University of Technology
Chemical Engineering Department

B.Sc. PROGRAMME
IN
CHEMICAL ENGINEERING

OUTLINE OF
SYLLABUSES ALLOCATION OF SUBJECTS
&
WEEKLY LOAD

1991 - 1992
INTRODUCTION

Chemical Engineering is distinguished from other branches of Engineering by its strong dependence on chemistry. This enables the chemical engineer to understand properties involving changes in physical state, chemical composition, or energy content for systems ranging in scale from molecules to full sized manufacturing plants.

The chemical engineer may be employed in an established industry producing chemicals, petroleum products, petrochemicals, pharmaceuticals, synthetic Fibers, Foods, plastics or metals. These products are steadily needed in an increasing amounts due to the expanding growth of population. His function may be involved in making innovations in existing operations, doing research, development and analysis of existing plants, technical services, or scale up.

Due to his board knowledge, the chemical engineer often occupies a dominant position in the above mentioned industries.

He may also apply his knowledge in such diverse areas as air and water pollution or biomedical research.

The formal course work for B.Sc. Programme involves mathematics, including both analysis and computer applications, chemistry, mechanics, electricity and chemical engineering principles and practice subjects including fluid dynamics, heat transfer, unit operations, chemical reactor
design, thermodynamics, and chemical processes. In addition, the programme involves subjects in humanities and social sciences to help the student to a fuller appreciation of his relationship and responsibility to society in general.

A considerable emphasis is laid, in this department, on practical training and laboratory work, which helps students in getting better understanding of the theoretical part of their curriculum.

Moreover students are required to spent twelve weeks, training in industry during summer vacations.

This booklet contains the academic programme and the syllabus for both technical and social subjects which are taken by the chemical engineering students during their four years study.

Prof. M. S. Hamood

Chairman of Chemical
Eng. Dept.
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# First Year B.Sc Syllabus

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**Note:**

* 1st term

** 2nd term

Total hours: 30 hours
### Second Year B.Sc Syllabus

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**Note:**

* 1<sup>st</sup> term
** 2<sup>nd</sup> term

Six weeks industrial training
# Third Year B.Sc Syllabus

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**Note:**

* 1<sup>st</sup> term

** 2<sup>nd</sup> term

Six weeks industrial training
### Fourth Year B.Sc Syllabus

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**Note:**

* 1st term
** 2nd term

Total hours: 26.5 hours
Total hours for the four years = 116.5 hours
Total units for the four year = 145 units
First Year B.Sc Syllabus

1-1 National Education and Socialism

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Refer to centralize curriculum
1-2 Mathematics (1)

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1- Revision
Slope and equation of the straight line, Trigonometric functions and their sketches, Functions, Definitions; Domain, Range, Inverse of functions, Absolute value, Limits, Definitions of the limit of a function Theories about limits, Lim$_{x\to0}$ sin $x/x$, Continuity, Differentiation and integration of algebraic functions.

(12 hrs)

2- Determinants
Definitions and properties, Solution of systems of equations (Cramers Rule).

(9 hrs)

3- Solution of the Algebraic Equations
Second and third order.

(3 hrs)
First Year B.Sc Syllabus

4- Transcendental Functions
   Trigonometric, INV., Natural logarithmic, Exponential and power functions, Sketches.
   (12 hrs)

5- Conic Sections
   Circle, Parabolic, Ellipse.
   (4 hrs)

6- Hyperbolic Functions
   Definitions, Derivatives and integrals.
   (4 hrs)

7- Application of Integrals
   Area between two curves, Volumes, Length of curves, surface area.
   (12 hrs)

8- Methods of Integration
   Basic formula, Power of trigonometric functions, Integrals involve \( \sqrt{a^2 - x^2}, \sqrt{a^2 + x^2}, \sqrt{x^2 - a^2} \), Integrals of \( ax^2 + bx + c \), Partial functions, Integration by parts, The substitution \( U = \tan \left( \frac{x}{2} \right) \), Improper integrals (conv. and dity).
   (15 hrs)
First Year B.Sc Syllabus

9- Complex Numbers
Definitions, Argands diagram, Product and quotient of two numbers, \( z = r (\cos r + i \sin r) \) and roots of equation, conjugate numbers, DeMoivros theorem.

(6 hrs)

10- Vector Analysis
Vector components and the unit vector \( i \) and \( j \), Addition and subtraction of vectors, Length of vector, multiplication by scalars, Zero vector, Direction, Unit vector.

(1 hrs)

11- Polar Coordinates
The polar coordinates system, Graphing of polar coordinates, Derivatives and tangent lines and area in polar.

(5 hrs)
First Year B.Sc Syllabus

1-3 Material and Energy Balance

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1- Concept of Chemical Engineering
Units, Dimensions, Conversion factors, Temperature, Pressure, Composition, Chemical analysis, Chemical equations.

