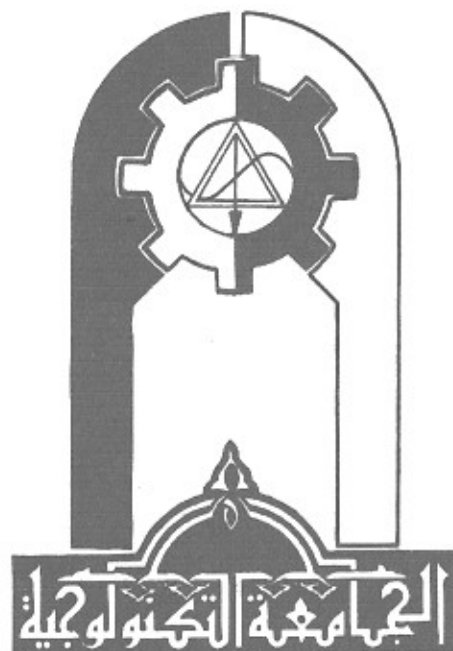# MINISTRY OF HIGHER EDUECTION

University Of Technology

Chemical Engineering Department

**B.Sc PROGRAMME IN
CHEMICAL ENGINEERING
AND
M.Sc. PROGRAM**

**OUTLINE OF
SYLLABUSES ALLOC3ATION OF SUBJECTS
AND
WEEKLY LOAD**

2007-2008

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

The formal course work for B.Sc. programme involves mathematics, including both analysis and computer application, chemistry, mechanics, electricity chemical engineering principles and practice subjects including fluid dynamics, heat, unit operation, chemical reactor design, thermodynamics, and chemical processes. In addition the programme involves English Language which is essential for any engineering student to enable him/her to benefit from thousands of textbooks and periodicals.

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 subjects which are taken by the chemical engineering students during their four years study.

Prof. M. A. Zablouk
Chairman of Chemical Eng. Dept.

Contents

B.Sc. Programme

Subject Symbol	Subject	Hours / Week						Units
		First Term			Second Term			
		Theoretical	Practical	Tutorial	Theoretical	Practical	Tutorial	
CE. 111	English Language	2	-	-	2	-	-	4
CE. 121	Mathematics	3	-	1	3	-	1	6
CE. 141	Principle of Chemical Engineering	3	-	1	3	-	1	6
CE. 221	Chemistry	3	2	1	3	2	1	8
CE. 131	Engineering Drawing and AutoCAD	1	2	-	1	2	-	4
CE. 231	Mechanics and Strength of Materials	2	-	1	2	-	1	4
CE. 331	Electrical Technology	1	-	1	1	-	1	2
CE. 321	Computer Science	2	2	-	2	2	-	6
CE. 431	Workshop	-	6	-	-	6	-	4
Total		17	12	5	17	12	5	44

Note: The student is required to complete twelve weeks summer training in industry

Number of Hours / Week

First Term	Second Term
34	34

Key of subject symbol (from lift):

CE : Chemical Engineering
First No. : Order of subject within specialization
Second No. : specialization
     1 : Human subject
     2 : Basic subject
     3 : General subject
     4 : Specific subject
Third No. : Year of Study
     -U : Unit Operation of Chemical Industry Branch
     -R : Refinery Engineering of Oil and Gas Branch

Subject Symbol	Subject	Hours / Week						Units
		First Term			Second Term			
		Theoretical	Practical	Tutorial	Theoretical	Practical	Tutorial	
CE. 112	Human Rights	2	-	-	2	-	-	4
CE. 122	Mathematics	2	-	1	2	-	1	4
CE. 142	Fluid Flow	3	2	1	3	2	1	8
CE. 132	Properties of Materials	1	-	1	1	2	1	3
CE. 222	Computer Programing & MATLAB	2	2	-	2	2	-	6
CE. 242	Fuels Technology	1	2	1	1	-	1	3
CE. 342	Thermo dynamics	2	-	1	2	-	1	4
CE. 232	Physical Chemistry	2	2	1	2	2	1	6
Total		15	8	6	15	8	6	38

Number of Hours / Week

First Term	Second Term
29	29

A-Unit Operation of Chemical Industry Branch

Subject Symbol	Subject	Hours / Week						Units
		First Term			Second Term			
		Theoretical	Practical	Tutorial	Theoretical	Practical	Tutorial	
CE. 113	~~Democracy~~ *Thermodynamics*	3 2	-	2 1	3 2	-	2 1	4 6
CE. 133	Applied Mathematics	3	-	1	3	-	1	6
CE. 143	Mass Transfer *Unit operation*	3	2	1	3	-	1	7
CE. 233	Statistics and ~~Instruments~~ Measurement	1	2	1	1	—	1	3
CE. 243	Reactor Design	3	-	1	3	-	1	6
CE. 343	Heat Transfer	3	-	1	3	2	1	7
CE. 443	Equipment Design by Computer	2	2	1	2	2	1	6
CE. 543-U	Biochemical Engineering	2	-	1	-	-	-	2
CE. 643-U	Environmental Engineering	-	-	-	2	-	1	2
Total		19	5	7	19	5	7	43

Number of Hours / Week

First Term	Second Term
31	31

B-Refinery Engineering of Oil and Gas Branch

Subject Symbol	Subject	Hours / Week						Units
		First Term			Second Term			
		Theoretical	Practical	Tutorial	Theoretical	Practical	Tutorial	
CE. 113	Democracy	2	-	-	2	-	-	4
CE. 133	Applied Mathematics	3	-	1	3	-	1	6
CE. 143	Mass Transfer	3	2	1	3	-	1	7
CE. 233	Statistics and Instruments	1	1	1	1	1	1	3
CE. 243	Reactor Design	2	-	1	2	-	1	4
CE. 343	Heat Transfer	3	-	1	3	2	1	7
CE. 443	Equipment Design by Computer	2	2	1	2	2	1	5
CE. 543-R	Storage and Transport of Crude and Petroleum Products	-	-	-	2	-	1	2
CE. 643-R	Combustion Engineering	2	-	1	-	-	-	2
Total		19	5	7	19	5	7	43

Number of Hours / Week

First Term	Second Term
31	31

A-Unit Operation of Chemical Industry Branch

Subject Symbol	Subject	Hours / Week						Units
		First Term			Second Term			
		Theoretical	Practical	Tutorial	Theoretical	Practical	Tutorial	
CE. 144	Project	1	2	-	1	2	-	4
CE. 244	Transport Phenomena	3	3	1	3	-	1	7
CE. 344	Process Control	2	-	1	2	3	1	5
CE. 444-U	Chemical Industries	2	3	1	2	3	1	6
CE. 134	Optimization	-	-	-	2	-	1	2
CE. 544-U	Engineering of Catalyst	2	-	1	-	-	-	2
CE. 644-U	Corrosion Engineering	-	-	-	2	-	1	2
CE. 744-U	Technology of Oil and Gas	-	-	-	2	-	1	2
CE. 234	Industrial Management and Safety Requirements	2	-	1	-	-	-	2
CE. 844-U	Polymers Technology	2	-	1	-	-	-	2
Total		14	8	6	14	8	6	34

Number of Hours / Week

First Term	Second Term
28	28

B- Refinery Engineering of Oil and Gas Branch

Subject Symbol	Subject	Hours / Week						Units
		First Term			Second Term			
		Theoretical	Practical	Tutorial	Theoretical	Practical	Tutorial	
CE. 144	Project	1	2	-	1	2	-	4
CE. 244	Transport Phenomena	3	3	1	3	-	1	7
CE. 344	Process Control	2	-	1	2	3	1	5
CE. 444-R	Petroleum Refining	2	3	1	2	3	1	6
CE. 134	Optimization	-	-	-	2	-	1	2
CE. 544-R	Engineering of Catalyst	2	-	1	-	-	-	2
CE. 644-R	Petrochemical Industries	2	-	1	-	-	-	2
CE. 744-R	Gas Technology	-	-	-	2	-	1	2
CE. 234	Industrial Management and Safety Requirements	-	-	-	2	-	1	2
CE. 844-R	Environmental Pollution	2	-	1	-	-	-	2
Total		14	8	6	14	8	6	34

Number of Hours / Week

First Term	Second Term
28	28

CE 111	**English**	Units	4
		Theoreti al	2 hr/week
		Tutorial	- hr/week
		Practic: l	- hr/week

6-Prepositions:
   A general idea

(1hrs)

7-Conjunctions
   A-Main Conjunctions
   B-Subsidiary

(1hrs)

8-Interjections:
   Common ones

(1hrs)

Second Semester

1- Comprehension
Reading Scientific Passages
   1-Electricity in Early Days
   2-Comets
   3-Exploring the moon

(16hrs)

2- Grammatical Points

1-Articles
   A-definite
   B-indefinite

(2hrs)

2-The Sentence
   A-Structure
   B-Types
   C-Main Parts:
         1-Subject
         2-Predicate
   D-Expansion

(8hrs)

3-Written and Oral Translation

(4hrs)

| University of Technology | *Chemical Engineering Department* | **First Year B.Sc. Syllabus** |

		Units 6
CE 121	**Mathematics**	Theoretical 3 hr/week
		Tutorial 1 hr/week
		Practical - hr/week

1- Revision:

Equation of the straight line, Trigonometric functions and their sketches, Domain, Range, Inverse of functions, Absolute value, limits, Limits, applications, Polar coordinates (general definition) Conic sections (general definition).

