Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

### Semester - III

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<td>CHE 301</td>
<td>Industrial Stoichiometry</td>
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<tr>
<td>CS 312</td>
<td>Data Structure and Database Concepts</td>
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<tr>
<td>CH 313</td>
<td>Chemistry</td>
<td>L 3 T 1 P 0</td>
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<td>EE 314</td>
<td>Electrical Machines</td>
<td>L 3 T 1 P 0</td>
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<td>M 315</td>
<td>Mathematics-III</td>
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**Practical**

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<td>CS 382</td>
<td>Data Structure and DBMS Lab</td>
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<td>EE 383</td>
<td>Electrical Machines Lab</td>
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Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

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<td>CHE 402</td>
<td>Mechanical Operations</td>
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<td>CHE 403</td>
<td>Material Science &amp; Technology</td>
<td>3 0 0 3</td>
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<tr>
<td>CHE 404</td>
<td>Energy Sources and Their Utilization</td>
<td>3 1 0 4</td>
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<td>CHE 405</td>
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<td>CHE 493</td>
<td>Fluid Mechanics Lab</td>
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Total of Practical: 0 0 12 6

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<td>CHE 494</td>
<td>Chemical Engineering Drawing</td>
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Total of Semester: 36 28
West Bengal University of Technology  
BF-142, Salt Lake City, Kolkata-700064

Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Chemical Engineering  
Semester – V

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<tr>
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<tr>
<td>CHE 501</td>
<td>Machine Design</td>
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<td>CHE 502</td>
<td>Process Heat Transfer</td>
<td>3 1 0</td>
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<tr>
<td>CHE 503</td>
<td>Chemical Process Technology-I</td>
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<td>CHE 505</td>
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<tr>
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<td>Heat Transfer Lab</td>
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West Bengal University of Technology  
BF-142, Salt Lake City, Kolkata-700064

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Chemical Engineering  
Semester – VI

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<td>Chemical Process Technology-II</td>
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<td>Instrumentation and Process Control</td>
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<td>Numerical Methods in Chemical Engineering</td>
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### Chemical Engineering
#### Semester - VII

<table>
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<tr>
<td>CHE 701</td>
<td>Mathematical Methods in Chemical Engineering</td>
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<td>Modeling, Simulation and Optimization</td>
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<td>CHE 792 Process Instrumentation and Control Lab</td>
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| Total of Semester                                  | **34** | **33** |

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5
Chemical Engineering
Semester - VIII

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<td>Transport Phenomena</td>
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<table>
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<tr>
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<th>CHE 704: ELECTIVE - II</th>
<th>CHE 804: ELECTIVE - III</th>
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<tr>
<td>CHE 605 A</td>
<td>Pulp &amp; Paper Technology</td>
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<td>CHE 605 B</td>
<td>Catalysis &amp; Catalytic Reactor Design</td>
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<td>CHE 605 C</td>
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<td>Petrochemical Technology</td>
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<td>CHE 605 F</td>
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**Total Credits**

1st Semester – 30
2nd Semester – 30
3rd Semester – 26
4th Semester – 28
5th Semester – 28
6th Semester – 28
7th Semester – 33
8th Semester – 36
Total: 239
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

3rd Semester

Industrial Stoichiometry (CHE 301)

Module I: 10L

Units and Dimensions: Buckingham Pi-theorem, Dimensionless groups, Conversion of equations.

Introduction to Chemical Engineering Calculations: Basis, Mole Fraction and Mole Percent, Roul't's Law, Henry's law, Dalton's law, Amagat's law, Behavior of ideal gases. Real gas relationships, Vapor Pressure.

Module II: 10L

Mathematical Requisites: Solution of simultaneous equations, use of log-log and semi-log graph paper, triangular diagram, Graphical differentiation and graphical integration, least square method, curve fitting, Method of Regression, use of standard numerical software.


Module III: 10L


Module IV: 10L

Combined Material and Energy Balances: Simultaneous Material and Energy Balances: Industrial process calculations for Distillation, Combustion, Crystallization, Drying and Evaporation etc.

Revision: 5L

Text Books / References:
2. Basic Principles and Calculations: Himmelblau: Prentice Hall, 6th Ed. in Chemical Engineering

CS-312-- Data Structure and database concepts

Module I: 10L

Module II: 10L
Introduction to Graphs (undirected and directed) & Different Representation: Trees (Basic concepts and representations), Breadth first search (BFS) and Depth first search (DFS) algorithms, Spanning Trees, Minimum Spanning Tree (Prim’s, Kruskal’s algorithms), Dijkstra's Shortest Path Algorithm.

Module III: 10L
Sorting and Searching Algorithms: Linear search, Binary search; Bubble sort, Insertion sort, Selection sort, Quick sort. Introduction: Database System and Concept Architecture, Data Model, scheme & instances, Data Independence, Database Languages, Database Manager, Database Administrator, Database User, Relational Model & ED Diagram.
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Module IV: 10L
Database Language: SQL, definition, manipulation, control, DBA function; Distributed Database Concepts.
Basic Concept of Computer Networking, LAN, MAN, WAN, Protocols, Web help for Chemical Engineering Application.

Text Book
3. Corman, Introduction to algorithms, PHI
5. Date C. J., “Introduction to Database Management”, Vol-I,II,III, Pearson Education
7. Tennenbaum- “Computer Networks”, Pearson Education PHI

Reference:
2. Tennenbaumz “Data Structures using C”, Pearson Education PHI
3. N. Deo., Graph Theory PHI

Chemistry (CH 313)

Module I: 10L
Colloids: Introduction; Classification of colloids; Size and shape; preparation of sols; Origin of charge in Colloidal particles; Stability of Colloids; Kinetic, Optical & electrical properties; Electrokineletic phenomena; Electrical Double Layer; Ultracentrifuge and Molecular weight determination of Macromolecules.

Viscosity: Definition of a liquid; Determination of Viscosity; Shear Viscosity; Intrnsic Viscosity; Molecular weight from Viscosity measurement; Newtonian and non Newtonian Fluids (Pseudoplastic, Dilatant, Bingham Plastic fluids).

Module II: 10L
Surface Tension: Introduction; Origin of Surface Tension; Surface energy; Laplace & Young-Laplace Equation, Capillarity; Contact Angle; Measurement of Surface Tension by Capillary rise method; Variation of Surface Tension of a liquid with Temperature and Concentration.

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

Module III: 10L
General Organic Chemistry: Common organic reactions: nucleophilic; electrophilic; addition and substitution; Different types of conversion; Important reactions of carbonyl compounds; Markownikof’s rule; peroxide effect.
Preparation and synthetic application of Acetoacetic ester, Malonic ester and Grignard’s reagent;

Module IV: 10L
Aminoacids: Classification; General methods of preparation and properties of amino acids, polypeptide synthesis, General properties of proteins, colour tests, enzymes.
Carbohydrate: Classification, Glucose and fructose, Mutarotation, epimerisation, Inter–conversion of aldose and Ketose; Methods of ascending and decending sugar series; Disaccharides: Sucrose, maltose, cellobiose (brief properties and mention of structures).

Revision: 5L

Text Books / References:
1. Physical Chemistry: P. W. Atkins; Oxford
2. Physical Chemistry: G.W.Castellan, Narosa
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5. Organic Chemistry: Morrison & Boyd; PHI/Pearson Education.

Electrical Machines (EE 314)

Module-I: 10 L
D.C. Machines—Generators and Motors: Constructional features and principles of operation of shunt, Series and compound generators and motors. Performance characteristics, starting speed controls and breaking of motors.

Module-II: 10 L
Application of Static and Rotating Machines: Two quadrant and four quadrant operation of motors. Choice of D.C. motors for different applications. Constructional features and principles of operation of 1-phase transformers, Open Circuit Test and Short Circuit Test, Equivalent Circuit, Typical applications of transformers and A.C. motors.

Module-III: 10 L

Module-IV: 10 L
Synchronous Machines: Synchronous generators and motors, Principles of operations and simple equivalent circuit, Method of synchronization of synchronous generator, Application of synchronous machines and 3-phase transformer.