(24 hrs)

2- Material Balance Calculation
Without and with chemical reaction, Recycle, By pass and purge calculations for study state, Combustion calculation.

(30 hrs)

3- Definitions of Ideal Gas Laws
Real gas, Vapour pressure calculation.

(9 hrs)

4- Energy Balance
General energy balance, Enthalpy, Heat capacities their predictions and variation with temperature, Heat effects.

(15 hrs)

5- Simultaneous, Mass and Energy Balance.

(12 hrs)
First Year B.Sc Syllabus

1-4 Analytical Chemistry

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1- Introduction
Atomic weight, Molecular formula, Chemical equations, Mole concept, Chemical equilibrium. (2 hrs)

2- Solution
Definition, Preparation and properties, Concentration; Physical Methods, Percentages, PPM, Chemical methods; Molarity, Molality, Normality, Formality, PH, POH, Solubility, Dilute solutions, Saturated and supersaturated solutions. (8 hrs)

3- Analytical Methods of Analysis
a- Qualitative Analysis (2 hrs)
First Year B.Sc Syllabus

b- Quantitative Analysis
i- Volumetric (titrimetric) analysis, Acid - base, Redox, precipitation, Complex titration, Methods of calculations, Titration curves.

ii- Gravimetric Analysis
Precipitation reactions; Direct and indirect methods of analysis, ksp.

iii- Instrumental Methods of Analysis;
   a- Electromagnetic spectrum
   b- Photochemistry; Photometric methods, Colourimetry, atomic absorption.
   c- PH - meter

Note:

* 1st term
First Year B.Sc Syllabus

1-5 Organic Chemistry

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1- Introduction
Definition, Carbon atom, Classification of organic compounds.

3 hrs)

2- Aliphatic Compounds
Nomenclature, Preparation, Properties, Reaction:
a- Alkanes  b- Alkenes  c- Alkynes

26 hrs)

3- Aromatic Compounds
Structural formula of benzene ring, Nomenclature, Preparations, Properties, Chemical reactions; Nitration, Sulphonation, Halogenation, Alkylation, Benzene - homologues; Preparation properties, Chemical reactions of:- toluene, xylene, ethyl benzene, styrene, phenols, anilines, naphthalene.

(20 hrs)
First Year B.Sc Syllabus

4- Heterocyclic Compounds
   Pyridine, Furan, Pyrrole (3 hrs)

5- Introduction to Polymer and Carbohydrates (4 hrs)

6- Organo - Metallic Compounds (4 hrs)

Note:

** 2nd term
**First Year B.Sc Syllabus**

**1-6 Engineering Drawing**

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1- Introduction

Drawing instruments and their uses, Types of lines used in drawings.

(12 weeks)

2- Geometrical Constructions

(12 weeks)

3- Pictorial Drawings (Isometric and Oblique)

(12 weeks)

4- First and Third Angle Projection. Multiview drawings.

(12 weeks)

5- The Findings of 3rd View

(12 weeks)

6- Sectioning

(12 weeks)

7- Fastners

(12 weeks)

8- Assembly and Detail Drawing

(12 weeks)
First Year B.Sc Syllabus

1-7 Mechanics and Strength of Materials

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A- Mechanics

1- Principles of Statics

2- Resultants of Force Systems

3- Equilibrium of Force Systems

4- Friction

5- Centroids and Centers of Gravity

6- Moment of Inertia

7- Frame Works Analysis

8- Forces in Space

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First Year B.Sc Syllabus

B- Strength of Materials

1- Internal Forces in Non - Rigid Bodies (1 hr)
2- Definition of Stress and Strain
   Types of stresses and strains, Shear stress. (2 hrs)
3- Hooks law (2 hrs)
4- Free - Body Diagrams (: hr)
5- Stress - Strain Diagrams
   Stress, Strain diagrams for ductile and brittle materials. (: hrs)
6- Proportional Limits
   Elastic limit, Stiffness elasticity, Plasticity, Toughness resilience, Hardness, Poisson's ratio, Bulk modulus. (: hrs)
7- Composite Stress (1 hrs)
8- Thermal Stress (: hrs)
9- Torsion and Power Transmission by Shaft (: hrs)
10- Beam, Shear and Moments in Beams Deflection (1 hrs)
First Year B.Sc Syllabus

1-8 Computer Science

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1- Introduction
The need of data processing, Historical background, Application of computers, Electronic computer generations, Kind of computers, Micros, minis, and main-frame.