(12 hrs)

2- Differentiation and Integration:

Algebraic functions and trigonometric functions, Application (limits, Hop tals rule)

(6 hrs)

3- Transcendental Functions:

Inverse of Trigonometric functions, Natural logarithmic Exponential and Power functions (Definitions, Properties, Sketches, Derivatives and Integrals.

(12 hrs)

4- Hyperbolic Functions:

Definitions, Properties, Sketches, inverse and Derivatives and Integrals.

(8 hrs)

5- Determinants:

Definitions, Properties, Solution of systems of equations (Cramers Rule)

(6 hrs)

6- Application of Definite Integrals:

Area between two curves, Volumes, Length of curves, Surface area.

(12 hrs)

7- Moods of integration:

Substitution, Integration by parts, The Substitution $U = \tan\dfrac{X}{2}$, 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, Improper Integrals (conv and dity)

(16 hrs)

8- Complex Numbers:

Definitions, Argands diagram, Addition and subtraction and multiplication and dividing numbers, Trigonometric and exponential formula of complex number, Demoivors theorem, Roots of equation, Power of complex numbers.

(9 hrs)

9- Vector Analysis:

Definition, Addition and subtraction of vectors, Multiplication by scalars, Direction, products of vector (scalar product and vector product).

(9 hrs)

		Units	6
CE 141	**Principle of Chemical Engineering**	Theoretical	3 hr/week
		Tutorial	1 hr/week
		Practical	- hr/week

1- Concept of Chemical Engineering:

Units, Dimensions, Conversion factors, Conversion equation, 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 steady state, Combustion Calculation.

(30 hrs)

3- Ideal Gas laws:

Definitions of Ideal gas, Real gas, Ideal gases mixture, Real gas mixture.

(9 hrs)

4- Energy Balance:

General energy balance, Enthalpy, Heat capacities their predications and variation with temperature, Heat effects.

(18 hrs)

5- Simultaneous, Mass and Energy Balance:

(9 hrs)

		Units 8
CE 221	**Chemistry**	Theoretical 3 hr/week
		Tutorial 1 hr/week
		Practical 2 hr/week

Part –1- Analytical Chemistry

1- Introduction:
Atomic weight, Molecular formula, Chemical equations, Mole concept, and Chemical equilibrium.

(4 hrs)

2- Solution:
Definition, Preparation and properties, Molarity, Normality, Formality, PH, POH, Solubility

(8 hrs)

3- Analytical Methods of Analysis:

a-Qualitative Analysis

b-Quantitative Analysis.

  i.   Volumetric (titrimetric) & analysis,
       Acid- base, Redox, Precipitation, Complex titration, Methods of calculation, Titration curves

  ii. Gravimetric Analysis
       Precipitation reactions, Direct and indirect methods of analysis, Ksp.

  iii. instrumental Methods of Analysis
       Photometric,, Colourimetic, Potentiometric titration, , PH-measurements Chromatography, Atomic absorption.

(33 hrs)

CE 221	**Chemistry**	Units	8
		Theoretical	3 hr/week
		Tutorial	1 hr/week
		Practical	2 hr/week

Part –2- Organic Chemistry

1- Introduction:
Definition and classification of organic compounds.

(3 hrs)

2- Aliphatic Compounds:
Nomenclature, Preparation, Properties, Reactions.
- a) Alkanes
- b) Alkenes
- c) Alkynes
- d) Aliphatic Derivatives: Alkyl halides Alcohol's, Ethers, Aldehydes Ketones, Esters Carboxylic acids, Amines, Mercaptans, Carboxylic acids, Amines, Mercaptans, Thiophenes, Disulphide.

(20 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.

(10 hrs)

4- Heterocylic Compounds:
Pyridine, Furan, Pyrrole.

(3 hrs)

5- Introduction to Polymer and Carbohydrate:

(5 hrs)

6- Organo-Metallic Compounds:

(4 hrs)

		Units	4
CE 131	**Engineering Drawing and AutoCAD**	Theoretical	1 hr/week
		Tutorial	- hr/week
		Practical	2 hr/week

Part –1- Engineering Drawing

1- Introduction:

General information a bout engineering drawing and its importance. Drawing instruments, Types of lines used in drawings, Hidden lines.

(2 hrs)

2- Geometrical construction:

(2 hrs)

3- Pictorial Drawings:

(Isometric and Oblique)

(2 hrs)

4- Projection Drawings:

First and Third Angle Projection.

(4 hrs)

5- The Finding of 3 rd view:

(6 hrs)

6- Sectioning:

(6 hrs)

7- Fasteners:

(2 hrs)

8- Assembly and detail drawing:

(4 hrs)

CE 131	**Engineering Drawing and AutoCAD**	Units 4
		Theoretical 1 hr/week
		Tutorial - hr/week
		Practical 2 hr/week

Part –2- AutoCAD

1- Definition of AutoCAD programs, its applications, and explain the connection between its program and engineering drawing.

2- Explain in details the command of AutoCAD drawing (line, circle, …atc.), and giving the applications examinations.

3- Explain the drawing of projections and sections (2D) in engineering shape, using the command of Layer and Dimensions.

4- Giving a simple idea for three – dimensions drawing (3D).

5- Forming a simple shape for three - dimensions drawing (3D).

6- Explain the method of forming for three – dimensions shape, and giving the applications examinations.

CE 231	**Mechanics and Strength of Materials**	Units 4
		Theoretical 2 hr/week
		Tutorial 1 hr/week
		Practical - hr/week

A-Mechanics

1- Principles of static's:

(2 hrs)

2- Resultants of Force systems:

(5 hrs)

3- Equilibrium of force systems:

(5 hrs)

4- Friction:

(6 hrs)

5- Centurions and Centers of Gravity:

(5 hrs)

6- Moment of Inertia:

(4 hrs)

7- Principle of Movement:

(3 hrs)

B-Strength of Materials

1- Internal Forces in Rigid Bodies:

(1 hrs)

2- Definition of stress and strain:
Types of stresses and strain, shear stress.

(1 hrs)

3- Stress- Strain Diagrams:
Stress- strain diagrams for ductile and brittle materials

(2 hrs)

4- Proportional limits:
Elastic limit, stiffness elasticity, plasticity, Toughness, Resilience, Hardness, Working stress.