Revision: 5 L

Text Books / References:
1. Electrical Technology: Edward Hughes. Pearson Education
2. Hubert, Electrical Machines, Pearson Education
4. Electrical Machinery: Bhimra,

Mathematics – III (M 315)

Code: M 315
Contact: 3L + IT
Credit: 4
Allotted Hrs.: 48L

Fourier Series:
Introduction; Euler’s formula; Problems related to Fourier series; Conditions for Fourier expansion; Functions having points of discontinuity; Change of Interval; Even and Odd function; Half Range series; Typical Waveforms (square, saw-toothed, triangular, half wave rectifier, full wave rectifier)

12L

Series Solution of Ordinary Differential Equation (ODE); Special Functions:
Introduction, validity of series solution of an ordinary differential equation, general method to solve equation of the type: \( P_0 y'' + P_1 y' + P_2 y = 0 \); Problems; Bessel’s equation; Properties of Bessel’s function; Recurrence formula for Bessel’s function of first kind \( J_n(x) \); Equation reducible to Bessel’s equation; Legendre’s equation, Legendre function, Recurrence formula for Legendre function \( P_n(x) \); Orthogonality relation.

14L
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

### Partial Differential Equations (PDE) and its Applications:
Introduction, linear and nonlinear PDE of first order; Examples; Homogeneous Linear PDE of 2\textsuperscript{nd} Order with constant coefficients and variable coefficients; Separation of variables, Formulation and solution of wave equation (1D); One Dimensional heat flow equation and solution; Two Dimensional heat flow equation and solution.

### Statistics:
Mean, median; mode; Standard Deviation, Variance, Random Variable; Discrete and Continuous Probability Distributions: Distribution and Density Function, Mathematical Expectation; Standard Probability Distributions: Binomial, Poisson, and Normal; Correlation and Regression; Linear Curve Fitting—Least Square Method.

Total 48L

### Text Books / References:
5. Advanced Engineering Mathematics, GreenBerg, Pearson Education
6. Statistical Methods: N.G.Das
7. Elements of partial Differential Equation: Sneddon, MGH

### CHE 391 – Instrumental methods of analysis Lab
1. Determination of Sulfur in coal by Turbidity Meter.
2. Preparation of standard curve (Absorbance vs. concentration) of a standard protein by Folin's Method using visual Spectrophotometer.
3. Determination of Fe\textsuperscript{3+}/Cu\textsuperscript{2+} by Colorimeter Method.
5. Analysis of gaseous mixture using TCD/FID.
7. Determination of Molecular Weight by UV Spectrophotometer.
9. Determination of any optically active substance in the presence of non-active species by a polarimeter.

### CS 382—Data Structure & data base Lab
2. Study of AutoCAD Packages w.r.t. 2D and 3D objects—drawing, dimensioning, resizing, multiplicity aspects, connections; Block diagram representation of Chemical process, drawing/Editing of special blocks; integration of blocks/units for a complete flow diagram.
3. Dynamic and Static Data Exchange between Database and Auto CAD
4. Data Structure using C++ - Linked-List
5. Interface between C language and SQL Server
6. Data Exchange between VB and MS Access

EE 383 – Electrical Machines Lab

1. To study the open circuit and short circuit tests of a single-phase transformer.
2. To study the speed control characteristics of a D. C. shunt motor.
3. To study the saturation characteristics of a D. C. generator.
4. To study the external load characteristics of a D. C. shunt generator.
5. To study the speed-torque characteristics of an induction motor.
6. To study the open and short circuit characteristics of an alternator.

4th Semester

Chemical Engineering Thermodynamics (CHE-401)

Module I: 10 L

Basic concepts and definitions: What is thermodynamics? Macroscopic and microscopic view. The scope of thermodynamics. Thermodynamic systems and surroundings. Concepts of force, properties, energy, temperature, pressure, heat work, equilibrium, phase, process etc.


Module II: 10 L

Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.


**Thermodynamic property relations:** Maxwell relations. Joule – Thomson coefficient, Clapeyron equation and enthalpy of vaporization.

**Module III:** 13 L

**Solution Thermodynamics: Theory:**

**Solution Thermodynamics: Applications:**

**Module IV:** 7 L


**Text Books / References:**
3. A Text Book of Chemical Engineering Thermodynamics, Narayanan, PHI
5. Chemical and Process Thermodynamics: Kyle PHI.

### Mechanical Operation (CHE 402)

**Module I:** 10 L

**Screen Analysis:** Mixed particle sizes, Differential and cumulative analysis, Screen effectiveness, Ideal and Actual Screening, Types of screen, commercial screening equipment

**Transportation & Storage of Solids:** Studies on performance and operation of different conveyors eg. Belt, Screw, Apron, Flight etc. and elevators. Centrifugal discharge, continuous, positive discharge: storage bin for solid and feeders.

**Module 2:** 10 L


**Module 3:** 10 L

**Principles of particle Mechanics:** free and Hindered settling, terminal velocity, Stock’s law & Newton’s law regimes of settling, Batch sedimentation, Design of continuous clarifier, classification, froth flotation. Cyclone separator, electrostatic precipitator.

**Mixing:** Mechanism of mixing, power consumption in mixing, power number, flow number, froud number, various types of agitator, solid-solid mixing equipment. Mixing effectiveness and mixing index.
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Module 4: Filtration 10 L

Text Books/References:
1. Unit Operations of Chemical Engineering By McCabe Smith and Harriot TMH, 5th Edn.
2. Introduction to Chemical Engineering 2nd Vol. By Badger & Banchero

Material Science & Technology (CHE 403)

Module - I: 10L

Module - II: 10 L

Module – III: 10 L
Basic principles of metal extraction: Pyrometallurgy: calcinations, roasting—oxidizing, predominance area diagrams, multiple hearth, flash and fluo-solid, sintering, smelting, slag and its classification. Steelmaking process flow diagram: Iron making (Operation involved in Blast furnace)-- Steel making (oxygen blown converter – LD) -- Secondary steel making / refining (ladle processing, vacuum degassing, ladle furnace processing) – Continuous casting - with emphasis on application of the concepts of physicochemical principles involved, moving/packed bed reactor, gas-liquid two-phase flow, heat transfer with phase change (solidification).

Module - IV: 10 L
Principles of Hydrometallurgy and Electrometallurgy, Extraction of Aluminum: Hall-Heroult process, Electrolytic refining; Sources of Zinc & Copper: Pyro & Hydro metallurgical extraction of copper & Zinc; Extraction of Lead, Recent development in Lead smelting.

Text Books and References:
1. Lawrence, H. Vanvlack, Elements of Material Science and Engineering, Pearson Education.
3. Lakhtin, Engineering Physical metallurgy; MIR publishers.
4. Ray, Sridhar & Abraham. Extraction of non ferrous metal, EWP

Energy Sources & Their Utilization (CHE 404)

Module I: 10 L
Introduction: Conventional and non-conventional energy resources, Global Energy consumption pattern.

Module II: 10 L
Liquid Fuels: Constitution of petroleum, theory of formation of crude, characterization of crude oil & petroleum fuels, operation and flow-sheet of crude distillation, catalytic cracking, coking, visbreaking and reforming processes, Process of
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Revised Syllabus of B.Tech in CHE(To be followed from the academic session, July 2006 i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

a typical Indian refinery. Parameters and testing logistics of petroleum products—Octane no.; Cetane no.; Aviation fuel, Power no.; Pour point; Smoke point; Char point; Cloud point; Flash point; Fire point; Aniline point and Diesel index.
Liquid fuel from coal: Bergius and Fischer Tropsch process, Other Synthetic Liquid fuels.

Module III: 10L


Bio Gas: Principles and Operation of Aerobic & Anaerobic Digestors, Biogas generation and management.

Module IV: 10 L


Nuclear energy: Nuclear reactions and power generation.

Text/ Reference Books:
1. Fuels & Combustion: Dr. Samir Sarkar, Orient Longmans
2. Fuel and Combustion: Sharma S.P. and Chanra Mohan

Fluid Mechanics (CHE 405)

Module I: 10 L

Fundamental Concepts: Fluid as a continuum, Terminologies of fluid flow, velocity – local, average, maximum, flow rate – mass, volumetric, velocity field; dimensionality of flow; flow visualization – streamline, pathline, streak line, stress field; viscosity; Newtonian fluid; Non-Newtonian fluid; Reynolds number—its significance, laminar, transition and turbulent flows: Pandtl boundary layer, compressible and incompressible flows.

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

Basic equations in integral form: Basic laws for a system; relation of system derivatives to the control volume formulation; conservation of mass; momentum equation for integral control volume, momentum correction factor, differential control volume analysis; first law; Navier Stokes equation – specific applications.

Module II: 10 L

Internal incompressible viscous flow: Introduction; flow of incompressible fluid in circular pipe; laminar flow for Newtonian fluid; Hagen-Poiseuille equation; flow of Non-Newtonian fluid, introduction to turbulent flow in a pipe; energy consideration in pipe flow, relation between average and maximum velocity, Bernoulli’s equation–kinetic energy correction factor; head loss; friction factor; major and minor losses, Pipe fittings and valves.

