calorific value – Weathering and grindability index of coal – Theories of origin and stages of formation – Coal washing techniques – Carbonisation – Coke ovens – Gasification – Briquetted and pulverized fuels
Gaseous fuels: Fuel gas and flue gas analysis – Calorific value – Production and utilization of Natural gas, producer gas, water gas and carbonated water gas
Combustion: Terminology – Calculation of air requirement – Grates, burners and stokers
Furnaces: Classification – Construction – Thermal efficiency – Fuel economy – Furnace aerodynamics – Types of furnaces used in process industries – Chimneys and draughts
Nuclear energy: Nuclear fuels – Nuclear reactors – Classification – Various types of nuclear reactors and principles of working
Energy audit: Energy conservation and auditing – Guidelines and procedures for energy audit – Domestic, industrial and transportation sectors

Recommended Books:
Gilchrist, J.D., Fuels, Furnaces and Refractories, Pergamon Press, 1977

CHE 305 Chemical Reaction Engineering I

Kinetics of homogeneous chemical reactions – Classification of chemical reactions – Rate expressions – Analysis of simple rate equations – Interpretation of kinetic data for single and complex reaction under constant volume and variable volume conditions – Differential , integral, half life and total pressure method – Temperature dependence of rate – Arrhenius – Collision and activated complex theories.
Non elementary reaction kinetics – Fundamentals – Active intermediates – Pseudo, steady state hypothesis – Searching for a mechanism – Enzymatic reaction fundamentals – Michaelis and Menten kinetics – Batch reactor calculations – Inhibition of enzyme reactions – Multiple enzyme and substrate systems.
Isothermal reactor design – Design structure for isothermal reactors such as batch, semi-batch, CSTRs and PFRs for single and complex reactions – Problems on optimization – Startup of CSTRs
Multiple reaction system – Series and parallel reactions in flow reactors – Product distribution – Yield and selectivity – Maximizing the desired product in parallel reactions – Different reactors and schemes for minimizing the unwanted product – Maximizing the desired product in series reactions – Algorithms for solution to complex reactions

Recommended Books:

CHE 307 Mass Transfer II

Continuous rectification – Binary systems – Fractionation – Equipment – Ponchan-Savarit method- Feed tray location – Minimum reflux ratio – Optimum reflux ratio – Total reflux
McCabe –Thiele method – Calculation of ideal stages for situations such as total condenser, partial condenser – Concept of q-line – Location of feed tray – Minimum reflux ratio – Calculations for total reflux – Rectification of Azeotropic mixtures – High purity products – Kremser’s equation – Packed bed distillation – Introduction to Transfer unit concept – Introduction to multicomponent distillation
Liquid extraction – Applications – Equilibria – Ternary systems – triangular and other coordinates – Choice of solvent – Single stage and multistage cross current and counter current extraction with reflux – Extraction equipment – Design criteria Leaching – Applications of leaching operation – Leaching equipment – Equilibria – Batch and multi stage cross current and counter current leaching operations

Recommended Books:
Foust et al, Principles of Unit Operations, John Wiley and Sons, NY, 2nd Ed., 1980
Badger and Banchero, Introduction to Chemical Engineering, McGraw-Hill, NY
Coulson and Richardson, Chemical Engineering –Vol II, Pargamon and ELBS, 3rd Ed., 1970
Norman, Absorption, Distillation and Cooling Towers
Robinson and Gilland, Distillation

CHE 309 Process Plant Materials

Selection of process materials – Economic considerations – Fabrication, mechanical properties and strength of materials – Effect of temperature on mechanical properties – Testing and inspection of materials
Properties and uses of ferrous metals – Cast iron – plain carbon steels – Classification of steel – alloy carbon steels – alloy steels – Thermal and electrical insulating materials
Non-ferrous metals and alloys – Generalised properties and field of application of nonmetals – Wood, Stoneware – Glass – Fused silica – Carbon – Natural and synthetic rubber
Plastics as material of construction – PVC, Polyfibres, PTFE, Glass, FRP – Protective coating and cladding – Glass, rubber and metal lining of process vessels – Ceramic protective materials