(2 hrs)

CE 231	**Mechanics and Strength of Materials**	Units 4
		Theoretical 2 hr/week
		Tutorial 1 hr/week
		Practical - hr/week

5- Hook law:

(2 hrs)

6- Poisson's ratio, Composite stresses:

(4 hrs)

7- Volumetric stress, Bulk modules:

(4 hrs)

8- Thin walled Cylinders:

(4 hrs)

9- Thermal stress:

(4 hrs)

10- shear and Moments in Beam:
Deflection

(4 hrs)

11- Wind Effect on the Tower high Tower:

(2 hrs)

University of Technology	*Chemical Engineering Department*	First Year B.Sc. Syllabus

		Units	2
CE 331	**Electrical Technology**	Theoretical	1 hr/week
		Tutorial	1 hr/week
		Practical	- hr/week

1- **Semiconductors Equipment:**

(3 hrs)

2- **Rectifiers and Detectors:**

(2 hrs)

3- **Electronic Amplifiers:**

(4 hrs)

4- **D.C. Circuits:**

(2 hrs)

5- **D.C. Generators and Motors:**

(3 hrs)

6- **A.C Circuits:**

(3 hrs)

7- **Polyphases Circuits:**

(2 hrs)

8- **Transformers and Induction Motors:**

(3 hrs)

9- **Starters:**

(2 hrs)

10- **Integrated Circuits, Measuring Instruments, Tranducers, Transmitter:**

(4 hrs)

11- **Electrical Heating Appliance:**

(2 hrs)

University of Technology	*Chemical Engineering Department*	**First Year B.Sc. Syllabus**

CE 321	**Computer Science**	Units 6 Theoretical 2 hr/week Tutorial - hr/week Practical 2 hr/week

1- Introduction:
Component (hard ware), computer work, computer, composition, Application

(2 hrs)

2- Files:
Definition, Types, Nomenclature, MSDos, External and internal commends.

(4 hrs)

3- Intoduction to window operating system:
Desktop, Mouse, my computer-icons, close window, stand by.

(2 hrs)

4- Folders:
Size and cascade, windows folder construction, construction choose file or folder find file or folder copy file or folder.

(2 hrs)

5- Start up:
Start up, Print, shutdown windows, format & Test Floppy disk, Arrange Icons, Run, Help.

(2 hrs)

6- Word Program:
File commands (New, Open, Close, Save, Save as, Page setup, Edit, Undo typing, Repeat Typing, Cut, Copy, Paste, Clear, Select All, Find, Replace, Goto).

(2 hrs)

7- Menu Table:
View (zoom, Header and footnote, Tool bar Insert (Picture, Footnote, Symbol, Page numbers, Textbox, Object).
Format (Paragraph, Font, Borders, Bullets & numbering Spelling and grammar
Table (shading, Columns, Insert, Table Insert Rows, Language, Delete, Cells, Split Cells, Select Row, Select column) (Table Autoformat Sort, Formula).

(6 hrs)

8- Program Excel:
Open, Taskbar, Toolbar, Format, Sheet, Cell, Construction of sheet, Open file, Clear (Delete), Save (Save as), Close, cascade, Copy and Paste, Add, Delete, Find, Replace, Auto summation, Insert, equation, Format sheet, Auto format, Print, Print preview, Draw.

(12 hrs)

CE 321	**Computer Science**	Units	6
		Theoretical	2 hr/week
		Tutorial	- hr/week
		Practical	2 hr/week

9- Power Point:

Definition

FILE: New, Open, Open, Close, Save, Save as, Page set up, Print, Exit)

EDIT: Undo, Repeat, Cut, Copy, Paste, Select All, clear Duplicate, Delete slide, find, Replace

FORMAT: Font, Alignment, Text Direction slide, Layout, Background, Apply Slid Show, View show, Rehearse timing design set up show, present Animation, Animation Preview, Slide Transition).

(11 hrs)

10- Auto Cad:

Introduction, define screen draw, select point in the screen Limits, Status, Circle, Erase, Line, Color, Point, zoom, Redraw, Arc, Ellipse, Polygon, Donut, Solid, Fill Break, Copy, More, Pan, Mirror Trim, Extend, Charge, Line type Ltscale, Dis Area, Trace, Hatch text, Snap, Grid, Rotate, Cops, Ortho, Fillet, Dim Layer.

(14 hrs)

11- Internet:

(6 hrs)

		Units	4
CE 431	<u>Workshop</u>	Theoretical	- hr/week
		Tutorial	- hr/week
		Practical	6 hr/week

<u>Refer to Centralize Curriculum</u>

University of Technology	*Chemical Engineering Department*	Second Year B.Sc. Syllabus

		Units	4
CE 112	**Human Rights**	Theoretical	2 hr/week
		Tutorial	- hr/week
		Practical	- hr/week

Standard Syllabus

| CE 122 | **Mathematics** | Units 4
 Theoreti al 2 hr/week
 Tutorial 1 hr/week
 Practic: l - hr/week |

1. Partial Differentiation:

Function of two or more variables, limits and continuity, partial d:rivatives, chain rule, Gradients, Directional derivatives, Higher order derivatives, Maxima, minimum and saddle points, Lagrange multipliers.

(10hrs)

2. Multiple integrals:

Double integrals, Area, Triple integrals in rectangular coordinates, Physical application of double and triple integration.

(9hrs)

3. Ordinary Differential Equations:

Solution of first order ordinary differential equations, Solution of se:ond order ordinary differential equations, and higher order differential equation.

(9hrs)

4. Infinite Series:

Power series of functions, Taylor's theorem, Integration, Diffe:rentiation, Fouries series, Even and odd functions, Half range expansion, Periodic fun:tions.

(8hrs)

5. Function and Definite Integrals:

The error function, The gamma function, The beta function, factorial function.

(6hrs)

6. Vector Analysis:

Products of three vectors, Equation of lines and planes.

(5hrs)

7. Complex Algebra:

Continuity, Derivation of Complex Variables, Analytic function, Int:gration of functions of complex variables and cauchy's theorem.

(5hrs)

8. Matrices:

The Matrix, Matrix algebra, The transpose of matrix, The inverse of matrix, Eigen Values and Eigen vectors, solution of linear equation by matrix.

(8hrs)

| CE 142 | **Fluid Flow** | Units 8
Theoreti :al 3 hr/week
Tutorial 1 hr/week
Practic: l 2 hr/week |

1. Introduction:

Physical properties of fluid, Definition of type fluid: Newtoni:n's, non-Newtonian, Incompressible, compressible fluid, static, Dynamic fluid, she:r stresses in fluid.

(4hrs)

2. Dimensional- Analysis:

Rayleigh's method (Power series), Buckingham's Π-theorem.

(6hrs)

3. Fluid- Dynamic:

Fluid dynamic system, Boundary layer, Continuity equation, Momentum equation, Bernoulli's equation, Euler's equation, Application of Bernoulli': equation and continuity equation.

(10hrs)

4. Newtonian's Fluid-(Incompressible Fluid):

Laminar and Turbulent flow, Reynolds's number, Friction losses an l Pressure drop in pipes and Fitting, Determine of pipe diameter, Flow in Branch pipe :, Friction losses in non-circular pipes, velocity Distribution.

(10hrs)

5. Non- Newtonian Fluid:

Definition, Type of fluid depend on time, Calculation of friction an l pressure drop for general time independent in laminar and Turbulent flow.

(6hrs)

6. Compressible Fluid in pipes:

Pressure wave, Mach number, General equation, General eq ation for isothermal and adiabatic condition, work for isothermal and adiabatic of Cc mpressor.

(10hrs)

7. Flow-Measurement:

Pilot-tube, Orifice meter, Venturi meter, Rotameters, Notch air Wei s, Special Flowerets (Hot wire anemometer, Gas meter).

(12hrs)

8. Pumping of Liquids:

Calculation of Total head, NPSH, Performance characteristi :s curve, Calculation of horsepower, equipment, and cost.

(8hrs)

9. Flow of Fluid Through Granular Beds:

Beds & Packed Column, Fixed beds, Fluidized Bed.

(8hrs)

| CE 142 | <u>**Fluid Flow**</u> | Units 8
 Theoretical 3 hr/week
 Tutorial 1 hr/week
 Practical 2 hr/week |

10. <u>Mixing of liquids in Tanks:</u>

Mixing, Mixers type, Small blade area, large blade area, Dimensionless groups, Power consumption.

(6hrs)

11. <u>Two- Phase Flow and Pressure drop in pipes :</u>

(4hrs)

12. <u>Introduction in unsteady Flow:</u>

(6hrs)

CE 132	**Properties of Materials**	Units	3
		Theoretical	1 hr/week
		Tutorial	1 hr/week
		• Practical	2 hr/week

1. Engineering requirement for materials:

Mechanical Properties, stress-strain curve, elasticity, plasticity, ductility, young modulus, tensile stress, yield stress, bricking stress, true and engineering stress-strain diagram.

(4hrs)

2. Atoms and atomic coordination:

Ionic bond, inter-atomic distance attraction forces between atoms, coordination number, covalent bond, Metallic bond.