Module III: 10 L

Flow measurement: Introduction; general equation for internal flow meters; Orifice meter; Venturimeter; concept of area meters: rotameter; Local velocity measurement: Pitot tube. Anaemometer.

Resistance of immersed bodies: Introduction; concept of drag and lift; variation of drag coefficient with Reynolds number; streamlining; packed bed; concept of equivalent diameter and sphericity; Ergun equation.
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Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Module IV: 10 L

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

Fluidization: Introduction; different types of fluidization; fluidized bed assembly; governing equation; industrial use.

Revision: 5L

Text Books / References:
1. Introduction to Fluid Mechanics: Fox & McDonald, John wiley
2. Unit operations of Chemical Engineering: McCabe, Smith and Harriot, TMH, 5th Edn.
3. Mohanty, Fluid Mechanics, PHI
5. Fluid Dynamics and Heat Transfer: Knudsen and Katz, MGH
6. Transport Process and Unit Operations: Geankoplis, 3rd Edn. PHI

Mechanical Operations Lab (CHE-491)

1. Verification of Rittinger’s Law and determination of grindability index of a drop weight crusher for a given granular solid sample.

2. Determination of reduction ratio and capacity of a laboratory scale ‘Ball Mill’.

3. Estimation of capacity and reduction ratio of a batch ‘Hammer Mill’.


5. Determination of overall effectiveness of a sieve shaker for a given solid sample of unknown size.

6. Estimation of Mixing Index at different time and power consumption for fluid mixing for different rotational speed of the impeller.

7. Determination of rate of sedimentation for a given slurry by plotting interface height vs. time.

8. Design of a continuous thickener by conducting a batch sedimentation test for a given sedimentation duty.

9. Determination of specific cake resistance ‘\(\alpha\)’ and filter medium resistance ‘\(R_m\)’ by filtering a slurry using plate and frame filter press.

10. Estimation of ‘\(\alpha\)’ (specific cake resistance) and ‘\(R_m\)’ by filtering a slurry using a batch centrifugal filter.

Energy Lab (CHE 492)


2. Determination of carbon residue of fuel oil.

3. Determination of aniline point of a fuel oil.

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

5. Atmospheric Distillation of petroleum product.

6. Determination of Flash Point & Fire Point of an oil by ABLE apparatus.
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

11. Determination of calorific value of solid and liquid fuel by Bomb Calorimeter.
12. Determination of vapour pressure of petroleum product using Reid apparatus.

Report Writing & Technical Language Practice Laboratory
(HU 484)

1. Introductory lecture is to be given to the students so that they get a clear idea of the syllabus and understand the need for having such a practice lab in the first place (3 hours)
2. Conversion practice is done on given situation topics. The students are also made to listen to pre-recorded cassettes produced by British Council and also by the Universities of Oxford and Cambridge (6 hours)
3. Group Discussions:- The students are made to understand the difference between the language of conversion and group discussion. Strategies of such discussions are to teach to them. It is also helpful to use videocassettes produced by the U.G.C. on topics like group-discussion. After wards the class is divided into groups and the students have to discuss on given topics on current socio-economic-political-educational importance (12 hours)
4. Interview sessions-students are taught the do’s and don’ts of facing a successful interview. They then have to face rigorous practices of mock-interviews. There simulations of real life interview sessions where students have to face an interview panel (12 hours)
5. Presentations: The secrets of an effective presentation are taught to the students. Then each and every student has to make lab presentations with the help of the Overhead projector/ using power point presentation and other audio-visual aids in the laboratory. They also have to face the question answer sessions at the end of their presentation (12 hours)
6. Classes are also allotted to prepare the students for competitive examinations like the T.O.E.F.L. by making the students listen to specially produced C.D. cassettes of such examinations (3 hours)

The overall aim of this course is to inculcate a sense of confidence in the students and help them to become good communicators in their social as well as professional lives.

Text Books/References:
1. Sharma—Business Correspondence & Report Writing, TMH
2. Prasad—Group Discussion & Interview (With Audio Cassette) , TMH

Chemical Engineering Drawing (CHE 494)

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

1. Flange Coupling
2. Hydraulic Pipe Joints
3. Valves
4. Stuffing Box
5. Belt-Pulley
6. Screw Jack
8. Assembly Drawing of any Chemical Engineering equipment.

Text Book/ References:
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006 i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

5th Semester
Machine Design (CHE 501) 10L

**Module-I**

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

**Module-II**

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

**Module-III**

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

**Module-IV**

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

**Text Book**

1. Process Equipment Design – Brownell and Young, John Wiely and sons
3. Design of Machine Elements, Sharma & Purohit, PHI
4. Design of Process Equipment – Hesse and Rushton
Revised Syllabus of B.Tech in CHE(To be followed from the academic session,July 2006 i.e. for the students who were admitted in Academic Session 2005-2006).The syllabi of other semesters will be published soon.


Process Heat Transfer (CHE 502)

Module I            10L
Heat Transfer by Conduction:
Classification of different Modes; Concept of heat diffusion (conduction), Fourier’s Law; Thermal Conductivity – constant and variable; Thermal Diffusivity; Steady State Conduction – Rectangular (Cartesian), Cylindrical and Spherical coordinates; Compound Resistance in Series; Critical thickness of insulation, One dimensional unsteady state heat conduction, Lumped system analysis, Slab – use of transient temperature chart.

Module II            10L
Heat Transfer by Convection:

Heat Transfer in Turbulent Region: Dittus-Boelter Equation; Correction for temperature variation over pipe cross section; Physical interpretation of different Dimensionless groups; Reynolds analogy, Colburn Analogy; Wilson Equation;

Natural Convection; Correction of Laminar flow equation for Natural Convection.

Module III                      10L
Heat Transfer of Fluids with Phase Change:
Introduction; Dropwise and Film-Type Condensation; Coefficients for Film-Type Condensation: Nusselt Equation for Vertical and Horizontal Tubes; Condensation of Superheated Vapors; Heat Transfer to Boiling Liquids: Pool boiling of Saturated Liquid; Film Boiling.

Radiation Heat transfer:
Introduction; Monochromatic emissive power; Weins displacement law; Plank’s law of radiation; Kirchoff’s Law; Emissivity of Solids; Absorption of Radiation; Lambert-Beer’s law; Absorption by gases. Radiation between surfaces, Concept of View Factor.

Module IV                      10L
Heat Exchange Equipments:
Typical Heat Exchange Equipment; Parallel Flow, Countercurrent Flow, and Cross Flow; General Design of Heat-Exchange Equipment; Different types of Heat Exchanger: Double Pipe Heat; Shell and Tube (1-1, 1-2, 2-4); Introduction to Plate Type; Condensers: Shell and Tube;

Evaporation:
Introduction; Liquid Characteristics; Types of Evaporator; Performance of tubular evaporator: Capacity, Steam economy; Boiling Point Elevation (Dühring Rule); Outside Heat Transfer Coefficients; Enthalpy Balance for a Single Effect Evaporator; Introduction to Multiple Effect Evaporator: Forward feed, Backward feed, Mixed feed, Parallel feed; Design concept of Multiple Effect Evaporator.

Text Books:
4. Heat Transfer, B. K. Dutta, PHI

References:
1. Coulson & Richardson: Chemical Engineering (IV)
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Chemical Process Technology – I (CHE 503)

Module I: 10 L


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

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

Module II: 8 L

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

Module III: 11 L

Fertilizer Industries: Production and consumption pattern, Different grades of fertilizer.

Raw materials, Physico-chemical principles of manufacture, flow-sheet and sequence of operation, details of major equipments, advancement of process technology and major engineering problems, uses of the following: Nitrogen industries: Ammonia, Nitric acid, Urea and ammonium nitrate. Phosphorus industries: phosphorus, phosphoric acid, Calcium phosphate, Triple super phosphate, Ammonium phosphate.

Module IV: 11 L


Paints, pigment and surface coating industries: Raw materials, methods of production and uses.

Pulp and Paper industries: Raw materials, Method of production, sequence of operation, Major engineering problems


Text Books / References:

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

Chemical Reaction Engineering (CHE 504)
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006; i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Module: I 10L
Introduction; Definition of reaction rate;
Kinetics of homogeneous reaction: Concentration-dependent term of a rate equation, single and multiple reaction, Elementary & Nonelementary reactions, kinetic view of equilibrium for elementary reactions, Molecularity and order of reaction, Representation of reaction rate, Kinetics for non elementary reactions, related problems, Temperature-dependent term of a rate equation: Arrhenius law, Transition state Theory, related problems;
Enzymatic Reaction: Definition and Mechanisms, Michaelis-Menten kinetics.