**Recommended Books:**

**CHE 311 Heat Transfer Operations Lab**
Experiments based on Heat Transfer operations

**CHM 303 Chemistry IV lab**
Experiments:
1. Gravimetric estimation of silica and Fe in Haematite ore
2. Gravimetric estimation of Cu in brass
3. Gravimetric estimation of Ni in stainless steel
4. Gravimetric estimation of Zn in ZnO pigment
5. Gravimetric estimation of Pb in white lead pigment
6. Gravimetric estimation of total lead in red lead pigment
7. Gravimetric estimation of BaSO₄ in lithopone
8. Gravimetric estimation of Phosphorous in phosphate fertilizer
9. Gravimetric estimation of Silica and R₂O₃ in cement
10. Qualitative/quantitative analysis using UV-visible spectrophotometer
11. Qualitative/quantitative analysis using IR spectrophotometer
12. Separation and estimation of anions/cations by chromatographic method

**Recommended Books:**
Vogel Text book of Quantitative Chemical Analysis 5th Ed.

**CHE 302 Process Equipment Design and Drawing**
Introduction to process and mechanical design – Design preliminaries.
Parts of chemical process equipments - Cylindrical shell, covers, flanges, supports – Welded and bolted-flange connections between parts – Process equipment internals – Material specifications - Equipment fabrication and testing.
Hydrodynamic and mass transfer aspects.
Detailed process, mechanical design and drawing of the following chemical process equipments are to be carried out:
Heat exchangers – Double Pipe, Shell and Tube Heat Exchangers
Evaporators- Standard Vertical Tube Evaporators
Reactors- Tank Reactor, Tubular Reactor
Tall towers – Distillation columns – Absorption towers – Packed, Sieve-Tray and Bubble-Cap columns.

**Recommended Books:**
2. Unfired Pressure Vessel code - BIS 2825.
3. Shell and Tube Heat Exchanger Code- BIS 4503

CHE 304 Pollution Control and Safety

Man and environment – Nutrient and hydrologic cycles – Types of pollution – Legislation to environmental pollution – Aspects of pollution control
Evaluation and characterization of wastewater – Treatment methods – Advanced wastewater treatment – Sludge treatment and disposal – Solid waste management
Noise pollution and control
Ambient and stack gas sampling – analysis of air pollutants – Principles of air pollution – Plume behavior – Meteorological factors affecting air pollution – Equipment for control and abatement of air pollution
Pollution control of effluent in chemical industries such as Fertiliser, Petroleum refinery, Pulp and paper and Tannery industries

Recommended Books:

CHE 306 Chemical Reaction Engineering II

Non isothermal homogeneous reactions – Temperature effects – Principles of stability – Design procedures for adiabatic and non-isothermal conditions for batch and flow reactors – Optimum temperature progression – Multiple reactions and effect of temperature on product distribution
Design and analysis of biological reactors – Cell growth – Batch bioreactor – Chemostat system – Oxygen limited fermentation – Scaleup.


Recommended Books:

CHE 308 Transport Phenomena

**Recommended Books:**
C.J. Geankoplis, Transport Process and Unit Operations.

**CHE 310 Process Dynamics and Control (3 1 0 4)**


**Recommended Books:**
3) Carlos A. Smith and Armando B. Corripio, Principles and Practice of Automatic Process Control, John Wiley
4) Jairath, A.K., Control Systems, CBS Publishers

**CHE 312 Elective I (3 0 0 3)**

**ECE 308.4 Neural Networks and Fuzzy Logic**

Neural Networks: Fundamental concepts and models of Artificial Neural Systems – Biological neurons, Mc-culloch pits model, Feed forward and Fb network, Supervised and unsupervised learning. N/N learning rules.  
Classifiers: Classification model, features and decision regions, discriminant functions - Linear single layer classifiers, Multi layer classifiers – Linearly non separable pattern classification – error back propagation training – learning factors – applications of EBPTA Single layer feedback networks – Basic concepts of dynamical systems – Discrete time and gradient type Hopfield networks – Applications in optimization problems such as A/D networks, Travelling salesman tour length etc.