(3 hrs)

2- Computer Hardware
Peripherals, Binary system

(1 hrs)

3- Programming Languages
Low level, High level

(3 hrs)

4- Programming In Basic
Algorithms and flowcharts, Input/output, Control statements, Arrays

(4 hrs)
First Year B.Sc Syllabus

1-9 Work Shop

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1- Automotive Mechanics
2- Electricity
3- Foundary
4- Carpentry
5- Fitting
6- Sheet Metal
7- Machining
8- Welding
9- Forging
Second Year B.Sc Syllabus

2-1 National Education and Socialism

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Refer to centralize curriculum
Second Year B.Sc Syllabus

2-2 Mathematics

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1- Partial Differentiation

Functions of two or more variables, Limits and continuity, Partial derivatives, Chain rule, Gradients, Directional derivatives, and tangent plane, Higher order derivatives, Maxima, minima and saddle points, Lagrange multipliers

(10 hrs)

2- Complex Algebra

Revision, The complex variables, Derivation of complex variables, Analytic function, Integration of functions of complex variables and Cauchy's theorem.

(4 hrs)

3- Multiple Integrals

Double integrals, Area, Triple integrals in rectangular coordinates, Physical application in the three dimensions.

(4 hrs)

4- Ordinary Differential Equations

Solution of first order ordinary differential equations, Solution of second order ordinary differential equations,
Solution of higher order ordinary differential equations.

(3 hrs)

5- Vector Analysis
Revision, Quadratic surfaces, Green's theorem, Stock's theorem.

(4 hrs)

6- Function and Definit Integrals
The error function, The gamma function, The beta function, Evaluation of definit integrals.

(6 hrs)

7- Infinite Series
Power series of functions, Taylor's theorem, Convergence of power series, Integration, Differentiation, Multiplication and division, Fouries series, Even and odd functions, Half range expansion, Periodic functions

(10 hrs)

8- Matrices

(8 hrs)
2-3 Fluid - Mechanics

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1- Introduction

Physical Properties of fluid, Definition of type fluid (Fluid, Newtonian, Non - Newtonian, Incompressible, Compressible fluid and static, dynamic fluid).

(2 hrs)

2- Dimensional - Analysis

Rayleigh's method (normal method), Buckingham's OPO theorem.

(6 hrs)

3- Fluid Static

Pressure measuring devices (manometers, mechanical gauges, tanks head).

(4 hrs)

4- Incompressible Fluid, (Newtonian fluid)

Continuity equation, Derivation of Bernulli's equation, correction to Bernulli's equation, Effect of friction, Calculation of friction in straight pipe and fitting, Calculation of pressure drop in straight pipe.

(10 hrs)
Second Year B.Sc Syllabus

5- Flow Measurement
   Pitot tube, orifice meter, venturi meter, Rotameters,
   Notch or weirs.  
   (12 hrs)

6- Pumping of Liquid
   Calculation of Total head, NPSH, Performance characteristics curve, Calculation of horsepower, Equipment.
   (6 hrs)

7- Non-Newtonian Fluid
   Definition, Type of fluid depend on time, Calculation of friction & pressure drop for general time independent in laminar & Turbulent flow.
   (2 hrs)

8- Compressible Fluid
   Pressure wave, General equation, General eq. for isothermal & adiabatic condition, Work for isothermal & adiabatic, equipment.
   (12 hrs)

9- Flow of Fluid Through Granular Beds & Packed Column
   Fixed bed, Fluidised bed
   (6 hrs)
Second Year B.Sc Syllabus

2-4 Properties of Materials

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1- Atomic Structure  
(4 hrs)

2- Crystaline Structure  
(5 hrs)

3- Miller Indices, X-Ray diffraction  
(3 hrs)

4- Imperfection in Crystals  
(4 hrs)

5- Atoms Movements in Engineering Materials  
(4 hrs)

6- Thermal Properties of Engineering Materials  
(2 hrs)

7- Electrical Properties of Engineering Materials  
(3 hrs)

8- Solid Solution  
(2 hrs)

9- Phase Diagrams  
(1 hrs)
Second Year B.Sc Syllabus

10- Ferrous Metals and Non-Ferrous Metals and their Alloys
(6 hrs)

11- Corrosion
Types of Corrosion and Corrosion Prevention
(6 hrs)

12- Polymers
Definition, Classification, Molecular weight distribution, Effect of molecular weight on the properties of polymers, Types of polymers and rubbers and their uses.
(6 hrs)

13- Ceramics
Action of heat on clays SiO_2 – Al_2O_3 – Phase diagram, Differential thermal analysis (DTA), Refractories and glasses.
(6 hrs)

14- Composite materials
Methods of preparation of composite materials, (cermets), Mechanism of adhesion between metallic molten and ceramics materials. Fibers and types, Reinforced plastic, Dispersion of powder without and with phase change.
(6 hrs)

Note:

** 2nd term
2-5 Computer Programming

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1- Control Statements
GO TO, IF Then, Looping, For, Next, Multiple Loops, ON GO TO, Application in series evaluation, Statistics, and Newton - Raphson Iteration.