Module: II 10L
Single Ideal Reactors: Introduction; Basic division of ideal reactors, Ideal Batch Reactor, Space-time and Space-velocity, Steady-state Mixed Flow Reactor: Design Equation, Graphical Representation of Design Equation, related problem; Steady-state Plug Flow Reactor: Design equation, graphical representation, related problem; Stoichiometric Table, Elementary idea and design equations for Bioreactor: Mass Balance for Cell, Substrate and Product;
Design for Single Reactions: Size and comparison of single reactors: Batch Reactor, PFR, MFR, General Graphical Comparison; Multiple-Reactor Systems: PFRs in Series and/or in Parallel, Equal-size MFRs in Series, MFRs of different sizes in Series, Determining the best size combination of reactor size for a given combination, Reactors of Different Types in Series, Recycle Reactor: Definition of Recycle Ratio, Design Equation, Optimum Recycle ratio.

Module III: 10L
Design for Multiple Reactions: Introduction, Reactions in Parallel, Qualitative aspects of Product Distribution, Quantitative Treatment of Product Distribution and of Reactor Size: Definition of Instantaneous and Overall fractional yield, graphical representation; Reactions in Series: Successive First-order Reactions, Product Distribution, Quantitative Treatment of PFR, MFR and Batch Reactor.
Solid-Catalyzed Reaction: Introduction; Basic idea of catalysis, Catalyst properties, Steps in catalytic reaction: Qualitative discussion on Pore Diffusion, Adsorption, Surface reaction and Desorption, Concept of Rate limiting step; Design of reactors for gas-solid reactions: Design equation and data analysis of heterogeneous system; Quantitative aspects of Pore diffusion controlled reactions (single cylindrical pore, first-order reaction): Material balance for the elementary slice of catalyst pore, Definition of Thiele Modulus and Effectiveness Factor.
Fluid-Particle Reactions: Introduction; Different behavior of reacting solid particles; Selection of a Model; Qualitative discussion on Progressive-Conversion Model & Unreacted-Core Model; Comparison of Models with Real Solution.

Module IV: 10L
Distribution of Residence Times for Chemical Reactors: General Characteristics; Residence-Time Distribution (RTD) Function; Measurement of the RTD: Pulse Input; Related problems; Characteristics of RTD: Integral Relationships, Mean Residence Time, Different Moments of RTD, RTD in Ideal Reactor: RTD in Batch and PFR, Single CSTR, PFR/CSTR series RTD; Reactor Modeling with the RTD: Introduction, Concept of Macromixing & Micromixing, Zero Parameter Model: Segregation Model & Maximum Mixedness Model

Text Books / References:
2. Elements of Chemical Reaction Engineering, Fogler, PHI
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006 i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Separation Processes-I (CHE 505)

Module-I
10L
FUNDAMENTALS OF MASS TRANSFER:
Principles of molecular diffusion and diffusion between phases, Fick's Law, Diffusivity, Equation of continuity, Diffusion in solids. A definition of Mass transfer coefficient, other definitions of mass transfer coefficient, correlation of mass transfer coefficients, Theories of Mass Transfer, mass transfer across interfaces, Analogy between momentum, heat and mass transfer, Concept of stage wise processes.

Module-II
10L
ABSORPTION:
Introduction, The mechanism of absorption, Absorption equipment, Diameter and height calculations for packed columns, Kremser equation, H. E. T. P., H. T. U., and N. T. U. concepts, Packed tower design, height of column based on conditions in the gas film, height of column based on conditions in the liquid film, height of column based on overall coefficients, plate type towers, number of plates by use of absorption factor.

Module-IV
14L
DISTILLATION:
Introduction, Vapor - liquid equilibria, Relative volatility, Ideal and non -ideal solutions, Batch, differential and equilibrium distillation, Enthalpy concentration diagram, Rectification of binary systems, Design of rectification column, calculation of number of plates in a distillation column by McCabe-Thiele method, importance of reflux ratio, calculation of number of plates by Ponchon and Savarit method, Azeotropic & Extractive Distillations, Introduction to multicomponent distillation.

Module-IV
6L
ADSORPTION:
Introduction, nature of adsorbents, batch adsorption, Adsorption isotherms, Adsorption equipment, breakthrough curves, design of fixed bed adsorption column.

Text Books / References:
2. Transport process and Unit Operations: Geankoplis. 3rd Edn., PHI.
4. Multicomponent Distillation: Holland, C. D., PHI.
5. The Elements of Fractional Distillation: Robinson, C. S. and Gilliland, E. R. MGH.
7. Separation Processes: King, C. J. MGH.
8. Design of Equilibrium Stage Processes: Smith, B. D. MGH.
9. Distillation: van Winkle, M., MGH.

Heat Transfer Lab (CHE 591)
1. Determination of thermal conductivity of metal bar using Fourier's Equation.
2. Heat loss through lagged pipe and determination of thermal conductivity of insulating material.
3. Determination of thermal conductivity of insulating powder in a spherical vessel.
4. Determination of heat transfer coefficient of air in forced convection and to study the effect of velocities on heat transfer coefficient.
5. Determination of over all heat transfer coefficient in Counter current double pipe heat exchangers.
6. Determination of over all heat transfer coefficient in Parallel flow double pipe heat exchangers.
7. Determination of over all heat transfer coefficient and efficiency of Shell & Tube heat exchanger.
8. Determination of over all heat transfer coefficients in film wise and drop wise condensation.
10. Determination of Stefan's Boltzman constant using \( \frac{dTe}{dt} \) from temperature vs. time plot.
11. Determination of capacity and economy for single,double effect evaporator.
12. Determination of Biot Number and Fourier number in unsteady state heat transfer process

Process Equipment Design and Drawing-I (CHE 592)

1. Flow sheeting: Plan and Space layout of Chemical Processes
3. Pipeline design, valve and fittings.

Chemical Reaction Engineering Lab (CHE-593)

1. Determination of rate constant \( \mathcal{R} \), effect of temperature on \( \mathcal{R} \) and activation energy for a non-catalytic liquid phase homogenous reaction (ethyl acetate and aqueous sodium hydroxide solution) carried out in an isothermal batch reactor.
2. To predict the degree of conversion from time temperature data for the reaction: hydrolysis of acetic anhydride with water in presence of an acid catalyst (sulfuric acid) carried out in an adiabatic batch reactor.
3. Determination of rate constant \( \mathcal{R} \) and variation of the concentration of NaOH with time for the saponification reaction between ethyl acetate and caustic soda carried out in an isothermal semi-batch reactor.
4. Determination of rate constant \( \mathcal{R} \) for saponification of ethyl acetate with NaOH, a non-catalytic homogenous liquid phase reaction at ambient condition in a plug Row reactor (straight tube type).
5. Determination of rate constant \( \mathcal{R} \), effect of temperature on \( \mathcal{R} \) and activation energy for a non-catalytic homogenous reaction (ethyl acetate and NaOH) carried out in an isothermal continuous stirred tank reactor (CSTR).
6. Study of RTD in a packed bed reactor using a pulse input of the tracer to measure the axial dispersion coefficient.
7. Determination of rate constant \( \mathcal{R} \) for saponification of ethyl acetate with NaOH, a non-catalytic homogenous liquid phase reaction at ambient condition in a coil type plug flow reactor.
8. Study of RTD in a straight tube PFR using a pulse input of the tracer to measure the axial dispersion coefficient.
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6th Semester

Separation Processes-II (CHE 601)

Module-I

10L
HUMIDIFICATION & DEHUMIDIFICATION PROCESSES:
Humidification and dehumidification operations, Characteristics of saturated and unsaturated vapor gas mixtures, Dry and wet bulb thermometry, Psychometric chart, Adiabatic saturation curves, Gas liquid contact, Design of humidifiers, Dehumidification operation, Principle and design of cooling towers (Natural draft, forced draft and induced draft cooling towers).

Module-II

15L
LIQUID-LIQUID EXTRACTION & LEACHING:
Introduction to Extraction, Liquid-liquid equilibria, Triangular diagram, Selectivity and choice of solvents, Stage wise contact, co-current & countercurrent extractor, Stage type extractors and differential extractors, Determination of number of equilibrium stages by graphical method for multistage extraction, Extraction efficiency.
Introduction to leaching, general principle, factors affecting the rate of extraction, Liquid -solid equilibria, calculation of number of stages, batch processes, countercurrent washing, stage calculation methods.

Module-III

8L
DRYING & CRYSTALLIZATION:
Introduction to drying, Rate of drying, Batch drying mechanism, the mechanism of moisture movement during drying, classification and selection of dryer.
Introduction to crystallization, Theory of Crystallization, Formation and growth of crystals, crystal yield, Rate of crystallization.