Fundamental concepts and models of artificial neural systems – Biological neurons – Mc-culloch pits model – Feed forward Fuzzy Logic: Introduction-Block diagram representation of different types of fuzzy systems, concept of membership functions, generation of membership functions with examples Fuzzy mathematics- Brief comparison of classical sets and fuzzy sets, Basic operation on fuzzy sets, fuzzy complement, fuzzy union(s-norms), fuzzy intersection (t-norms), averaging operators Fuzzy relations and extension principle -Fuzzy relations, Cartesian product, composition of fuzzy relations projection and cylindrical extension, extension principle.  
Fuzzifiers and defuzzifiers: Fuzzifiers -exponential, triangular and trapezoidal fuzzifiers. Defuzzifiers- Centre of gravity, center average, Maximum defuzzifiers Design of fuzzy systems -Design of Fuzzy rule based systems to develop nonlinear functions, inverted pendulum controller, modeling of serial transmission of a digital signal over a channel etc.

**Recommended Books:**
1. Neural Networks for Pattern Recognition , Bishop, Oxford University Press
2. Introduction to Artificial Systems by Jacek M. Zurada, Jaico publications

**CHE 312.1 Introduction to Cryogenic Engineering**


**Recommended Books:**
Russel B. Scott, Cryogenic Engineering, D.Van Nostrand Co., Inc.,

**CHE 312.2 Project Engineering**

Preliminary data on projects – Process Engineering – Project evaluation and development – Block flow diagram – Process flow diagram – Process and instrumentation diagram – Pilot plants – Engineering design and drafting – Plant location and layout – Piping design – Plant utilities – Insulation – Instrumentation – Safety in plant design – Project engineering management – Project scheduling – PERT and CPM techniques – Gantt chart – Optimum project design with suitable examples such as heat exchangers, pumps, vessels and evaporators

**Recommended Books:**
1. Howard F. Rase and M.H. Barrow, Project Engineering of Process Plants, John Wiley
6. V.W. Uhl and A.W. Hawkins; Technical Economics for Chemical Engineers; AIChe; 1971
7. J. Modes and Philips; Project Engineering with CPM & PERT, Renhold Publishing Co.

**CHE 312.3 Introduction to Biochemical Engineering**

Cell growth – Batch growth – Determining cell mass concentration – Growth patterns and kinetics in batch culture – Factors affecting growth kinetics
Quantification of growth kinetics – Unstructured non-segregated models to predict specific growth rate – Models with growth inhibitors – Logistic equation – Growth models for filamentous organisms – Models for transient behaviour – Models with time delay – Chemically structured models
Recommended Books:

BIO 312 E FOOD PROCESSING TECHNOLOGY [4 0 0 4]

INTRODUCTION TO FOOD PROCESSING
Biotechnology in relation to the food industry; nutritive value of food; types of microorganisms associated with food - their sources, types and behavior

FOOD SPOILAGE & PRESERVATION

Food Preservation : Rheology of Food Production, Food Preservation Using Irradiation, Characteristics of Radiations of Interest in Food Preservation., Principles Underlying the Destruction of Microorganisms by Irradiation, Processing of Foods for Irradiation, Application of Radiation. Legal Status of Food Irradiation, Effect of Irradiation of Food constituents; Food Preservation with Low Temperatures, Food Preservation with High Temperatures, Preservation of Foods by Drying.