(4hrs)

3. Crystal structure:

Crystal structure, unit cell, types of unit cells simple cubic, Face centered cubic, body centered cubic, atomic packing factor, Previous lattice, Miller index, crystalline Planes, X-ray diffraction.

(4hrs)

4. Atomic disorder in solid:

impurities in solids, solid solutions in metals, Imperfection incrystals, point defect, line dislocation, surfaces + grain boundaries.

(4hrs)

5. Atomic movement in solid state:

Atomic diffusion, self-diffusion, diffusivity Fick's first law, diffusion constant, diffusivities versus temperature, Factors effect diffusivity.

(4hrs)

6. Phase diagrams:

Definition of alloys, binary alloys, phase diagrams (equilibrium thermal diagrams), eutectic; solid solution and combination type diagram, Iron-carbon face diagram, allotrope Trans formation (polymorphism).

(4hrs)

7. Corrosion:

Definition, why it happen, Type of corrosion, Form of corrosion, corrosion reactions (anode + cathode) corrosion rate measurement, methods of prevention.

(4hrs)

Note:
☐ 2nd term

| CE 222 | <u>**Computer Programming & MatLAB**</u> | Units 6
Theoretical 2 hr/week
Tutorial - hr/week
Practical 2 hr/week |

<u>Part –1- Visual Basic</u>

1. <u>**Introduction to Visual Basic**</u>:
   Open, Save File As... . Standard EXE file.

   (2hr)

2. <u>**Menus:**</u>
   Form window, Project Explorer window, Properties window, Code window, Project window, Toolbox window, Debug window.

   (4hr)

3. <u>**Using Toolbox:**</u>
   Simple examples on using toolbox items.

   (4hr)

4. <u>**Variables:**</u>
   Data, numerical and string data, variables, Assignment statement, mathematical and logic operations.

   (4hr)

5. <u>**Arithmetic operators:**</u>

   (2hr)

6. <u>**Condition:**</u>
   If .... Then statement, multiple If .... Then statement, If .... Then .... else, multiple If ....Then .... Else , Select case statement.

   (4hr)

7. <u>**Messages:**</u>
   Msgbox, InputBox.

   (4hr)

8. <u>**Loop:**</u>
   For .... Next Loop, Do while .... Loop, Do .... Loop While, Exit For , Exit Loop.

   (4hr)

9. <u>**Array:**</u>
   Array definition, Declaring Arrays, Using for next Loop with Arrays, Arrays and operations on Arrays.

   (6hr)

10. <u>**Database:**</u>
    Working with database, Adding and deleting records, Displaying data.

    (8hr)

CE 222	**Computer Programming & MatLAB**	Units 6
		Theoretical 2 hr/week
		Tutorial - hr/week
		Practical 2 hr/week

Part –2- MatLab

1. **Introduction to Matlab**:
   M-files, getting help.

   (2hr)

2. **Algebra**:
   2.1 Variable Names
   Variable names must start with a letter and the intial letter can be followed by letters

   (1hr)

   2.2 Basic Arithmetic
   Addition +, Subtraction -, Multiplication *, Division /, Exponentiation ^.

   (1hr)

   2.3 Functions
   - abs: absolute value abs(-2)
   - sqrt: square root sqrt(4)
   - max: largest element in an array max([132,129,66,120])
   - min: smallest element in an array min([132,129,66,120])
   - factorial: factorial function factorial(12)
   - round: round (up/down) to an integer round(3.5)
   - floor: round down to an integer floor(-3.1)
   - ceil: round up to an integer ceil(-3.1)
   - exp: exponential exp(1)
   - log: natural logarithm log(exp(2))
   - log10: logarithm to base 10 log10(100)

   (2hr)

   2.4 Complex Numbers
   MATLAB can also handle complex numbers
   2.5 Loops

   (1hr)

3. **Solving Equations**:
   For solving equations, you can use the command solve.
   3.1 Representing a function
   To represent a function, use the command inline.

   (1hr)

   3.2 Differentiation
   To differentiate a function, we use the command diff

   (1hr)

CE 222	**Computer Programming**	Unit; 6
		Theoretical 2 hr/week
		Tutorial – hr/week
		Practical 2 hr/week

3.3 Integration
We can use MATLAB for computing both definite and indefinite integrals using the command int.

(1hr)

3.4 Differential Equations
We can use MATLAB to solve differential equations. The command for finding the symbolic solution is dsolve. For that command, the derivative of the function y is represented by Dy.

(1hr)

3.5 Multiple integrals

(1hr)

3.6 Limits
You can use limit to compute limits, left and right limits as well as infinite limits.

(1hr)

4. Graphics:
4.1 Two-Dimensional Plots
The simplest way to graph a function is to use the command ezplot

(2hr)

4.2 Curves in Three-Dimensional Space
The command for drawing 3D curves is ezplot3.

(2hr)

5. Vectors and Matrices:
5.1 Vectors
You can enter a vector by typing a list of numbers separated by either commas or spaces inside the square brackets.
- dot (dot product)
- cross (cross product)
- norm (norm or length of a vector)

(2hr)

5.2 Matrices
- A+B (matrix addition)
- A-B (matrix subtraction)
- c*A (scalar multiplication)
- A*B (matrix multiplication)
- A' (conjugate transpose of A)
- det(A) (determinant of square matrix A)
- rank(A) (rank of A)

(2hr)

	Units 3
CE 342 **Fuels Technology**	Theoretical 1 hr/week
	Tutorial 1 hr/week
	• Practical 2 hr/week

1. Energy and Fuel:

Energy and his classification in Technology section, Physical and chemical classification of fuel, solid Fuels (coal), the industrial processes on coal to Derived different Product.

(3hr)

2. Properties of oil stocks and prepare fractions oil:

Oil stocks, industrial processes which applied from the well to the different fractions in tower distillation and the processes on fraction.

(4hr)

3. Petroleum Fractions properties :

Benzene, Kerosene, Jet Fuel, Diesel, lubricants oil Asphalt, Fuel oil.

(9hr)

4. Gaseous Fuels and Liquefied gases:

Energy source types gases fuel types and liquefied gases which source of energy in industrial and houses.

(4hr)

5. Combustion Calculation:

Different type of equations about the subject and from it found the component which burner and the combustion equation and guess the flue gases and study behavior of combustion.

(6hr)

6. Burner of gases fuel:

The burner types of gases fuel and liquid fuel properties arrange it in Furnace.

(2hr)

7. Combustion in Furnaces:

Furnace types in oil industrial, Boilers and steam production that used in different industrial.

(2hr)

Note:
☐ 1st term

CE 242	**<u>Thermodynamics</u>**	Unit 4
		Theoretical 2 hr/week
		Tutorial 1 hr/week
		Practical - hr/week

1. <u>Introduction</u>:
Fundamental quantities Time, Length, Mass, Force, Temperature.

(2hrs)

2. <u>First Law and Other Basic Concepts</u>:
Joules experiments, Internal Energy Formulation of the first law, Thermodynamics state and state functions Enthalpy, The steady state flow processes, The reversible processes, Heat Capacity and specific Heat, Equilibrium, the phase rule.

(4hrs)

3. <u>Applications of the Equations of Ideal Gases, Generalized Correlation and the Acentric Factor.</u>

(8hrs)

4. <u>Heat Effects</u>:
Heat capacities of gases as a function of temperature, solids and liquids, Heat change accompanying phase change, Heat of industrial reactions.

(6hrs)

5. <u>The Second Law of Thermodynamics</u>:
Heat engine, Entropy, Second law limitation and real process Entropy change and irreversibility and probability (statistical thermodynamics), Third law of thermodynamics.

(6hrs)

6. <u>Thermodynamics Properties of Fluids</u>:
Relationships among the thermodynamics properties (including Helomtz and Gibes free energies and chemical potential), Steam formation and two phase system, Saturated temperature and pressure, Triple point, Wet vapor and dryness fraction, Types of thermodynamic tables and diagrams, Steam power plant cycle and analysis, Barometric condenser, Metering and throttling processes, Steam and as urbines.

(10hrs)

7. <u>Refrigeration and Liquefaction</u>:
Refrigeration cycles (Carnot, Air, Vapor – Compression) and Comparisons, Choice of refrigerant, Absorption Refrigeration, The heat pump, Liquefaction process.