Module-IV

7L
MEMBRANE SEPARATION PROCESSES:
Introduction to advance separation processes, classification of membrane processes, Dialysis, Ultra filtration, Reverse Osmosis, reverse osmosis in water treatment plant, Pervaporation, Electro dialysis, membrane fouling, liquid membrane.

Text Books / References:
1. Separation Processes: King, C. J., MGH.
3. Transport Process and Unit Operations: Geankoplis. 3rd Edn., PHI.

Chemical Process Technology – II (CHE 602)

Module I:

10L
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

**Module I**

**Soaps, Detergents & Glycerin:** Classification of cleansing compounds, uses, Methods of soap production, Methods of detergent manufacture, Methods of production of Glycerin. Process description & flow sheet of each process.

**Module II**

**Sugar and starch industries:** Manufacturing process with flow diagram, Sugar refining, manufacturing process of starch and their different by-products.

**Fermentation industries:** Industrial Alcohol, Absolute Alcohol; their production process with flow diagram.


**Module III**

**Unit operation in organic synthesis:** nitration, sulfonation, amination, Halogenation, Hydrolysis with examples.

**Petrochemicals:** Methanol, Vinyl chloride, Ethylene oxide, Isopropanol, Butadiene, Phenol and Phthalic anhydride – their manufacturing process with flow diagram and engineering problems.

**Synthetic Fibre industry:** Rayon, Nylon, Terelyne – Methods of production and flow diagrams.

**Module IV**

**Polymerisation:** Principles of polymerization, Different methods of polymerization, manufacturing process and flow diagram for Polyethylene, PVC and Phenol formaldehyde.

**Rubber industry:** Natural and synthetic rubber (SBR, Butyl rubber).

**Text Books / References:**

3. Venkateswarlu, S. (Ed.) Chemtech (II) Chemical Engineering Development Centre, IIT, Madras
6. Unit operation in organic synthesis : P.H. Groggins.

**Instrumentation and Process Control (CHE 603)**

**Module I**

Introduction: Principles of measurement. Error Analysis, Static and dynamic characteristics of instruments; Temperature measurement: Filled system Thermometer, Thermocouples, resistance thermometers, radiation and optical pyrometers; Pressure: Manometers, elastic deformation and electrical type gauges. Vacuum gauges: mechanical, electrical and ionization types; Flow: Head flow meters, area flow meters, positive displacement flow meters, mass and magnetic flow meters; Level: Direct and inferential type; composition. Analytical principles involving emission spectrometry, I R, spectroscopy, gas chromatography, Polarography, x-ray and pH.

**Module II**


**Module III**

25
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006 i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.


**Module IV** 10L


**Text Books / References:**
1. Instrumentation, measurement and analysis – B. C. Nakra & K. K. Chaudhury (TMH)
2. Process systems analysis & control – D. R. Coughanowr MGH.
3. Chemical Process Control – G. Stephanopoulos PHI.

**Numerical Methods in Chemical Engineering (CHE 604)**

**Module I:** 10L

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

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

**Module II:** 10L


**Module III:** 10L

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

**Numerical Solution of ODE:** Initial and boundary value problem- Euler's Method, Runge-Kutta Method(2nd, 3rd and 4th order), Euler's predictor-corrector method (Heun’ method)- finite difference method (forward, backward and central differences). Solution of a set of ODEs. Application in chemical and bio-chemical reaction.

**Module IV:** 10L

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

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

**Text Book and references**
1. Mathematical Methods in Chemical Engineering : V. G. Jenson and Jeffrey
2. Applied Mathematics in Chemical Engineering: Mickley TMH
3. Mathematical Methods in Chemical Engineering: S. Pushpavanam, PHI
5. Applied Numerical Methods: Carnahan, H.A.Luther and J.O.Wilkes, Wiley

**Elective – I (CHE 605)**

**Pulp & Paper Technology (CHE 605 A)**
Revised Syllabus of B.Tech in CHE(To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Classification of pulp, Pulp making process, Treatment, Bleaching and testing of pulp, By product utilization and chemical recovery processes in the paper industry, Methods of production of paper from pulp. Different paper products. Pollution control problems in paper industries, Recovery of different chemical from the waste.

Text Books / References:
3. Pulp Technology and Treatment for Paper: J. Clark, Miller, Freeman, S. F.

Catalysis & Catalytic Reactor Design (CHE 605 B)

Module I: 10L
Introduction to homogeneous and heterogeneous catalysis; Rate equation; Factors affecting heterogeneous catalytic reaction; Types of catalytic Reactor and their performance equations; Related Problems.

Module II: 10L
Catalyst Preparation; Concept of Promoter & Inhibitor; Catalysis mechanism; Langmuir-Hiselwood model.

Module III: 10L
Determination of Catalyst surface area and particle size; Pore volume Distribution; Design of Fixed Bed and Fluidized Bed Reactors; Two Dimensional Model.

Module IV: 10L
Catalyst deactivation mechanism; Related Problems; Concept of Nanotechnology in Catalyst.

Text Books/ References:
2. Elements of Chemical Reaction Engineering, Fogler, PHI

Food Processing Engineering (CHE 605 C)


Text Books / References:
2. Food Processing & Preservation, Sivashankar, PHI

Ceramic Technology (CHE 605 D)

Module-I: 10L
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

General: Concepts of Materials Science, Definition & scope of ceramics, Classification of Ceramic materials: conventional & advanced, silicate structures, Principal ceramic raw materials: general idea about their mining & purification, physical & chemical properties, availability & uses.

Module-II:  
White ware & ceramic coatings: Manufacturing process technology of white ware bodies specially high voltage & high tension insulators, bone china crockeries etc, basic properties & testing. Definition of glaze & enamel, their types & adherence mechanism, elementary ideas on their process technologies & properties.

Module-III:  

Module-IV:
Refractories & kilns: Classification of refractories-conventional & monolithies, phase diagrams of simple refractory systems like silica-alumina, magnesia-silica, magnesia-alumina, etc. manufacture, basic properties, testing & applications. Various types of kiln & furnaces used in ceramic industries with heat economy systems.

Text Books / References:
1. Elements of Ceramics: F. H. Norton, Pearson Education
2. Fine Ceramics: F. H. Norton, MGH.

Petrochemical Technology (CHE 605E)

Module I:
- Petrochemical Industries & their feed stocks: Survey of Petrochemical industry.Resources and generation of different feedstocks – their purification, separation of individual components by adsorption, low temperature fractionation and crystallization.

Module II:
- Petrochemicals based on methane, ethylene, acetylene, propylene and butane: Acetylene & methanol from methane, VCM, VAM, ethylene oxide and ethylene glycol, ethanol amines from ethylene, VCM, VAM, acrylonitrile etc. from acetylene. Isopropanol, propylene oxide, glycerine, acrylonitrile, acrylic acid, acrolien etc. from propylene. Production of Butadiene by dehydrogenation of Butane.

Module III:
- Synthetic Detergents: Classification of detergents, Production of Keryl Benzene sulphonate etc., filter, binders, dyes, perfumes etc. for detergents. Hard and soft detergents.
Revised Syllabus of B.Tech in CHE(To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Module IV: 10 L

Synthetic fibres, rubbers, plastics, resins: Method, mechanism & types of polymerization, production of HDPE, LDPE, PP, PVC, Polystyrene, Polybutadiene etc. Manufacture of Polymers, nylons, acryl fibres etc. Production of phenol formaldehyde resin, Epoxy resin Production principle of ABS plastic, polycarbonates etc. Manufacturing techniques of Butyl rubber, SBR, Isoprene rubber etc.

Text Books / References:
2. Petrochemical processes: Chauvel, Gulf Publishing
4. Advanced Petrochemicals: Dr. G. N. Sarkar, Khanna Publishers

Shellac Processing Technology (CHE 605 F)
Syllabus to be designed

Numerical Computations Lab (CHE 691)

Module-I: Numerical Methods (Programming language: C/FORTRAN)
1.0 Solution of Linear System by Gauss Elimination method and Gauss-Seidel iterative method: Steady-state solution of isothermal CSTR in Series in which a first-order reaction is taking place.
2.0 Solution of a non-linear equation by Newton-Raphson method.
3.0 Solution of a set of non-linear equations by Newton method: steady-state solution of a non-isothermal CSTR in which a first-order reaction is taking place.
5.0 Numerical solution of ODEs by Runge-Kutta method: Unsteady-state solution of Multiple reactions in a CSTR or Binary distillation column

Module-II: Use of MATLAB / POLYMATH software to solve following problems:
6.0 Solution of Linear System: Steady-state solution of isothermal CSTR in Series in which a first-order reaction is taking place.
7.0 Solution of a set of non-linear equations: Steady-state solution of a non-isothermal CSTR in which a first-order reaction is taking place.