(6 hrs)

2- Subscripted Variables
Arrays and subscripts, DIM, One - dimensional arrays, Two - dimensional arrays, Applications in numerical methods.

(6 hrs)

3- Subprograms
Types of subprograms, Functions, DEF FN, Subroutines, GOSUB RETURN, Applications.

(6 hrs)

4- Peripheral Operations
Printers, LLIST, L PRINT, Cassette recorders, Floppy drives, Files, SAVE, LOAD, MERGE, File I/O operations.

(6 hrs)
Second Year B.Sc Syllabus

5- Graphics

CRT, Types of screens, Pixels, Screen, Pset, Line, Circle, Draw, Applications in curve plotting.

(1 hrs)

6- Other Computer Languages

FORTRAN, Structured programming, Fourth - generation languages, Application packages, Artificial intelligence.

(1 hrs)
## 2-6 Thermodynamics

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1- Introduction


(2 hrs)

2- First Law and Other Basic Concepts


(4 hrs)

3- Applications of the Equations of Ideal Gases, Generalized Correlation and the Acentric Factor.

(8 hrs)
Second Year B.Sc Syllabus

4- Heat Effects

5- The Second Law of Thermodynamics
Heat engine, Entropy, Second law limitation and real process, Entropy change and irreversibility and probability (statistical thermodynamics), Third law of thermodynamics. (5 hrs)

6- Thermodynamics Properties of Fluids.
Relationships among the thermodynamics properties (including Helmotz and Gibbs free energies and chemical potential), Steam formation and two phase system, Saturated temperature and pressure, Triple point, Wet vapour and dryness fraction, Types of thermodynamic tables and diagrams, Steam power plant cycle and analysis, Barometric condenser, Metering and throttling processes, Steam and gas turbines. (10 hrs)
7- Refrigeration and Liquification

Refrigeration cycles (Carnot, Air, Vapor - Compression) and Comparisons, Choice of refrigerant, Absorption Refrigeration, The heat pump, Liquifaction processes.

(1? hrs)

8- Phase Equilibrium

The nature and criteria of equilibrium, Binary system, Vapor pressure of an ideal solution and non-ideal solutions, Henry's law, Activity and activity coefficients, Flash separation calculations.

(6 hrs)

9- Chemical Reaction Equilibrium

Thermodynamics of ideal gases and mixtures, Derivation of the general equilibrium expression, Chemical equilibrium of ideal and non-ideal gases, Reaction equilibrium in solutions, effect of temperature on chemical equilibrium.

(6 hrs)
Second Year B.Sc Syllabus

2-7 Fuel Technology

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1- Energy and Fuels
2- Classification of Fuels
3- Evaluation of Crude Oil
4- Production of Petroleum Fractions
5- Motor Gasoline
6- Kerosine and Jet Fuels
7- Diesel Fuels
8- Fuel Oils
9- Lubricating Oils and Asphalts
10- Gaseous Fuels
11- LPG, LNG
12- Combustion Calculations
13- Combustion Characteristics
14- Gaseous Fuels Burners
15- Liquid Fuels Burners
16- Combustion in Furnaces and Boilers

Note:

* 1st term
Second Year B.Sc Syllabus

2-8 Physical Chemistry

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1- The Discription of Physical Systyems - PVT
   Equation of state of an ideal gas, Equation of state and PVT relationships, PVT behaviour of real gases, The Van der Wall's equation and liquefaction of gases, The reduced state of real gases & Redlich - Kwong equation.

(10 hrs)

2- Change of State

(10 hrs)
3- Surface Chemistry
Pressure difference across curved surfaces, Surface tension, and capillary rise, Langmuir adsorption isotherm and langmuir theory of adsorption, Calculations of surface area of the adsorbent, BET equation for surface area calculation.

(10 hrs)

4- Chemical Kinetics
The rate of chemical reactions, order of reaction and rate constant, zero, first, second and third order rate equations, Reversible reactions, Consecutive reactions, Parallel reactions, Determination of the order, Reactions in flow systems, Effect of temperature on reaction rate, The transition - state theory, Catalysis and homogeneous catalysis and heterogenous reactions, Enzyme reactions and kinetics of reactions.

(18 hrs)

5- Electrochemistry
Conductivity measurements, Diffusion and ionic mobilities, Activity and ionic strength, Determination of activity coefficient from solubilities, The Debye - Huckel theory, Acid - base catalysis and their dissociation constant.