(10hrs)

University of Technology	*Chemical Engineering Department*	<u>Second Year B.Sc. Syllabus</u>

CE 242	**<u>Thermodynamics</u>**	Units 4
		Theoretical 2 hr/week
		Tutorial 1 hr/week
		Practical - hr/week

8. <u>Phase Equilibrium</u>:

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

(8hrs)

9. <u>Chemical Reaction Equilibrium</u>:

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

(6hrs)

CE 232	**Physical Chemistry**	Unit 6
		Theoretical 2 hr/week
		Tutorial 1 hr/week
		Practical 2 hr/week

1. Change of State:
One component systems: Water, carbon dioxide and helium, Vapor pressure and external pressure, Liquid-vapor composition diagram, Liquid-Liquid binary solution mixture, Roulette's law for ideal mixtures, Non-ideal Liquid mixtures, The principle of distillation, Henry's law, solubility of gases in Liquids.

(10hrs)

2. 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.

(12hrs)

3. 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.

(16hrs)

4. Catalysis:
Reaction of catalyst in homogeneity system, Enzyme reactions and Kinetic of reactions

(6hrs)

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

(6hrs)

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 EMF, Standard electrode potentials, Standard free energy and entropy of aqueous ions, Calculation of EMF of a cell, Oxidation-reduction reactions, Concentrations cells, Electrolysis, Corrosion. Kinetic of reactions.

(8hrs)

		Units	4
CE 113	**Democracy**	Theoretical	2 hr/week
		Tutorial	- hr/week
		Practical	- hr/week

Standard Syllabus

| CE 133 | __Applied Mathematics__ | Unit 6
Theoretical 3 hr/week
Tutorial 1 hr/week
Practical - hr/week |

1. Revision ordinary differential equations:

First and second order, simultaneous differential equations, Application for chemical engineering.

(18hrs)

2. Solution of differential equations by series:

Simple series, method of Frobeins, Bassel's equation. Application for chemical engineering.

(18hrs)

3. The Laplace transformation:

The Laplace transformer, Properties of the Laplace transformation. The inverse transformation. Inversionby partial fraction. Convolution. Solution of differential equations. The transforms of special functions. Step function, staircase function, periodic function, Trigonometric function.

(18hrs)

4. Partial Differential Equations:

Formulating of partial differential equations. Solution of partial differential equations. Method of separating variables and Laplace transformation method.

(18hrs)

5. Numerical Analysis:

The difference operators. Interpolation. Finite difference equations. Solution of first and second order differential equations.

(18hrs)

		Units	7
CE 143	**Mass Transfer**	Theoretcal	3 hr/week
		Tutoria	1 hr/week
		• Practical	2 hr/week

1. Introduction:
(4hrs)

2. Mass transfer fundamentals:
Steady state mass transfer. Diffusion in binary and multicompouent gases. Diffusion in binary and multicompouent liquids. Connective mass transfer. Mass transfer coefficients. Two-film theory. Penetration theory. Unsteady state mass transfer methods

(25hrs)

3. Methods of gas-liquid separation (absorption and stripping):
Determination of interfacial mole fractions. Individual and overall mass transfer coefficients. Effect of gas solubility on equilibrium curve. Single stage absorption, multistage absorption. Finding number of stages graphically and through use of correlations for absorption and stripping. Packed columns limits of operation. Design of packed beds for dilute and concentrated solutions. Finding number of transfer units. Absorption with chemical reaction.

(16hrs)

4. Binary distillation:
Introduction, (T-x,y) and (x,y) equilibrium curves. Flash or equilibrium distillation for binary and multicomponent mixtures. Distillation with reflux using Mckabe-Thiele. Sorel method to find number of stages. Fenske equation to find minimum reflux ratio and minimum theoretical stages. Column efficiency. Thermal method for finding number of ideal stages (Ponchoue-Savarit Method). Multicomponent differential distillation.

(25hrs)

5. Multicompouent distillation:
Dew and bubble points calculation methods. Multicomponent equilibrium relationships. Minimum reflux and minimum number of stages. Short-cut method. Checking validity of reflux ratio used. Operating limits of distillation columns.

(14hrs)

6. Mechanical separation process and size reduction:
Classification of equipment. Particle shape factor. Power requirements in crushers. Particle size analysis.

(6hrs)

Note:
☐ 1st term

CE 233	**Statistics and Instrument Measurements**	Unit 4
		Theoretical 2 hr/week
		Tutorial - hr/week
		Practical - hr/week

Part A: Statistics

1. Introduction:
Qualitative and conclusive statistics, population samples, graphical representation of data.

(4hrs)

2. Table and graphical representation:
Primary data, repeatability, normal distribution.

(4hrs)

3. Media determination:

(4hrs)

4. Scatter determination:
Standard and relative deviations.

(4hrs)

5. Standard distributions:

(8hrs)

6. Chi distribution:
Confidence limits, Chi test, degree of freedom.

(4hrs)

7. Curve fitting:
Least square method, linear relations, exponential equations, gradient, and correlation coefficient.

(4hrs)

Part B: Measurements

1. Measurements:
Absolute and relative. Environmental conditions. Application on physical properties.

(4hrs)

2. Errors:
Types of errors, determination of errors.

(8hrs)

3. Instruments:
For temperature, Pressure, level, composition, velocity, flow rate.

(16hrs)

		Units 6
CE 243	**Reactor Design**	Theoretical 3 hr/week Tutorial 1 hr/week Practical - hr/week

1.Introduction:

Stoichiometry, reaction rate constant, order of reaction, reversible and non-reversible reactions, conversion, yield, selectivity.

(9hrs)

2. Types of reactors:

Batch reactors, continuous flow reactors i.e. CSTR, PFR. Industrial reactors.

(9hrs)

3. Bach reactors:

Design equation, reaction time, maximum production rate, non-isothermal operation, adiabatic operation

(18hrs)

4. Tubular reactors:

Design equation, isothermal and non-isothermal operation, residence time, length of reactor, number of tubes, pressure drop, space velocity.

(18hrs)

5. Continuous stirred tank reactions:

Design equation for isothermal operation, scale-up of liquid-phase batch data to the design of CSTR. CSTR's in parallel and in series.

(15hrs)

6. Unsteady state operation of reactors:

Start up of CSTR, semi-batch reactor.

(9hrs)

7. Multiple reactions:

Operation in parallel and in series for single and multiple reactions to obtain maximum amount of desired product.

(6hrs)

8. Comparison between reactors:

Comparison between batch, tubular, and CSTR for single and multiple reactions

(6hrs)

	Units 7
CE 343 **Heat Transfer**	Theoretical 3 hr/week
	Tutorial 1 hr/week
	• Practical 2 hr/week

1. Modes of heat transfer:
Material properties of importance in heat transfer.

(2hrs)

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-convection systems, fins.

(24hrs)

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.

(18hrs)

4. Heat exchangers:
Various types and their general characteristics. Fouling factor. Heat exchanger mean temperature differences. Co-current and counter-current flow.

(12hrs)

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

(6hrs)

6. Condensation and Boiling Heat Transfer:
Condensation of single vapors. Design calculations for condenser, condenser-subcooler and superheater condenser.

(9hrs)

7. Radiation and furnace design:
Radiation properties, shape factor, heat exchange for non black bodies, parallel planes, shields, gas tradition, boiler.

(9hrs)

8. Unsteady state heat transfer:
Temperature as a function of time, lumped capacity system, quenching of small bodies, heating of tank reactor.

(10hrs)

Note:
☐ 2nd term

		Units	6
CE 443	**Equipment Design using Computers**	Theoretical	2 hr/week
		Tutorial	- hr/week
		Practical	1 hr/week

Part (A)

1. Process Planning:

Scheduling and flow sheet design. Flow sheet types and designation. Block diagram. Process flow sheet. Piping and instruments diagram. Utility flow sheet. Equipment layout and plot plan. Project evaluation. Feasibility studies. Site selection. Project cost estimation.

(6hrs)

2. Piping networks and pumps:

Pipe fittings, valves. Steam traps. Piping design standards. Piping material and selection. Pump specifications and data sheets. Optimum diameter. Types of pumps. Hydraulic characteristics for centrifugal pumps.