Process Equipment Design and Drawing-II (CHE 692)
1. Design and Drawing of Evaporator.
2. Design and Drawing of Reactor.
3. Design and Drawing of Dryer.

Mass Transfer Lab (CHE-693)
1. Determination of diffusivity of volatile liquids in air using Stefan tube.
2. Study of simple batch distillation to verify of Rayleigh’s equation.
3. To draw vapor liquid equilibrium diagram using Othmer still.
4. Experiment on wetted wall column to determine $k_L$ (liquid phase mass transfer co-efficient).
5. To study the performance of a rectification column (plate type).
6. To study the absorption CO$_2$ in NaOH solution in a packed tower.
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006 i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

7. To study the drying characteristics curve under constant drying condition in a rotary vacuum or tray dryer.

8. Experiment on batch adsorption (to verify adsorption isotherms).

9. Experiment on liquid-liquid extraction (to determine overall efficiency for a three stage counter current and cross current system).

10. Determination of dry bulb temperature, wet bulb temperature, barometric pressure and psychometric properties of air.

7th Semester

Mathematical Methods in Chemical Engineering (CHE 701)

Module I

10L

Mathematical statement of Chemical Engineering problems: Introduction; Representation of the problems: Solvent extraction in two stages, Solvent extraction in N stages, Simple water still with preheated feed, unsteady state operations; Dependent and Independent variables and parameters; boundary conditions.

Matrix: Introduction; Matrix algebra; Determinant of square matrix and matrix products; Transpose, Adjoint & Inverse of a matrix; Rank & degeneracy of a matrix; Sub matrix; Solution of linear algebraic equations; Matrix series; Differentiation & Integration of matrix; Lambda matrix; Characteristics equation; Sylvester’s theorem; Solution of systems of linear differential equations by matrix.

Module II

10L


Solution by series: Introduction; Infinite series; Power series; Method of Frobenius and Related problems: Temperature distribution in a transverse fin of triangular cross section, Tubular gas preheater; Bessel's Equation, Problem of heat loss through pipe flanges, properties of Bessel function.

Module III

10L

Partial differentiation & Partial Differential Equations: Introduction; Interpretation of partial derivatives, Formulation of partial differential equations; Boundary conditions; Particular solutions of partial differential equations; Orthogonal functions; Method of separation of variables; Laplace transform method.

Module IV

10L

Finite Differences: Introduction; The Difference Operator ($\Delta$); other difference operators; Interpolation & Extrapolation; Finite Difference Equations: Linear Finite Difference Equations & Nonlinear Finite Difference Equations; Differential-Difference Equations; Related Chemical Engineering Problems.

Text Book/ References:

2. Mathematical Methods in Chemical Engineering: S. Pushpavanam: Prentice Hall of India

Modeling, Simulation and Optimization (CHE 702)

Module I

10L

Introduction to mathematical Model and Simulation: Concept of Mathematical model, simulation and process analysis. Lumped and distributed parameters models- hydraulic tank, mixing vessel, simultaneous mass and energy balance.

Modeling of Batch and Continuous Process: Batch heating of multi-component flash drum, Steady-state flow processes involving non-reactive systems-Extraction column (plate type), Continuous heating in a stirred tank using jacket and using coil, Mixing in flow processes.
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006 i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Module II: 10L
**Modeling of Heat and Mass Transfer:** Concentration gradient across a bubble plate, Simultaneous heat and mass transfer in packed bed, Start-up of double pipe heat exchangers, Shell and tube heat exchanger, Simulation of multi-component distillation column: Wanke-Henke bubble method, sum-rate method and simultaneous correction method.

Module III: 10L
**Chemical Reactor Simulation:** Modeling and simulation of isothermal and non-isothermal operation of batch reactor, CSTR and Semi-batch reactor, Steady-state multiplicities in CSTR, Thermal stability analysis of CSTR, Non-isothermal operation of a single-homogeneous gas phase reaction in PFR, Diffusion and chemical reaction-catalytic reaction in packed bed reactor.

Module IV: 10L
**Introduction to Flow sheeting:** Concept of flow sheeting, Various methods of flow sheeting-equation oriented approach and modular approach.

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

**Text Book/ References:**
1. Luyben, W.L., Process modeling simulation and Control, MGH
2. Edger, T.F. and Himmelblau, D.M., Optimization of Chemical Process, MGH
3. Henley and Seader, Multistage separation
4. Froment and Bischoff, Chemical reactor analysis and design, Weiley.

Project Engineering (CHE 703)

Module I: 10 L
**Basis of chemical plant design:** Steps in process development, feasibility survey, pilot and semi commercial plant design, scale up and scale down techniques, plant location and plant lay out, plant utilities, environment and safety clearances.

Mathematical tools for analysis in design: Basic statistical techniques, testing of hypothesis, t-test, F-test, chi-square test, basic concepts of ANOVA, one way and two way classification models.

Module II: 10 L
**Depreciation:** Types of depreciation, Depletion, concepts of service life, salvage value, and book value, straight-line method, text book and double declining balance method, sum of the years digit method and sinking fund method for determination of depreciation.

Interest, annuities, costing and project evaluation: simple, compound and continuous interest, annuity, fixed and working capital, factorial method of cost estimation for plants, present worth, cash flow and discounted cash flow and rate of return, pay-back period, perpetuity and capitalized costs, pay out period, sensitivity analysis, alternative investments and replacements.

Module III: 10 L
**Optimum Design and Design strategy:** Basic principle of Optimum Design, general procedure for determining optimum conditions, Breakeven analysis, Optimum production rate in plant, determination of optimum economic pipe diameter and optimum flow rate in condenser, optimum design in separation columns.
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Module IV: 10 L
Bar chart, Gantt chart, Milestone Chart, Concepts of Network Analysis: PERT, CPM, Numbering a network, Statistical distribution associated with PERT network, Earliest Expected time and Latest allowable occurrence time calculation, Slack, determination of critical path, concepts of Float.

Revision: 5L

Text Book/ References:
1. Peter and Timmerhaus, Plant Design and Economics for Chemical Engineers.
2. Himmelblau, Chemical Engineering Plant Design.
3. Sinnott, R.K., Coulson and Richardson’s Chemical Engineering Vol. 6 (Chemical Engineering Design)
4. Montgomery, Design of Experiments

Elective-II (CHE 704)

Polymer Science & Engineering (CHE 704 A)

Definitions and concepts of terms used in polymer engineering, Polymerization reactions, Polymer structures functionality and Degradation, Characterization of polymers, Molecular weight, Physical, Chemical and Mechanical properties and their determination, Classification of polymers, Methods of polymerization, Mechanism and Kinetics of polymerization, Analysis of polymerization reactions, Polymer processing, molding, Cold and hot compression, Transfer injection and jet types extruding, Calendening, Skiving, Sheet forming, Atmospheric and fluid pressure forming, Lamination and impregnating, Coating, Expanding, Casting, Embedding, Spinning and finishing.

Text Books / References:
3. Outlines of Polymer Technology, Sinha, PHI

Petroleum Refinery Engineering (CHE 704 B)

Module I: 10 L
Exploration and Refining of Crude Oil: Introduction, Indian and world reserve of crude oil and its processing capacity, Market demand & supply of petroleum Fractions. Exploration, Drilling and Production of crude oil; engineering data of crude and fractions. Characterization factor, Key Fraction Number and correlation index methods for evaluation of crude & fractions. TBP, ASTM, EFV, and their inter-convertibility, yield Curve etc.

Module II: 10 L
Desalting of crude, pipe still furnaces, preflashing operation, Atmospheric and vacuum distillation units, different types of Reflux arrangements, Calculation of tray requirement for ADU column, Test methods and specifications: Distillation, Aniline point, Reid vapour pressure, Smoke point, flash point fire point, Carbon residue, viscosity and viscosity index, refractive index, Copper & silver strip corrosion, Octane No, cetane No, sulphur content, calorific value, Total acid number, oxidation stability, cloud point, pour point etc.

Module III: 10 L
Thermal conversion Processes: Thermal cracking processes – mechanism, applications e.g. visbreaking, thermal cracking, coking operations, Catalytic Conversion Processes: Catalytic cracking processes, Different FCC operating modes, Catalytic reforming operations, Hydro cracking, Simple process calculations.