(6 hrs)
6- Electrochemical Cells

Electromotive force (EMF) of a cell, Measurements of EMF - the potentiometer, The polarity of electrodes, The cell reactions and reversible cells, Free energy and reversible cells, Types of half cells and classification of EMF, Standard electrode potentials, Standard free energy and entropy of aqueous ions, Calculation of EMF of a cell, Oxidation - reduction reactions, Concentrations of cells, Electrolysis, Corrosion.

(6 hrs)
# Second Year B.Sc Syllabus

## 2-9 Electrical Technology

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1. Semiconductors Equipment (6 hrs)
2. Rectifiers and Detectors (4 hrs)
3. Electronic Amplifiers (8 hrs)
4. D. C. Circuits (4 hrs)
5. D. C. Generators and Motors (6 hrs)
6. A. C. Circuits (6 hrs)
7. Polyphases Circuits (4 hrs)
8. Transformers and Induction Motors (6 hrs)
9. Starters (4 hrs)

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Second Year B.Sc Syllabus

10- Integrated Circuits, Measuring Instruments, Transducers, Transmitter

(8 hrs)

11- Electrical Heating Appliances

(4 hrs)
Third Year B.Sc Syllabus

3-1 National Education & Socialism

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Refer to centralize curriculum
3-2 Applied Mathematics

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1- Revision ordinary differential equation, Simultaneous differential equations, Application for chemical engineering.  
(12 hrs)

2- Solution of differential equation by series, Simple series, Method of Proben's, Bassel's equation, Application for chemical engineering.  
(8 hrs)

(10 hrs)

4- Dynamic and control for chemical processes, Dynamic and control, Dynamic behaviour for 1st order system.  
(10 hrs)
Third Year B.Sc Syllabus

5- Partial Differential Equations

(8 hrs)

6- Numerical Analysis
The difference operators, Interpolation, Finite difference equations, Differentiation and integrations, Solution of first and second order differential equation.

(12 hrs)
Third Year B.Sc Syllabus

3-3 Unit operations (1)

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1- Unit Operation
Introduction, Definition of Unit operation process, Definition of Mass transfer, Classification of Mass transfer operations, Method of conducting Mass transfer operations, Kind of Mass transfer operations, Type of Mass transfer operations.

(4 hrs)

2- Diffusion
Introduction, Theory of diffusion, Ficks law, Molecular diffusion, Laminar and Eddy, Diffusion in gases, Equimolecular diffusion, Maxwell's law of diffusion, Steady state diffusion of A through (stagnant) nondiffuse B, Steady state diffusion in tube with change in path length, Diffusion through a varying cross-sectional area, Diffusion from sphere, Diffusion through non-uniform cross-sectional area, Diffusion of gases A & B plus convection, Steady state diffusion in multicomponent gas
mixture, Diffusion in Liquids, Equimolar diffusion of liquid A and B, Diffusion of Liquid A through non-diffuse B, Diffusion through varying cross sectional area, Diffusion in Multicomponent liquid mixture, Diffusion in solid, Diffusion in solid following Fick's law, Diffusion in solid using permeability equation, Calculation of diffusivity coefficient, for gas, for liquid, Determine diffusivity at different temp., Diffusivity at different temp., Diffusion in multicomponent plus convection.

3- Absorption of Gases
Definition, Conditions of equilibrium between gas and liquid, Influence of solubility of gas on equilibrium curve & mass transfer coefficients, Capacity of column for dilute mixture, Methods of calculating the number of transfer unit (N. T. U), Relation between the individual and overall height of mass transfer coefficient relation, Capacity of column for concentrated mixture, Limiting flow rates, Minimum theoretical liquid flow rate.

4- Distillation
Equilibrium relationship, Temperature composition diagram, Method of predicting equilibrium data, Partial vaporization and partial condensation, Types of distillation, batch distillation, flash distillation, continuous distillation, method of calculating plate column.
Upper operating line equation, Lower operating line equation, Lewis–Sorel method, McCabe and Thiele method, The intersection of the operating lines with feed composition, Feed at boiling point, Feed not at boiling point (q-line equation), Limits of reflux ratio, Total reflux, Minimum reflux ratio, Operating & optimum reflux ratio, The location of feed plate, Normal distillation column, Stripping – distillation column, Enriching – distillation column, Rectification with direct stream injection, Rectification tower with side streams Tray or stage efficiency, Ponchou – Savarit method "Enthalpy – concentration method", Upper & lower operating line, Reflux ratio, Min. reflux ratio, Total reflux ratio, q-line on Ponchoue – Savarit diagram, Distillation with two feed by Ponchoue – Savarit method, Calculation of heat of boiler and condenser, Multicomponent distillation, Equilibrium data, Relative volatility, Tray to tray calculation.

(40 hrs)

5- Mechanical Separation Process

1- Definition

2- Size reduction

(3 hrs)

Note:

* 1st term
### 3-M Project (1)

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1- Report Writing and Reviewing the Different Method of Manufacturing the Product.