BIOTECHNOLOGY IN FOOD INDUSTRY
Characteristics of Food Industry. Food manufacturing & processing, common additives, bioorganic additives, spoilage, prevention of spoilage, storage and preservation through biotechnological means, food packaging. Factors influencing food product development, marketing, and promotional strategies.

Food Industry: Basal metabolic rate, influences on nutritional status, dietary strategies for individuals, diet for specific groups, Market Place, ecologically sustainable production, risks and benefits of biotechnology to food industry.

APPLIED UNIT OPERATIONS IN FOOD PROCESSING
Unit operations applied to the food processing industry – Fluid flow applications, Heat transfer applications, Centrifugation, Filtration, Extraction, Membrane separations, Evaporation, Distillation, Absorption, Size reduction, Mixing, Drying, and Crystallization

Textbook:
1. Food biotechnology, A Roger, B Gordon and T John

Reference Books:
2. Biotechnology – Challenges for the flavor and food industry, W Lindsay, Elsevier applied science
3. Unit operations in food processing Earle, R. L. Pergamon Press

CHE 314 Mass Transfer Operations Lab (0 0 3 1)
Experiments based on Mass Transfer I and II course work

CHE 316 Seminar I (0 0 3 1)
This first course in seminar at level I is designed mainly for the student to develop oral communication skills. Each student shall give an oral presentation of the topic assigned to him. Simple topics of descriptive nature related to Process Instrumentation for which information is readily available will be allocated for each student. The student will make an oral presentation of the topic through overhead projector/slides for the presentation and submit the prepared manuscript after the presentation.

HS 401/402 Essentials of Management [3 0 0 3]
Definition of Management, its nature and scope, the functions of managers.
Planning: Types of plans, steps in planning, process of MBO, How to set objectives, strategies, policies and planning premises.
Strategic planning process: Decision making: steps in decision making, systems approach.
Organizing: Nature and purpose of organizing, span of management, factors determining the span, basic departmentation, Line and staff concepts, functional authority, art of delegation, decentralization of authority.

Human Resource Management: Systems approach to staffing, selection process, techniques and instruments, approaches to manager development and training

Human factors in managing: Theories of motivation, special motivation techniques. Leadership – leadership behaviour and styles, Managerial grid.
Communication: Process, barriers, effective communication techniques.
Basic control process, critical control points and standards.
Control Techniques: Budgets, non-budgetary control devices. Overall and preventive controls: Budget summaries:
Profit and loss control, control through ROI, direct control, preventive control, developing excellent managers.

International management: Managerial practices in Japan and USA and application of theory Z. The nature and purpose of international business and multinational corporations, unifier global theory of management.

Recommended Books:
1. Peter Drucker: Management, Task and Responsibility
2. Peter Drucker: The Practice of Management

CHE 401 Process Engineering Economics

Introduction to Process Engineering Economics – Economic decision making – Mathematics of cost comparisons
Time value of money – Types of interest – Rate return relationships – Series of cash flow – Annuities – Gradient and geometric series – Capitalised cost – Concept of continuous interest
Depreciation and Amortisation – Methods of depreciation – Comparison – Accelerated cost recovery systems – Depreciation accounting procedures – Depletion – Cost and percentage methods – Taxes and implication of taxes
Break even and sensitivity analysis – Break even charts – Optimisation – Single and double variable optimization – Optimum production rates – Maximum profit and minimum cost – Selected unit operations such as Fluid flow (optimum diameter of pipe), heat transfer (optimum thickness of insulation, optimum temperature or flow rate of fluid in a double pipe exchanger/condenser, optimum number of effects in an evaporator, optimum rate of heat transfer and cycle time) and Filtration (optimum number of cycles and time of filtration)
Cost estimation – Types of estimates – Method of estimating equipment costs – Cash flow operations – Methods of estimation of Fixed capital and Total capital – product cost estimation
Elements of book keeping – Profit and loss accounts – Balance sheet – PERT and CPM techniques – General considerations for Plant location and layout

Recommended Books:

CHE 403 Process Modeling and Simulation


Distributed parameter models – Formulation and solution of typical chemical engineering problems – Solution of SPLIT boundary value problems – Shooting technique – Counter current heat exchanger – Tubular reactor with axial dispersion – Counter current gas absorber – Tubular permeation process – Pipe line flasher etc.