Module IV: 10 L
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Finishing & Treatment processes: Different Hydrotreatment (eg. Hydro desulfurization) processes, Merox process, Doctor’s sweetening, Smoke point improvement, etc. Simple process calculations
Alternative fuels, Production and Specifications: Synthetic gasoline, Bio Diesel, Ethanol, Automotive LPG

Text Books / References:

Tea Processing Technology (CHE 704C)
Syllabus to be designed

Fertilizer Technology (CHE 704 D)
Types of fertilizers and their uses, Production and consumption patterns, Raw materials, Mini and large plants their merits and demerits, Symbiosis, Different nitrogen fixation Processes, Nitrogen cycle in the nature, Different nutrient of the soil and their removal, Status of ammonia production, Synthesis gas by reforming hydrocarbons from natural gas and naphtha. Consideration for primary reformer design, Secondary reforming design and operation, Synthesis gas by partial Oxidation of hydro-carbons, Reactor volume calculation, Sources of hydrogen, Gas purification, Shift reactor design, Methods for removal of carbon dioxide, Carbon dioxide absorber design, ammonia synthesis, Kinetics and catalysis, Urea superphosphate and other fertilizers.

Text Books / References:

Advanced Separation Processes (CHE 704 E)


Module II: Ultrafiltration: UF modules, applicability, concentration polarization.
Reverse Osmosis: Fundamentals of RO, Osmotic pressure, relation between chemical potential & osmotic pressure, factors affecting the performance of RO plant, RO membrane module, membrane age, advantages, disadvantages and application of RO process.

Chromatographic Separation: Theory of Chromatographic separation, selectivity or separation factor, Efficiency of Chromatographic system, types of Chromatography, Liquid Chromatography, Liquid-Solid Chromatography, Advantages & Disadvantages of Chromatographic Separation.
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e., for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

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

Revision: 5 L

Text Book/References:
1. J.D. Seader and Ernet J. Henlay; Separation Process Principles.
2. C.J. King; Hand Book of Mass Transfer.
3. John J. Meketta; Unit Operation.
4. Perry's Chemical Engineers Hand Book, MGH

Industrial Management (HU 715)

Module I: 10L
Principles of Management: Taylor and Fayol, Concept of production and productivity. Types of production system. Inventory control-EOQ Model, Model with price discount. MRP. Quality control: SQC (Acceptance sampling and control charts).

Module II: 10L
Financial statement and analysis: Basic Financial concepts, Risk and Return, liabilities, Importance of ratio analysis, types of ratios, liquidity ratio, current ratio, profitability ratio, Debt-equity ratio, expenses ratio, activity ratio, return on asset, Du-Dont chart.

Module III: 10L
Fund and cash flow analysis, Budgetary control, Different types of audit, Problem of allocation of limited resources in an optimal way.

Module IV: 10L
Formulation of linear programming problem, Graphical methods, Simplex techniques, Transportation and assignment models. Introduction to game theory, Equivalence of matrix game (2×2, m×2, m×m, 2×m) games.

Text Books/References:

References:
c. Modern Production and Operation Management:Buffa and Sarin, John Wiley.
d. Finantial Management: I.M.Pandey, Vikas

Project Work/ Plant Design (CHE 791)
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Each student shall be required under the supervision of a faculty to prepare a project work on a topic of design or to carry out investigation on an industrial research problem; the design / research work has to be carried out by the student himself occasionally consulting his supervisor. The work has to be allotted at the beginning of the seventh semester indicating the items to be carried out by the student. The report in duplicate has to be submitted in typed and bound form before the commencement of the VIII (final) semester examination. The examination shall include presentation of the research/ design report and a viva-voce.

**Processes Instrumentation and Control Lab (CHE 792)**

1.0 Temperature Measurement using Resistance Temperature Detector (RTD), Thermocouple.
2.0 Pressure gauge calibration using Dead Weight Tester
3.0 Liquid-Level Measurement using Air-Purge Method
4.0 Measurement using Load Cell
5.0 Study on Responses of First and second-Order Interacting and non-interacting Systems

6.0 Studies on Characteristics of Control Valve
7.0 Studies on the Stability and tuning of a Flow Controller
8.0 Response of a P & PI Controller
9.0 Demonstration of Bourdon tube, diaphragm gauge, etc

**Process Equipment Design and Drawing-III (CHE 793)**

1. Design and Drawing of the followings:
2. Absorption/ Stripping Column.
3. Rectification Column
4. Induced Draft Cooling Towers.

**Report and Viva-Voce on In-plant Training (CHE 794)**

Report should consist of:
1. A general overview of the Plant.
2. The products and raw material sources of the Plant.
3. Details of different equipments like valve, pump, heat exchanger, furnace, storage vessel, piping, basic control configurations etc.
4. Scheduling and Optimization of plant operations.

**Seminar (CHE 795)**

A Seminar topic will be allotted to individual student according to his/her subject of interest (students are also suggested to propose topics with relevant research papers during the time of allotment). A thorough report should be prepared based on which seminar presentation and question-answer session will be conducted

8th Semester
Transport Phenomena (CHE 801)

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

Vectors & Tensors:
Geometric representation of vectors; Einstein summation convention; Basic review of vector algebra; Representation using Kronecker delta and alternating unit tensor; Review of vector calculus. Tensors: dyadic products with another tensor, vector etc; tensor operations required for stress analysis.

Module II  
Momentum Transport:
Viscosity, Newton’s law of viscosity, calculation of momentum flux, Non-Newtonian fluids – Bingham model, Ostwald-de Waele model, Eyring model, Reiner-Philippoff model.

Shell momentum balance and boundary conditions – Flow of a falling film with constant/variable viscosity, Flow through a circular tube, Flow through annulus, Flow of two adjacent immiscible fluids, Creeping flow around a sphere.

Equations of Continuity and Motion in rectangular (Cartesian) coordinate system, Expression of stress tensor for Newtonian and non-Newtonian fluids; Special forms of equation of Motion – Euler equation, Navier-Stokes equation. Transformation of equations of Continuity and Motion to cylindrical coordinate system by changing variables and using vector calculus.

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

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

Dimensional analysis of equations of Continuity and Motion.

Module III  
Energy Transport:
Modes of heat transfer; concepts of (a) thermal conductivity – constant and temperature dependent, (b) thermal diffusivity and (c) heat transfer coefficient. Fourier’s law of heat conduction.

Shell energy balance and boundary conditions – Heat conduction with electrical, nuclear, viscous and chemical heat source, Heat conduction through composite walls, Heat conduction in fins.

Free convection – flow between two vertical walls.

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

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

Dimensional analysis of equation of Energy.

Module IV  
Mass Transport:

Shell mass balance and boundary conditions – Diffusion through stagnant gas film, Diffusion in a falling film, Diffusion with heterogeneous chemical reaction, Simultaneous mass and heat transfer problem.
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006 i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Equations of Continuity for binary mixture, simplification of general equation for special cases.

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

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

**Text Books:**

Biotechnology & Biochemical Engineering (CHE 802)

**Module I:**
10L
Introduction to biochemical Process industries; interaction of chemical engineering principles with biological systems; Microbiology; Fermentation pathways; Reactions in living systems.

**Module II:**
10L
Biocatalysts; enzymes and enzymatic reactions; Michaelis-Menten equation and its various forms; enzymatic immobilization and Kinetics of immobilized systems with diffusion.

**Module III:**
10L
Fermentation; Mechanism and kinetics (Monod model); types of fermenters; chemostat; chemostat, PFR, fluidized bed reactor, Bubble column and air lift fermenter; Mass transfer in microbial reactors; mixing phenomenon in bioreactors (RTD); sterilization of air and media; design of sterilizers.

**Module IV:**
10L
Downstream processing; separation process for cell mass and product, filtration, Centrifuging, membrane processes (Reverse osmosis, ultrafiltration, chromatographic separation,

**Text/Reference Books:**

Environmental Engineering (CHE 803)

**Module I:**
10 L

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

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

**Module III:**
10 L
Revised Syllabus of B.Tech in CHE(To be followed from the academic session, July 2006 i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Solid waste management, Sources and classification, public health aspects, Methods of collection and disposal methods: open dumping, landfill, incineration, composting, vermiculture; Solid waste management using bioremediation for specific pollutants like chromium, Mercury, ammonia / urea, phenolic sludges.

Module IV: 10 L
Pollution control in selected process industries – fertilizer industries, petroleum refineries and petrochemical units, pulp and paper industries, Tanning industries, Sugar industries, Dairy, Alcohol industries, Electroplating and metal finishing industries, Radioactive wastes, ranking of wastewater treatment alternatives.