(\text{\text{: hrs}})

2- Justify Production Capacity.

(\text{\text{: hrs}})

3- Choosing & Justifying Geographic Location of the Plant.

(\text{\text{: hrs}})

4- Brief Description of Chemical and Physical Processes Involved.

(\text{\text{: hrs}})

5- Process Planning

Scheduling and flow sheet design, Flow sheet types and designation, Block diagram, Process flow sheet, Piping and instruments diagram, Utility flow sheet.

(\text{\text{:4 hrs}})

6- Fundamental Concepts in Mass Balance

(\text{\text{: hrs}})

7- Fundamental Concepts in Energy Balance

(\text{\text{: hrs}})
3-4 Reactor Design

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1- Introduction
(4 hrs)

2- Type of Reactors
   Batch Reactors, Continuous - Flow Reactors i.e. CSTR, PFR, Industrial Reactors.
   (10 hrs)

3- Tubular Reactors
   Design Equation, Reaction time, Maximum production rate, Non isothermal operation, Adiabatic operation.
   (6 hrs)

4- Tubular Reactors
   Design Equation, Isothermal and nonisothermal operation, Space time, Space velocity.
   (8 hrs)

5- Continuous Stirred Tank Reactors
   Design Equation, Graphical methods (mixing).
   (6 hrs)
Third Year B.Sc Syllabus

6- Mixing

(4 hrs)

7- Applications of the Design Equations fitting CSTR, PFR
Reactors in series comparing Volumes of CSTR's in series

(10 hrs)

8- Reactor Design
Scale up of liquid - phase batch data to the design of a
CSTR.

(6 hrs)

9- Design of CSTR's
CSTR's in parallel, Design of PFR, Length of reactor,
Number of tubes, Pressure drop.

(6 hrs)

10- Comparison of Batch, PFR and CSTR for a single and
Multiple Reactions.

(4 hrs)

11- Unsteady State Operation of Reactors
Start up of CSTR, Semibatch Reactor.

(4 hrs)

12- Catalysis and Catalytic Reactor.
Synthesizing a rate law, Mechanism and rate limiting step.

(4 hrs)
Third Year B.Sc Syllabus


14- External Transport in Heterogeneous Reactions
Mass and heat transfer correlations.

15- Internal Transport Processes
Diffusion and reaction in porous catalysts.

16- Multiphase Reactor
Slurry reactor

(6 hrs)

(4 hrs)

(4 hrs)

(4 hrs)
Third Year B.Sc Syllabus

3-6 Management & Engineering Economics

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Part - One: Engineering Economics

1- Introduction to Process Economics

2- Elements of Economic Analysis
   Money value, Type of interest and interest, Compounding profitability analysis, Depreciation, Continuous cash flow, Discounted cash flow.

3- Visibility Studies
   (Technical and economic studies)

4- Cost Estimation
   Equipment cost, Fixed cost, Manufacturing cost, Plant cost.

5- Economic Design Criteria
   Profitability studies present value of future money
Third Year B.Sc Syllabus

compilation for capital, Evaluation of design criterion accounting for risk economic life of processes.

(6 hrs)

Part - Two: Industrial Management

1- Principles and Application of Management
   Basic elements of managing organization - production,
   marketing, Finance, public relation, Planning ... etc.
   (6 hrs)

2- Wages
   Payments and procedure, Motivation
   (4 hrs)

3- Maintenance
   Purpose and responsibility, Cost, Decision making.
   (4 hrs)

4- Quality Control
   Specification, Inspection of samples, Sampling, quality
   control chart.
   (4 hrs)

5- Training
   Objectives, Programs, Needs, Methods.
   (4 hrs)

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Third Year B.Sc Syllabus

6- Production Planning, Material handling, Production methods.  (? hrs)

7- Industrial Safety  (? hrs)

8- Feasibility Study of Project  (? hrs)
Third Year B.Sc Syllabus

3-7 Heat Transfer

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1- Modes of Heat Transfer

Material properties of importance in heat transfer.

(5 hrs)

2- Steady State Heat Conduction in One Dimension

Plane wall, Radial systems, Heat source systems, Boundary surrounded by fluids, Overall heat transfer coefficient, Extended surface conduction systems, Fins).

(12 hrs)

3- Principles of Convection

Transport equations, Fluid mechanism aspect of convection, Laminar boundary layer, Thermal boundary layer, Empirical and practical relations for pipe and tube flow, Flow normal to single and tube banks.

(10 hrs)

4- Heat Exchangers

Various types and their general characteristics, Fouling factor, Heat exchanger mean temperature differences, Co -
Third Year B.Sc Syllabus

current and counter - current flow, Parallel and series arrangements, Pressure drop calculations.