(6hrs)

3. Vessels and Tanks:

Types of vessels. Flash drums. LPG tanks. Criteria in vessel design. Stress considerations. Design of tall vertical vessel. Design of pressure vessels. Supports and foundations

(6hrs)

4. Heat transfer equipment:

Types of exchangers and applications. Exchanger ratings. Exchanger design. Exchanger specification sheets. Furnaces. Convection and radiation zones. Types of fuels. Burners and arrangements. Steam boilers, types of boilers.

(6hrs)

5. Mass Transfer Equipment:

Types of columns. Plate and packed Types of plates and packing. Design features. Pressure drops in columns.

(6hrs)

CE 443	**Equipment Design using Computers**	Units 6
		Theoretical 2 hr/week
		Tutorial - hr/week
		Practical 1 hr/week

Part (B) : Complete equipment design of each of the following units:

1. Pressure vessels, pumps and compressors:
Flash drum. Gas-liquid separator, LPG storage tanks. Cyclone separators. Gas movers and compressors. Pumps. Piping network. etc.

(8hrs)

2. Heat Equipment:
Shell and tube heat exchangers. Plate heat exchanger. Boilers. Furnaces. Vaporizers. Air coolers. Coil type heaters. Condensers. etc.

(10hrs)

3.Mass transfer equipment and reactors:
Distillation column. Absorber. Extractor. Dryer. Absorption towers. Leaching equipment. Scrubbers. Stripping towers. Reactors.

(12hrs)

University of Technology	Chemical Engineering Department	Third Year B.Sc. Syllabus

CE 543-U	**Biochemical Engineering** *Unit Operations Branch*	Units	2
		Theoretical	2 hr/week
		Tutorial	1 hr/week
		Practical	- hr/week

1. **Definition, introduction:**
(2hrs)

2. **Industrial micro organisms and methods of separation:**
(2hrs)

3. **Micro organisms genetics:**
(4hrs)

4. **Biotechnological methods of growths:**
   Liquid systems, batch and continuous cultures. Breaded cultures Solid Fermentation's
(6hrs)

5. **Single cells proteins:**
   Microorganisms used, treatment of waste, production of single cell protein. Diet value
(3hrs)

6. **Bakery yeast:**
   Dry and ready effective types.
(3hrs)

7. **Amino acids:**
   Clotamic acid.
(1hr)

8. **Organic acids:**
   Acetic acid.
(1hr)

9. **Enzymes:**
(1hr)

10. **Antibiotics:**
   Microorganisms producing antibiotics, Penicillin
(1hr)

11. **Industrial Alcohol:**
   Alcoholic fermentation, microorganism used, production method.
(1hr)

12. **Animal cell cultivation:**
(2hrs)

13. **Plant cell Cultivation:**
(1hr)

14. **Environmental cleaning using biotechnology:**
   In the fields of water treatment. Organic Pollutants. Petroleum wastes.
(2hrs)

	Unit	2
CE 643-U	Theoretical	2 hr/week
Environmental Engineering	Tutorial	1 hr/week
Unit Operations Branch	Practical	- hr/week

1. Introduction:

What is pollution and a historical brief on international concern with pollution. Types of pollutants and measurements. Pollution allowable limits in the environment.

(2hrs)

2. Cleaning of air and industrial gases:

Sources and effects of air pollution. Methods of control. Designing pollution equipment. Settling chamber, Cyclone separator, Venture scrubber, spray tower, cyclone scrubber, packed bed, electrostatic precipitator. Economic evaluation of gas cleaning.

(10hrs)

3. Water and heavy water treatment:

Physical methods of treatment. Occupation methods. River water cleaning, heavy water treatment. Desalination.

(10hrs)

4. Industrial and sewage treatment:

Industrial water treatment. Sewage water treatment.

(4hrs)

5. Solid pollutants:

Sources and effects. Methods of control of solid pollutants.

(4hrs)

CE 543-R	**Storage and Transport of Crude and Petroleum Products**	Units	2
		Theoretical	2 hr/week
	Refinery Engineering Branch	Tutorial	1 hr/week
		Practical	- hr/week

1. Fluid Flow:

Petroleum liquids flow. Petroleum gases flow. Designing pipe network from optimum velocity and diameter viewpoint. Crude and petroleum products pipelines, Heating and pumping stations, Increasing pumping rates by looping. Increasing pumping rates by polymer additives. Two-phase flow. Unsteady state flow and hammering.

(14hrs)

2. Pressure Vessels / Tanks:

Stress systems of shells. Bending and membrane shells. Equilibrium equation for a shell element and LPG tanks, Rotationally symmetrically loaded membrane shell. Crude oil huge tanks.

(8hrs)

3. Selection of Materials for Vessels and Pipelines:

Selection of materials for vessels to limit corrosion. Selection of materials for pipelines to limit corrosion. Catholic protection.

(8hrs)

		Units	2
CE 643-R	**<u>Combustion Engineering</u>**	Theoretical	2 hr/week
		Tutorial	1 hr/week
	Refinery Engineering Branch	Practical	- hr/week

1. <u>Combustion reaction stoichiometry:</u>

(8hrs)

2. <u>Excess air and flame temperature:</u>
3. <u>Combustion products:</u>
4. <u>Gas, solid, and liquid fuels:</u>
5. <u>Flammability limits:</u>
.

(8hrs)

6. <u>Flame and combustion speed:</u>
7. <u>Flame stability:</u>
8. <u>Gas, liquid and solid fuels burners:</u>

(6hrs)

9. <u>Combustion zones and temperature profiles:</u>
10. <u>Radiation and convection rooms in furnaces:</u>
11. <u>Furnaces and the tubular furnace:</u>
12. <u>Chimney height calculation:</u>

(8hrs)

13. <u>Furnace efficiency and heat loss calculations :</u>
14. <u>Furnace wall layers and refractories:</u>
15. <u>Tube layers in furnaces:</u>

Units   3

CE 244   **Project**

1. Introduction:
Literature, Methods of manufacturing, Capacity of the Process Physical and Chemical Properties.

2. Material and Energy Balances:
Review of Material and Energy balances, Flow sheet Symbols, PFD Information in Flow Diagram.

3. Choice of Process Devices and Equipments:
Pumps, Valves, Pipes, Measuring Devices and Controllers, Material of Construction, PID Plot.

4. Choice of Plant Location and Layout Standards:

5. Industrial Services:
Cooling Tower, Boilers, Study Problems from Industrial Waste Disposals, and How to Prevent the Environment, pollution.

6. Use a Computer Program to Design:
Introducing a Complete Project with Material and Energy Balances Design of Devices, Calculation of Costs, Choice of Location.

CE 344	**Transport Phenomena**

Units   7
Theoretical 3 hr/week
Tutorial   1 hr/week
• Practical   3 hr/week

1. Boundary Layer and analogies:

Boundary Layer in Laminar and turbulent Flow, Boundary Layer in Laminar sub Layer, Transition layer, Velocity distribution on Surfaces and Pipes, Momentum, heat and mass transfer molecular diffusion, Eddy transfer, Reynolds analogy, Modified Reynolds analogy, Chilton and Colburn analogy.

(20 hrs)

2. Evaporation:

Introduction, Types of Evaporations, Evaporation Equipment, Heat transfer in Evaporation Process, single, double and Multi effect Evaporators, Design of evaporators, Comparison of Forward, backward and Parallel effect evaporators, boiling Point rise.

(12 hrs)

3. Drying:

Introduction and general Principle in drying, Rate of drying, the mechanism of moisture movement, Calculation of rate of drying, moisture transport in Solids at Constant and falling rate Period, Capillary movement, Material and Energy Balances in Continuous dryers, Types of Dryers

(8 hrs)

4. Humidification, dehumidification and Cooling towers:

Humidification, dehumidification, Temperature humidity Chart for air – water system . Enthalpy – humidity –temperature chart. Addition of Vapor or liquid Stream to a gas Stream. Mechanism of dehumidification Evaluation of heat and Mass transfer Coefficient, Cooling tower, height of Packing in Cooling towers, Minimum gas Condition, Change of Condition of liquid and gas in Cooling towers.

(14 hrs)

5. Extraction:

Definition, Extraction process, Equilateral Triangular coordinates (Ternary Diagram), system of three liquid _ one pair partially soluble, system of three liquid _ two, pairs partially soluble, choice of solvent, Equipment in extraction cross _ current extraction, multi stage Cross Current extracting cross current for insoluble Liquid , Continuous Counter current extraction , Continuous Counter Current in Soluble , Liquid , Minimum Solvent , Counter Current extraction with reflux .