Recommended Books:

CHE 405 Chemical Process Industries (4 0 0 4)
Indian industry – A brief review
Detailed description of the processes along with neat flow diagrams, engineering problems that are encountered
fre quently during the process and major uses and application are to be discussed for the following.
Chloroalkali industry: Common salt – Caustic soda – Chlorine – Hydrochloric acid – Bleaching powder – Soda ash
Sulfur and sulfuric acid: Extraction of sulfur – Production of sulfuric acid from sulfur and other sources – Recent
advances
Fertiliser industry:
Ammonia – Nitric acid – Ammonium nitrate – Ammonium sulfate – Ammonium chloride – Urea
Phosphate industry: Elemental Phosphorous – Phosphoric acid – Superphosphates – NPK fertilizers
Oils, fats and waxes: Edible oils – Extraction of vegetable oil – Hydrogenation of oil – Soaps and detergents –
Manufacturing processes – Glycerin recovery
Pulp and paper: Chemical and mechanical pulp – Pulping methods – Chemical recovery of black liquor – Paper and
paper board
Sugar and starch: Sugar – Starch and modified starches – Glucose – Fermentation – Media for growth – Industrial
alcohol – Absolute alcohol – Acetone and Butanol
Petroleum: Origin – Composition – Classification of petroleum – Refinery operations – Products and their uses
Polymerisation: Classification of polymers – Modes of polymerization – Polyvinyl chloride – Polyethylene – Viscose
rayon , Nylon 6 and Nylon 66 – Natural and synthetic rubber

Recommended Books:
1. Faith, Keyes and Clark, Industrial Chemicals, 4th edn., F.A.Lowenheim and M.K.Moran, Wiley Interscience,
   1975.
2. Charles E. Dryden, Outlines of Chemical Technology, Edited and revised by M. Gopala Rao and Marshall

CHE 407 Elective II (3 0 0 3)
CHE 407.1 Polymer Engineering
Introduction – Definitions and concepts used in polymer engineering- Polymerisation reactions – Polymer structures
– Functionality and degradation – Characterisation of polymers – Natural and modified natural products – Synthetic
polymers – Addition and condensation products and their preparation
Methods pf polymerization – Mass, solution,emulsion and suspension polymerization processes – Reactions and
equipment used
Polymer processing – Moulding – Cold and hot compression – Transfer injection and jet types – Extruding –
Calendering and skiving – Sheet forming – Atmospheric and fluid pressure forming – Lamination and impregnating
– Coating – Expanding – Casting and embedding – Spinning and finishing

Recommended Books:
Herman S. Kaufman and Joseph J. Falcetta (Editors), Introduction to Polymer Science and Technology, Wiley Inter
Science Publications, 1977
David J. Williams, Polymer Science and Engineering, Prentice Hall Inc., 1971
Stanley Middleman, Fundamentals of Polymer Processing, McGraw-Hill,
Fred W. Billmeyer, Text Book of Polymer Science, Wiley Inter Science Publication
CHE 407.2 Advanced Biochemical Engineering  (3 0 0 3)
Genetic engineering – aims, techniques, achievements and prospects of genetic engineering – Process of gene expression, split genes and mRNA modification in eukaryotes, post translational modifications of proteins – Induction and mutation
Alteration of cellular DNA: Virus and phages – cell fusion – Commercial applications of microbial genetics and mutant populations – Recombinant DNA technology
Transport phenomena in bioprocess systems – Gas liquid mass transfer in cellular systems – Determination of oxygen transfer rates – Power requirements for sparged and agitated fermentors – Scale up and scale down of bioreactors
Design ans analysis of biological reactors – Ideal bioreactors – Sterilisation of reactors – Batch and continuous – Immobilised biocatalysts – Formations – Characterisation and applications – multiple bioreactors – Packed, fluidized and trickling bed reactors
Alternate bioreactor configurations – animal and plant cell reactor technology
Analysis for mixed culture fermentation systems – Neutrality, mutation, commensalisms and amenalism – Classification of interaction between two species – Competition and survival of the fittest – Volterra’s analysis of competition – competition and selection in a chemostat – Predation and parasitism – Model development via stability analysis – Effects of number of species and their interactions – definitions – Population dynamics in model of mass action form
Biological reactors in the mixed culture and with natural systems – uses of well defined mixed populations
Medical applications of bioprocessing engineering – Tissue engineering – Commercial tissue culture process