(8 hrs)

5- Shell and Tube Exchangers
Types and various specifications, Design calculations by conventional method and by effectiveness and (NTU) method, Optimum design calculation.

(4 hrs)

6- Condensation and Boiling Heat Transfer
Condensation of single vapour, Design calculations for condenser, Condenser - subcooler and desuperheater - condenser.

(6 hrs)

7- Radiation and Furnace Design
Radiation properties, Shape factor, Heat exchange for non black bodies, Parallel planes, Shields, Gas radiation, Boiler.

(10 hrs)

8- Unsteady State Heat Transfer

(8 hrs)

Note:

** 2nd term
# Third Year B.Sc Syllabus

## 3-8 Chemical Process Industries

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1- Chemical Operations
   Introduction and general methods of calculations of, Percentage conversion, percentage recovered - recycled ratio.

   (6 hrs)

2- Sulphuric Acid

   (4 hrs)

3- Ammonia, Nitric Acid, Nitrogenous Fertilizers

   (6 hrs)

4- Phosphates, Phosphoric Acid, Phosphate Fertilizer

   (6 hrs)

5- Electro Chemical Analysis
   Production of chlorine and chloride products, Caustic soda, Aluminium metal industry.

   (6 hrs)

6- Industrial Chemical Salts

   (4 hrs)
Third Year B.Sc Syllabus

7- Ceramic Industries (6 hrs)

8- Cement Industry (4 hrs)

9- Glass Industries (4 hrs)

10- Surface Coating Industries (4 hrs)

11- Vegetable Oils, Fats and Soaps (5 hrs)

12- Industrial Detergents (2 hrs)

13- Food Industries (3 hrs)
Fourth Year B.Sc Syllabus

4-1 National Education and Socialism

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Fourth Year B.Sc Syllabus

4-2 Project (2)

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Part - One: Theory

1- Principle of industrial design
2- Type of Industrial equipments
3- Pumps and piping network
4- Vessels and tanks
5- Heat transfer equipments
6- Mass transfer equipments

Part - Two

1- Complete Detailed Design of Main Equipments

Distillation, Absorption or stripping, Extractor, Heat exchanger, dryer, Furnace, Reactor, Separating vessel, storage tank, Piping system.

2- Choice of Suitable Control Devices for Used Equipment
3- Economical Studies

Fixed and operating cost, Equipment cost and cost of unit product.

4- Use a Computer Program to Design at Least Two Equipments
Fourth Year B.Sc Syllabus

4-3 Unit Operations (2)

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1- Boundary Layer and Analogies

Velocity distribution profile, Temperature distribution profile, Analysis of heat, mass, and momentum transfer.

(14 hrs)

2- Evaporation

Heat transfer in evaporators, Heat transfer coefficient, Boiling at submerged surface, Forced convection boiling, Vacume operation, Multiple - Effect Evaporators, General principles, The calculation of multiple - effect systems, Comparison of forward and backward feeds.

(14 hrs)

3- Drying

Introduction and general principles, Rate of drying, Drying periods, The mechanism of moisture movement during drying, Classification and selection of dryers.

(8 hrs)
Fourth Year B.Sc Syllabus

4- Crystallisation
   Introduction, Growth and properties of crystals, Nucleation, Crystallisation rate, Effect of impurities on crystal formation, Effect of temperature on solubility, Crystallisers, Batch crystallisers, Continuous crystallisers.

(3 hrs)

5- Humidification and Dehumidification and Cooling Tower
   Humidification terms, Humidity data for air - water systems, Temperature - Humidity chart, Addition of liquid or vapour to a gas, Dehumidification, Water cooling, Height of packing, Change in air condition, Evaluation of heat and mass transfer coefficients, Systems other than Air - water.

(14 hrs)

6- Extraction
   The mixing of liquid - liquid systems, liquid - liquid extraction, Application, Design consideration, Equilibrium conditions, Calculation of the number of theoretical stages in extraction operation, Co-current contact with partially miscible solvents, Co-current contact with immiscible solvents, Counter-current contact with
Fourth Year B.Sc Syllabus

partially miscible solvents, Counter - current with immiscible solvents, Continuous Extraction in columns.

(14 hrs)

7- Mechanical and Physical Separation Processes
Setting and sedimentation, Filteration and centrifugal separation.

(18 hrs)

Note:

* 1st term
## 4-4 Process Control

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1- Process Dynamics and Transient Response of the Systems
- Review of dynamic behaviour of first-order systems,
- Linearization techniques of non-linear systems,
- Transient response of interacting and non-interacting systems,
- Second-order systems and their dynamic characteristics,
- Transient response of transportation lag system

10 hrs)

2- Characteristics of the Closed Loops Systems
- Overall closed loops transfer functions and block diagram algebra,
- Transient response of simple closed control systems,
- Stability of control systems,
- Introduction to the frequency analysis and design techniques.