(22 hrs)

Note:

☐ 1st term

		Units 7
CE 344	**Transport Phenomena**	Theoretical 3 hr/week
		Tutoria 1 hr/week
		Practical 3 hr/week

6. Filtration:

Type of Filters, Filtration theory, Plate and frame filter press, leat filter, filtration at Constant ΔP, Filtration at Constant rate, washing Time.

(10 hrs)

7. Crystallization:

Introduction Equilibrium Solubility in crystallization, Classification of Crystallizes, Nucleation theory, Rate of Crystal Growth, Material and Energy balance in Crystallization.

(4 hrs)

		Units	5
CE 444	**Process Control**	Theoretical	2 hr/week
		Tutorial	1 hr/week
		• Practical	3 hr/week

1. Revision of Laplace Transformation:

(4 hrs)

2. Process Dynamic and Transient Response of the system:

Dynamic and Control For chemical Process, Dynamic behavior for 1st order system, lineraization, Interacting and non-interacting, Second order system, Transportation.

(16 hrs)

3. Characteristics of the closed loop System:

Over all closed loop transfer functions and block diagram algebra Transient of Simple Closed loops System, Stability of Control, Introduction to the Frequency analysis and design technique.

(20 hrs)

4. Industrial Controller:

Actions selection Criteria for Various Control modes, final Control element, Dynamics and Control of Chemical reactor System.

(10 hrs)

5. Dynamic and Control of some Complex Chemical Process:

Heat exchanger, distillation Column, Introduction to Computer Control of Chemical Process.

(10 hrs)

Note:

□ 2nd term

		Units	6
CE 544-U	**Chemical Industries**	Theoretical	2 hr/week
		Tutorial	1 hr/week
	Unit Operation Branch	Practical	3 hr/week

1. Chemical Processing:
Introduction, Operating Conditions, Type of Process.

(3 hrs)

2. Sulpher and Sulpheric acid:
Raw materials, Frasch Process, Iead Chamber Process, Contact Process, Oleum Production.

(4 hrs)

3. Ammonia and Nitric acid:
Raw materials, Production Steps, Production Process.

(6 hrs)

4. Nitrogenous Fertilizers:
Ammonium Sulphate, Ammonium nitrate, Urea.

(4 hrs)

5. Phosphoric acid:
Wet Process Phosphoric and, Electric Furnace

(4 hrs)

6. Phosphate Fertilizers:
Superphosphate, Triple Superphosphate.

(4 hrs)

7. Electrolytic Industries:
Principle and theory, Caustic Soda Production Chlorine Production

(4 hrs)

8. Industrial Salts:
Sodash Production

(3 hrs)

9. Ceramic Industries:
Raw materials, Chemical Conversions, Porcelain, Fire Clay

(4 hrs)

10. Cement Industries:
Raw materials, Portland Cement

(4 hrs)

11. Glass Industries:
Raw materials, Manufacture of Glass

(4 hrs)

CE 544-U	**Chemical Industries**	Units	6
		Theoretical	2 hr/week
		Tutorial	1 hr/week
	Unit Operation Branch	Practical	3 hr/week

12. Surface Coating Industries:
Paint, varnishes, lacquers

(4 hrs)

13. Oils and Fats:
Fatty acids, Manufacture of Vegetable Oils and Waxes

(4 hrs)

14. Soap and Detergents:
Soap Production, Detergents Production

(4 hrs)

15. Sugar Industries:
Cane Sugar, Beet Sugar

(4 hrs)

CE 134	**Optimization**	Units	2
		Theoretical	2 hr/week
		Tutorial	1 hr/week
		Practical	- hr/week

1. Introduction to Optimization Methods:

(4 hrs)

2. Organization of Optimization problems:

(4 hrs)

3. Single Variable:

Analytical methods, numerical methods, graphical methods, numerical Search, restriction Function, unrestricted Function, Direct search, Dichotomous Search, golden Search, Fibonacci Search

(12 hrs)

4. Multivariables Optimization Methods:
- Necessary Conditions For Extreme Values in graphical Cases.
- Solution by graphical method.
- Simplex method.
- Linear Programming and application in Chemical engineering (transportation mixing)

(10 hrs)

CE 644-U	**Engineering of Catalysts**	Units	2
		Theoretical	2 hr/week
		Tutorial	1 hr/week
	Unit Operations Branch	Practical	- hr/week

1. **Catalysts:**
Definitions, Properties of Catalysts

(2 hrs)

2. **Steps in a Catalytic Reaction:**
Adsorption, Surface Reaction, Decoration, Rate Equations for each Step

(4 hrs)

3. **Finding Rate Law and Mechanism:**
Equations of Rate Limiting Step.

(4 hrs)

4. **Design of Reactor for Gas – Solid Reactions:**
Basic Guidelines. Design Equations.

(8 hrs)

5. **Heterogeneous Data Analysis for Reactor Design:**
Deducing a Rate law from the Experimental Data, Finding a Mechanism Consistent with Experimental Observations, Evaluation of the Rate law Parameters, Reactor Design

(12 hrs)

CE 644-R	**Engineering of Catalysts**
	Refinery Engineering Branch

Units 2
Theoretical 2 hr/week
Tutorial 1 hr/week
Practical - hr/week

1. Introduction:

Properties of Catalysts, Determination of Surface Area, Void Volume and Solid Density, Pore Volume Distribution, Classification of Catalysts, Promoters and Inhibitors, Catalyst Poisoning. (4 hrs)

2. Rate Equations of Fluid-Solid Catalytic Reactions:

Rate of Adsorption, Desorption and Surface Reaction, Rate of the limiting Step, Mechanism, Design of Reactor for- Gas- Solid Reactions. Data Analysis for Reactor Design (10 hrs)

3. External Transport Processes in Heterogeneous Reactions:

Equations of Mass –and Heat Transfer, Calculations of the Concentrations on the Surface, Calculations of Temperature Differences in External Transport Processes, Fluidized Bed Reactors, slurry Reactors (4 hrs)

4. Internal Transport Processes:

Gaseous Diffusion in Single Cylindrical Pores, Surface Diffusion. Effectiveness Factor, Thiele – Type Modulus (4 hrs)

5. Design of Heterogeneous Calalytic Reactors:

Fixed – Bed Reactors, Fluidized Bed Reactor, Slurry Reactions (8 hrs)

		Unit	2
CE 744-U	**Corrosion Engineering**	Theoretical	2 hr/week
		Tutorial	1 hr/week
	Unit Operations Branch	Practical	- hr/week

1. **Introduction:**
   Definition of Corrosion, why it happens, direct and indirect disadvantages.
   (2 hrs)

2. **Types of Corrosion:**
   Dry Corrosion, wet Corrosion, Eight form of Corrosion
   (4 hrs)

3. **Mechanism of Crevice Corrosion:**
   (2 hrs)

4. **Electrochemical cell:**
   Electrode Potential, types of reference electrodes.
   (4 hrs)

5. **Corrosion rate Calculation:**
   Wet loss method, electrochemical method
   (2 hrs)

6. **Polarization:**
   Definition, Types.
   (4 hrs)

7. **Passivity:**
   (2 hrs)

8. **Effect of Temperature and velocity on corrosion reaction:**
   (2 hrs)

9. **Method of Protection:**
   (4 hrs)

10. **Instruments to measure Corrosion rate:**
   (4 hrs)

		Unit :	2
CE 844-U	**Technology of Oil and Gas**	Theoretical	2 hr/week
		Tutorial	1 hr/week
	Unit Operations Branch	Practical	- hr/week

1. **History and Development of Refinery Processes:**
   Kinds of Refineries.

   (2 hrs)

2. **Chemical Composition of Petroleum:**

   (2 hrs)

3. **Physical and Thermodynamic Properties:**
   Physical and Thermodynamic Properties of Petroleum oil and petroleum products.

   (2 hrs)

4. **Introduction to Processing:**
   Stabilization, dehydration, Tube still Heaters.

   (4 hrs)

5. **Fractionation of Petroleum:**
   Atmospheric and Vacuum Fractionation.