CHE 407.3 Petrochemicals
First generation petrochemicals – Alkanes – Akinenes and alkyenes – BTX aromatics – Diene base petrochemicals
Miscellaneous: Petroleum proteins – Synthetic detergents – Resins and rubber chemicals – Explosives (TNT, RDX, HMX)

Recommended Books:
Chem Tech IV, Chemical Engineering Education Development Centre, IIT Madras, 1978

CHE 407.4 Unit Processes in Organic Synthesis
Nitration: Mechanism of nitration reaction – Mixed acids for nitration – Preparation of nitrobenzene – Equipment used in nitration processes
Halogenation: Reaction mechanism – Chlorination of paraffins – Ethanol and aliphatic acids – Dehydrohalogenation – Sandmeyer reaction – Bromination and iodination – Equipment used
Sulphonation: Reaction mechanism – Sulphonation agents – Treatment of aliphatic and aromatic compounds with sulfuric acid – Preparation of benzene sulphonic acid – Sulphonation of fatty acids – Equipment used
Oxidation: Mechanism of oxidation reaction – Oxidation agents – Vapor phase and liquid phase oxidation – Conversion of iso to camphor – Aniline to quinine – Cyclohexane to adipic acid – acetaldehyde to acetic acid – Equipment used
Hydrogenation: reaction mechanism – Catalysts used – Hardening of fats – Hydrogenation of hydrocarbons – Equipment used
Alkylation: Reaction mechanism – Reagents – Preparation of anisole – carbitol and ethylene cellulose – Equipment used
Hydrolysis: Reaction Mechanism and reagents – Preparation of soaps – Fatty acids – Saccharification of wood – Amyl alcohols from chloropentane and phenol – Equipment used

**Recommended Books:**


**CHE 407.5 Advanced Process Dynamics and Control**

**Recommended Books:**

**Elective III**

**BIO 403.1 BIONANOTECHNOLOGY**

Introduction: From Biotechnology to Bionanotechnology, What is Bionanotechnology.

Biomaterials: Historical Overview and Current Directions; Proteins; Nucleic acids; Lipids, Polysaccharides; Host Response to Implantable Devices

Biomolecular Design: Recombinant Technology – Engineered DNA, Site-directed mutagenesis, Fusion Proteins; Regulation of Protein activity and action; Biomolecular motors – ATP, ATP synthase, Brownian ratchets; Traffic across Membranes – Potassium Channels, ABC Transporters, Bacteriorhodopsin; Biomolecular Sensing; Self-Replication; Machine-Phase Bionanotechnology – Muscle sarcomeres, Nerves.

Modern Bionanotechnology: Basic Capabilities; Nanomedicine – Computer-aided drug design, Immunotoxins, Liposomes, Artificial Blood, GeneTherapy, Personalized Medicine; Self-Assembly – DNA Scaffolds, Nanotubes, Fusion Proteins, Organic Molecules; DNA Computers; Molecular Design using Biological Selection; Artificial Life; Tissue Engineering and Artificial Cells; Hybrid Materials; Biosensors – Antibodies, Glucose levels, Engineered nanopores.