Text Books / References:
1. Pollution Control in process industries – S.P. Mahajan
2. Introduction to Environmental Engineering – Connwell & Devis. TMH.
3. Wastewater treatment for pollution control – S. J. Arceivala, TMH
5. Wastewater Engg. – Metcalf & Eddy, TMH
6. Environmental Pollution Control Engineering – C S Rao, New age
7. Standard Methods APHA / AWWA

Elective III (CHE 804)
Nanotechnology (CHE 804 A)
Introduction; Concept of miniaturization; Use of Microlithographic techniques to achieve dimensions less than 1000 nanometers; Sub-micron Lithography; Molecular Nanotechnology or Molecular Manufacturing; Concept of positional assembly and massive parallelism in Nanotechnology; Surface properties of fabricated Nanotechnological elements.

Text Book/ References:

Operation Research (CHE 804 B)
Introduction, Decision making, Development of OR, Application of OR, Linear programming, Formulation of LP models, Graphical solution, Simplex method, Duality theory and application, Transportation problem, Assignment problem, Network models, CPM and PERT, Crashing of network, Waiting line models, Elements of queuing models, Poisson arrival and exponential service time distribution, M/M/1 Queue, Finite population models, Queuing cost models, Simulation modeling, Use of random numbers, Flow chart development, Inventory control, Deterministic and Stochastic models, Buffer stocks.

Text Books / References:
1. Introduction to Operations Research: Gillett. TMH
2. Operations Research, Panneerselvam, PHI
3. Operation Research: Gupta, P. K. and D. S. Hira

Computational Fluid Dynamics (CHE 804 C)
Introduction to Computational Fluid Mechanics and Heat Transfer – Modeling of Transport Phenomena
Transport Equations – Equations of Continuity, Motion, Energy in dimensional and non-dimensional forms – Lagrangian and Eulerian forms
Conservative and Non-conservative forms of transport equations
Equations – Elliptic, Parabolic and Hyperbolic
Understanding the convection and diffusion terms
Generalized Advection-Diffusion Equation with source term
Initial condition and Boundary conditions – three kinds
West Bengal University of Technology
BF-142, Salt Lake City, Kolkata-700064

Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006, i.e., for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

Concept of discretization – Taylor series FDM and CV based FVM – one-dimensional unsteady state heat diffusion equation - Treatment of boundary conditions
Numerical solution of PDE - Explicit method – Stability – Convergence – Consistency
Thomas (Tri-diagonal Matrix) Algorithm - Implicit method
Discretization of two-dimensional unsteady state heat diffusion equation – Numerical solution - ADI method – Line-by line solution for multi-dimensional problem
Vorticity-Stream function approach
Primitive variable approach - Staggered grid
Discretization of the convection term - Upwind scheme - Central Difference scheme - Hybrid scheme - Power law scheme
Evaluation of pressure from Equation of Continuity
Pressure correction - Velocity correction
SIMPLE Algorithm – Residues in solution – Relaxation
Iterative scheme – Over and under relaxation - quick updation
Discussion on SIMPLER, SIMPLE-C
Solution of coupled equations – Thermal buoyancy
Validation of code and results – Benchmarking - Benchmark cases - Lid driven cavity - Flow in pipe - Estimation of location of vena contracta in orifice flow – Rayleigh-Benard convection

Test Books/References:
4. Computational Fluid Dynamics: P J Roache
7. Physical and Computational Aspects of Convective Heat Transfer: Tuncer Cebecci and Peter Bradshaw. Springer (Paperback Ed)

Safety and Hazard management (CHE 804 D)

Module I: 10L
Scientific principles, Engineering aspects of industrial safety in relation to economic and operational aspects, Safety regulations, Wind roses, Hazards due to fire, explosions and toxic chemicals, Fire Triangle, BLEVE, Runaway reaction, etc.

Module II: 10L
Tools for hazards identification: HAZOP, Fault Tree, Event Tree, FMEA, Dow Fire and Explosion Index, Mond Index, Safety Audits etc.

Module III: 10L
Risk analysis concept and methodology: Risk concept and measure of risk, Risk acceptance criteria, Quantitative risk analysis, Probit number.

Module IV: 10L
Engineering control of chemical plant hazards, Intensification and attenuation of hazardous materials, Industrial plant layout, Ventilation and lighting, Electrical system, Instrumentation etc, Fire prevention, Personnel protection devices, Laboratory safety, Emergency safety, Safety systems and disaster management.

Text Books & References:
3. Hazardous Waste Management: Wentz, C. A. MGH.
4. Environmental Risks & Hazards, Cutter, PHI
Revised Syllabus of B.Tech in CHE (To be followed from the academic session, July 2006 i.e. for the students who were admitted in Academic Session 2005-2006). The syllabi of other semesters will be published soon.

5. Chemical Engineering (vol-6): Coulson and Richardson

**Total Quality Management (CHE 804 E)**

**Module: I**

10L

Basic concepts— Three paradigms of management and evolution of concept of quality management, Organization: its basic objectives and goal, Mission and Vision, customer and secondary customer, Deming’s wheel, bottom line: profit vs quality, historical defilements: Juran, Deming, Ishikawa and Taguchi, Kaizen, JIT.

Basic statistical concepts associated with quality management, measurement of central tendency and dispersion, range versus variance, quality and process capability, probability distributions, concept of statistical quality control.

**Module: II**

10L

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

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

**Module III**

10L

Tools and techniques for improvement in TQM: type A techniques with a special reference to FPC & FD, QFD, SWOT analysis; type B techniques with a special reference to brainstorming, stratification, Ishikawa diagram, check sheet, Pareto diagram

Philosophy and concept of quality circle: formation, steering committee, power and functions of leader, dy. Leader, coordinator, facilitator, case studies.

**Module IV**

10L

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

**Text Books / References:**

2. Total Quality Management – A Primer: Sundara Raju S. M., TMH.
3. Fundamentals of Quality Control Improvement, Mitra, PHI
4. TQM -SK Ghosh, Oxford

**Project Work/ Plant Design (CHE 891)**

Each student shall be required under the supervision of a faculty to prepare a project work on a topic of design or to carry out investigation on an industrial research problem, The design / research work has to be carried out by the student himself occasionally consulting his supervisor. The work has to allotted at the beginning of the seventh semester indicating the items to be carried out by the student. The report in duplicate has to be submitted in typed and bound form before the commencement of the VIIIth (final) semester examination. The examination shall include presentation of the research/ design report and a viva-voce

**Report and Viva Voce on Project Work/ Plant Design (CHE 892)**

Defense of Project–Viva on the project in presence of external examiner along with internal teachers.

**Comprehensive Viva Voce (CHE 893)**

This is a Viva – Voce examination to ascertain the student’s overall grasp of the principles of Chemical Engineering and allied subjects
Students who have not studied Chinese language during their secondary education / who have not attained the requisite level of competence in the Chinese language to take CENG1001 can apply (i) to take credit-bearing Cantonese or Putonghua language courses offered by the School of Chinese especially for international and exchange students; OR (ii) to be exempted from the Chinese language requirement and to complete ENGG1003 Mathematics I (6 credits) AND CIVL2006 Soil Mechanics (6)

**SYLLABUS**
The syllabus applies to students admitted in the academic year 2014-15 and thereafter under the four-year curriculum.

**Definition and Terminology** Each course offered by the Department. More information. Syllabus of B.Tech in ECE (To be followed from the academic session, July 2011, i.e. for the students who were admitted in Academic Session 2010-2011) 2. 3. 4. 5. 6. 7. 8. 9. 10. Bell-Electronics Devices and Circuits-Oxford Dimitrijev- Semiconductor Devices- Oxford Singh & Singh- Electronics Devices and Integrated Circuits â€” PHI Bogart, Bisley & Rice- Electronics Devices and Circuits- Pearson Kasap-Principles of Electronic Materials and Devices-TMH Boylestad & Nashelsky- Electronics Devices and Circuit Theory- Pearson Salivahanan, Kumar & Vallavaraj- Electronics Devices and Cir Meanwhile, studentsâ€™ academic performance was measured using Grade Point Average (GPA). The results showed that there was a significant correlation of high level anxiety and low academic performance among engineering students, with significant correlation (p=0.000) and the correlation coefficient is small with r=-.264. Large of sample size required to strengthen the coefficient correlation was suggested for further research. Are created by insensible teaching or an over demanding syllabus. This then pushes students towards the surface. A form is to the write on each item-statement that best describes the intensity of their feelings: (1) not at all; (2). somewhat; (3) moderately so; (4) very much so. In responding to the T-anxiety scale (STAI Form Y-2) consists of.