   (2 hrs)

6. **Fractionation Towers:**
   Material and Energy Balances, Reflux, Temperature Distribution in Fractionation Towers, Tower Diameter

   (6 hrs)

7. **Thermal Cracking:**
   Catalytic Cracking

   (6 hrs)

8. **Natural Gas:**
   Refinery Gases

   (4 hrs)

9. **Natural Gas Processing Units:**

   (2 hrs)

	Units	2
CE 234 **Industrial Management and Safety Requirements**	Theoretical	2 hr/week
	Tutorial	1 hr/week
	Practical	- hr/week

1. **Management:**
   Principle of management, types and classifications, management responsibility, organization responsibility.

   (4 hrs)

2. **Industrial organization**
   Site, Feasibility study, Development of efficient work method (plant layout, flow of material, material handling), workstations, Inputs and Outputs, Production planning (types of productions).

   (3 hrs)

3. **Maintenance:**
   Classifications, cost, machine replacements, case studies and examples

   (3 hrs)

4. **Network Analysis:**
   Principles and applications, Critical Path Method (CPM), Gantt Chart, Pert techniques (examples and case studies).

   (3 hrs)

5. **Work Measurement Techniques**
   Time and Motion study.

   (3 hrs)

6. **Costing:**
   Framework of management, cost of production (row material cost, labor cost, machinery cost).

   (3 hrs)

7. **Quality Control:**
   Standardization, specification, sampling techniques, Inspections – analysis of results. Quality costs (preventive cost, appraisal cost and failure cost). Application of quality control chart – examples, Reliability.

   (4 hrs)

8. **ISO:**
   Requirements, applications, ISO series, Quality management system (QMS), Total Quality managements (TQM), Requirements and applications.

   (3 hrs)

9. **Safety Requirements:**
   Hazards (types e.g. industrial hazards, pollution (air pollution, water pollution, industrial pollution). Industrial by products and industrial waste, Safety requirements of industrial sites. Requirements of suitable work environment (examples with particular emphasis in chemical industry).

	(4 hrs)
	Units 2
CE 944-U **Polymer Technology**	Theoretical 2 hr/week
	Tutorial 1 hr/week
Unit Operations Branch	Practical - hr/week

1. Polymers:
Nomenclature

                                                   (2 hrs)

2. Polymers Classification:
Classification based on Sources, Classification based on Chemical nature of Polymers, Technical Classification of Polymers

        (2 hrs)

3. Polymerization:
Step growth, Polymerization (condensation polymerization) Free radical Polymerization, Ionic (cationic, Anionic) Coordination Polymerization (Steroregular Polymerization) Polymerization by group transfer

        (6 hrs)

4. Polymerzation Systems:
Bulk, Solution, Suspension, Precipitation

        (4 hrs)

5. Molecular Weight of Polymers:
Methods of measurement of molecular weight of Polymers

        (2 hrs)

6. Polymer composites:

        (2 hrs)

7. Polymer blends:

        (2 hrs)

8. Physical Properties of Polymers:

        (4 hrs)

9. Mechanical Properties of Polymers:
Tensile strength, Impact strength, Creep, hardness

        (4 hrs)

10. Polymer Processing:
Molding, Extrusion, Thermal Forming Calendaring

        (4 hrs)

		Unit	6
CE 544-R	**Petroleum Refining**	Theoretical	2 hr/week
		Tutorial	1 hr/week
	Refinery Engineering Branch	Practical	3 hr/week

1. Introduction:
History and Development of Refining Processes Kinds of Refineries.

(2 hrs)

2. Chemical Composition of Petroleum:

(2 hrs)

3. Physical and Thermodynamic Properties of Petroleum oil:

(2 hrs)

4. Evaluation of oil stocks:

(4 hrs)

5. Introduction to Processing:
Stabilization, dehydration, tube still heaters

(10 hrs)

6. Fractionation of Petroleum:
Atmospheric and Vacuum Fractionation

(2 hrs)

7. Fractionation Towers:
Material and Energy Balances, Reflux Temperate Distribution in Fractionation Tower, Tower Diameter

(8 hrs)

8. Treating Processes:
Removal of Acid Gases, Sweetening Processes, improvement in Performance and storage stability.

(8 hrs)

9. Upgrading processes:
Thermal Crackling, Cooking, Visbreaking, Catalytic, Cracking, Hydrocracking, Catalytic Reforming, Alkylation, Isomerisation.

(10 hrs)

10. Product Blending:
Blending of vapor pressure, octane number, viscosity, flash point aniline point, and pour point.

(6 hrs)

11. Manufacturing of lubricating oils:

(4 hrs)

12. Treating process using Hydrogen:

(2 hrs)

		Units	2
CE 844-R	**Gas Technology**	Theoretical	2 hr/week
		Tutorial	1 hr/week
	Refinery Engineering Branch	Practical	- hr/week

1. **Classification of Gaseous fuels thermodynamic:**

(3 hrs)

2. **Physical and Chemical Properties for natural Gas:**

(3 hrs)

3. **Drying of Gaseous Fuels:**
Drying by Adsorption, Drying by Absorption

(4 hrs)

4. **Sweetening of Gaseous Fuels:**
Sweetening by Adsorption, Sweetening by Absorption

(6 hrs)

5. **Gas Processing units:**
Flash Separation Processes, Distillation of multicomponemt gas mixture

(6 hrs)

6. **Liquefied Petroleum Gases:**

(2 hrs)

7. **Production of Hydrogen:**

(2 hrs)

8. **Sulfur recovery processes from Acid gases streams:**

(4 hrs)

		Units	2
CE 744-R	**Petrochemical Industries**	Theoretical	2 hr/week
		Tutorial	1 hr/week
	Refinery Engineering Branch	Practical	- hr/week

1. Introduction:
Chemical Process Industries

(1 hrs)

2. Basic Petrochemical Materials:
Low Olefins, Steam Cracking Processes Cooling, Purification Processes Cooling Processes, Purification Processes Compression, Separation Operations, Energy System, Diolefins, Sources of diolefins, Butadiene Separation, Isobutylene Production, Conversion Process For Production of diolefins, Higher Olefins Production methods of higher olefins, linear, Alkyl benzene Complex Aromatics, Basic materials Aromatic Sources, Separation of benzene – Toluene – Xylene, Syntheses Gas, Steam reforming, Partial Oxidation

(10 hrs)

3. Synthetic Zeolites:
(2 hrs)

4. Intermediate Petrochemicals:
Methanol, Ethylene Oxide Acetic Acid, Ethanolamine, Vinylchloride, Ethyleneglycol Acrylonitrile, Adipic Acid, Methyl Tetrabutyl ether, EthylbenZene, Styrene, Phenol, Nitrobenzene, Ethylene, Cyclohexane, Benzoic acid, Terephthalic acid.

(7 hrs)

5. Petrochemical Detergents:
(2 hrs)

6. Polymers:
LDPE, HDPE, PP, PVC

(4 hrs)

7. Synthetic Fibers:
(2 hrs)

8. Petrochemical Complexes:
(2 hrs)

		Units 2
CE 944-R	**Environmental - Pollution**	Theoretical 2 hr/week
		Tutorial 1 hr/week
	Refinery Engineering Branch	Practical - hr/week

1. Introduction:

Definition of Pollution, literature surveys on international interest of Environmental Pollution Problems. Pollutants, Type of Pollutants, Measuring Devices, Allowable level of Pollutants in Environment.

(2 hrs)

2. Air Pollution:

Air Pollutants, Particulate matter, SO_2, CO, NO, …etc Sources and effect, Control Treatment Methods, Design of some Equipment: Centrifugal, Cyclone, Scrubber, Packed Bed Ventura, Spray – tower, Electrostatic Separator, and Chimney Design.

(12 hrs)

3. Water – Pollution:

Water Pollutants, Sources and effect, Organic and non – organic, Radiation activity, Suspended Solids and Sculling Salts, Control Treatment of Water Pollution for: Drinking, Industry Processes, Desalination methods, Reverse Osmosis, Electrodalysis, Solar Distillation, Primary, secondary and advanced treatment of Wastewater, Treatment of oily Pollution.

(12 hrs)

4. Pollution of Solid – Waste:

Sources, Effects, Control Treatment method of Removal Solid – Waste, Treatment by economy methods.

(6 hrs)