20 hrs)
Fourth Year B.Sc Syllabus

3- Measurements

Absolute and relative measurements, independent and dependent variables, errors, types of errors, error estimation, propagation of errors, Measuring Instruments Temperature, pressure, flow rate, level.

(10 hrs)

4- Industrial Controller Actions

Selection criteria for various control modes, Final control elements, Dynamic and control of chemical reactor system.

(10 hrs)

5- Dynamic and Control of Some Chemical Processes

Dynamic and control of heat exchangers, Dynamic and control of Distillations columns, Introduction to computer control of chemical processes.

(10 hrs)

Note:

** 2nd term
### Fourth Year B.Sc Syllabus

#### 4-5 Biochemical Engineering

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1. Introduction (4 hrs)

2. Kinetics of Substrate Utilization (20 hrs)


4. Transport Phenomena in Biochemical Systems (9 hrs)

5. Design and Analysis of Biochemical Systems (12 hrs)

6. Application of Biochemical Engineering (8 hrs)
Fourth Year B.Sc Syllabus

4-6 Petrochemical Process Industries

Theoretical | Practical | Tutorial | Units
---|---|---|---
2 | | | |

1- Nature of Petrochemical Processes

20 hrs)

2- Basic Petrochemical Materials

Low olefins - production process of ethylene, Pyrolysis processes, Cooling processes, Gas compression, Product refinery, Separation operations, Energy system, Diolefin, Highers olefins, Aromatics, Synthesis gas.

5 hrs)

3- Intermediate Petrochemicals

Based on basic petrochemicals - Item (2) above

15 hrs)

4- Final Products

Polymers, Plastics, Elastomems, Fibers.

13 hrs)

5- Petrochemical Complexes

17 hrs)

66
4-7 Gas and Petroleum Refinery

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1- Physical and thermodynamical properties of hydrocarbon fluids

2- Vapour - Liquid behaviour of HC fluids, Flash Degasing) calculation

3- Separation by Absorption and Fractionation

4- Crude Oil Properties Evaluation of Crude Oils

5- Refinery Products

6- Crude Oil Distillation

7- Cracking Processes

8- Desulfurization

(7 hrs)

(4 hrs)

(4 hrs)

(2 hrs)

(2 hrs)

(6 hrs)

(4 hrs)

(2 hrs)
9- Catalysis: Reforming and Isomerization (4 hrs)

10- Lubricants (2 hrs)

11- Production Testing

12- Water - light carbon System Behaviour (2 hrs)

13- Adsorption Dehydration and Sweetening (4 hrs)

14- Absorption Dehydration and Sweetening (3 hrs)

15- Sulfur Recovery (2 hrs)

16- Liquefaction Processes (4 hrs)

17- Economic Evaluation

18- Cost Estimation (6 hrs)

19- Typical Design Calculations (4 hrs)

Note:

**2nd term**
Fourth Year B.Sc Syllabus

4-8 Statistics and Optimization

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Part One: Statistics

1- Introduction
Statistics, Descriptive and inductive statistics, Discrete continuous variables, Population, Sample, Graphical representation of data.

(4 hrs)

2- Frequency Distributions
Frequency distribution table, Relative frequency distribution table, cumulative distribution, graphical representation of frequency distributions.

(2 hrs)

3- Measures of Central Tendency
Arithmetic mean, Geometric mean, Root mean square, Median, Mode.

(2 hrs)
Fourth Year B.Sc Syllabus

4- Measures of Dispersion
   Mean, Absolute Deviation, Range, Standard deviation, variance.
(2 hrs)

5- Probability Distributions
   Discrete probability distribution - binomial distribution
   Poisson distribution, Continuous probability distribution,
   Normal distribution, Area under normal curve, Chi-square distribution.
(2 hrs)

6- Curve fitting
   Curve fitting, Method of least squares, Least square line,
   Non linear relations, Polynomials, Time series, correlation, Regression, Coefficient of correlation.
(5 hrs)

Part Two: Optimization

1- Introduction to Process Optimization
(3 hrs)

2- Organization of Optimization Problem System Models
(3 hrs)
Fourth Year B.Sc Syllabus

3- Single Variable
Analytical method, Numerical method, Graphical method, Numerical search, Bounded function, Open ended function, Direct search, Dichotomous search, Golden - Section search, Fibonacci search.

(6 hrs)

4- Multi Variable Optimization
Necessary and sufficient conditions for extreme values in general case, Slack variable, Graphical solution, Simplex method, Linear programming and its applications to chemical Engineering problems, Transportation, Blending, Scheduling.

(5 hrs)

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