Case Studies and Ethical Issues: Nanotube synthase; Nanoscale assembler; Nanosurveillance

Ethical considerations – Respect for life and Potential Dangers.

**Textbooks:**
1. “Bionanotechnology” by Goodsell David S, John Wiley & Sons

“Nanoscale Technology in Biological Systems” by Greco Ralph S, CRC Press

**CHE 409.1 Fertiliser Technology**

Indian Fertiliser industry – An overview – Fertiliser production and consumption
Role of fertilizers in agriculture – Nutrients for plant growth – Micro and macro nutrients – General concepts – Fertiliser raw materials and reserves – Global and Indian reserves – Ammonia feed stocks – Phosphate rocks – sulfur – Potash etc.
Production, transmission and storage of ammonia through various processes and raw materials – Ammonium salts and Nitric acid – Production of urea through various processes – Important applications
Phosphate rock – Geology, mining and beneficiation – Phosphoric acid production – different methods – Fertilisers derived from phosphoric acid
Potash fertilizers – Potassium chlorides, Sulphates and Nitrates – Compound fertilizers – Production and their applications – Problems encountered in fertilizer plants

**Recommended Books:**
CHE 409.2 Environmental Impact and Assessment and Environmental Management Plan

Introduction and need for impact assessment – Legislation and Pollution Control acts and Notifications

Recommended Books:
Peter Wathern, Environmental Impact Assessment – Theory and Practice, Unwin Hyman Ltd., 1988

CHE 409.3 Petroleum Refinery Engineering


Recommended Books:

BIO 403.2 METABOLIC ENGINEERING [4 0 0 4]

Induction-Jacob Monod model, catabolite regulation, glucose effect, cAMP deficiency, feed back regulation, regulation in branched pathways, differential regulation by isoenzymes, concerted feed back regulation, cumulative feed back regulation, amino acid regulation of RNA synthesis, energy charge, regulation, amino acid regulation of RNA synthesis, energy charge, regulation, permeability control passive diffusion, active transport group transportation. Alteration of feed back regulation, limiting accumulation of end products, feedback, resistant mutants, alteration of permeability, metabolites.

BIOSYNTHESIS OF SECONDARY METABOLITES
Precursor effects, prophophase, idiophase relationship, enzyme induction, feedback regulation, catabolite regulation by passing control of secondary metabolism, producers of secondary metabolites. Advantages of Bioconversions, specificity, yields, factors important to bioconversion, regulation of enzyme synthesis, mutation, permeability, co-metabolism, avoidance of product inhibition, mixed or sequential bioconversions, conversion of insoluble substances. Strain selection, improving fermentation, recognizing growth cycle peak, induction, feed back repression, catabolite repression, mutants resistant to repression, gene dosage.

Textbook:

References:

CHE 411 Reaction Engineering and Process Dynamics Control Lab (0 0 3 1)
Experiments based on the course work of Reaction Engineering and Process Dynamics and Control

CHE 413 Process Modeling and Simulation Lab (0 0 3 1)
Experiments based on Process Modeling and Simulation

CHE 402 Industrial Training ( - - - 1)
As a part of curriculum, the student is required to undergo industrial training for a period of not less than four weeks in an industry during the vacation period, preferably at the end of V or VI semester. However, the report may be submitted during the VIII semester for evaluation.

**CHE 404 Seminar II**

This course is aimed at developing skills in searching technical literature, coordinating and making a good technical written report. The students will give a seminar on the topic assigned to them on soft skills or technical topics. Proper weightage will be given to both types of presentation in the evaluation.

**CHE 499 Project Work**

Project work is to be carried out by the student(s) individually or in a group for the entire eighth semester (16 weeks) in an Industry or the Institute itself. The topics will be assigned at the beginning of VIII semester and the student(s) will work under the supervision of a guide and after completion of the project, the reports will be submitted for the purpose of evaluation.