

DEPARTMENT OF CHEMICAL ENGINEERING



SYLLABI OF COURSES

FOR

B.E. CHEMICAL ENGINEERING PROGRAMME

**NED UNIVERSITY OF ENGINEERING & TECHNOLOGY, KARACHI-75270
PAKISTAN**

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**NED UNIVERSITY OF ENGINEERING & TECHNOLOGY, KARACHI-75270
PAKISTAN**

Department of Chemical Engineering
NED University of Engineering and Technology
Karachi, Pakistan

COURSE OUTLINE FOR FIRST YEAR									
Fall Semester					Spring Semester				
Course code	Course title	Credit hours			Course code	Course title	Credit hours		
		Th	Pr	Total			Th	Pr	Total
CH-101	Chem. Engg. Principles	3	1	4	CH-106	Applied Chemistry	2	1	3
ME-101	Engg Mechanics	3	1	4	CH-107	Chemical Engineering Thermodynamics I	2	1	3
ME-104	Workshop Practice	0	2	2	ME-111	Engg Drawing	2	1	3
HS-104	Functional English	3	0	3	EE-118	Basic Electricity & Electronics	3	1	4
PH-122	Applied Physics	3	1	4	HS-105/HS-127	Pak. Studies or Pak. Studies (Foreigners)	2	0	2
					MT-114	Calculus	3	0	3

COURSE OUTLINE FOR SECOND YEAR									
Fall Semester					Spring Semester				
Course code	Course title	Credit hours			Course code	Course title	Credit hours		
		Th	Pr	Total			Th	Pr	Total
CH-208	Analytical Chemistry	2	1	3	CH-213	Chem. Process Industries	2	0	2
CH-210	Chemical Engineering Thermodynamics II	2	1	3	ME-209	Materials & Metallurgy	3	1	4
CH-209	Fluid Mechanics-I	2	1	3	CH-211	Fluid Mechanics-II	2	1	3
MM-205	Mechanics of Materials	3	1	4	MT-223	Ord. Diff Eqn. & Four. Sr.	3	0	3
IM-207	Comp. Prog. & Draft.	2	1	3	HS-205/HS-209	Islamic Studies or Ethical Behavior (for Non-muslims)	2	0	2
					CH-212	Particulate Tech.	2	1	3

COURSE OUTLINE FOR THIRD YEAR									
Fall Semester					Spring Semester				
Course code	Course title	Credit hours			Course code	Course title	Credit hours		
		Th	Pr	Total			Th	Pr	Total
CH-310	Fuel & Energy	2	1	3	CH-302	Separation Processes	3	1	4
CH-307	Heat Transfer	3	1	4	CH-306	Chem. Process Control	3	1	4
CH-309	Chem. Reaction Engg.	3	1	4	HS-304	Business Comm. & Ethics	3	0	3
CH-311	Mass Transfer	3	1	4	MT-331	Probability & Statistics	3	0	3
MT-332	Adv. Calc. & Lnr. Algebra	3	0	3	PF-303	App. Economics for Engrs.	3	0	3

COURSE OUTLINE FOR FINAL YEAR									
Fall Semester					Spring Semester				
Course code	Course title	Credit hours			Course code	Course title	Credit hours		
		Th	Pr	Total			Th	Pr	Total
CH-401	Process Mod. & Sim.	3	1	4	CH-417	Ind. Safety & Maint Mang	2	0	2
CH-414	Chem. Plant Design	2	0	2	CH-418	Ind. Org & Management	2	0	2
CH-404	Chem. Process Optim.	3	1	4	CH-###	Electives	2	0	2
CH-416	Pet. Ref & Petroleum	2	1	3	CH-413	Gas Engineering	2	0	2
MT-441	Adv. Math. Techniques	3	0	3	CH-415	Transport Phenomena	3	0	3
CH-499	Chem. Engg. Project	0	3	3	CH-499	Chem. Engg. Project	0	3	3

Elective Courses	
CH-408	Polymer Technology
CH-410	Water Purification
CH-411	Environmental Pollution Control
CH-412	Biochemical Engg.

CH-101	Chemical Engineering Principles
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Introduction to chemical engineering calculations, processes and process variables, Fundamentals of Material Balances, Single Phase Systems, Multiphase Systems, Energy and Energy Balances, Balances on Reactive Systems, Balances on Non Reactive Systems.

ME-101	Engineering Mechanics
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A) Statics:

General principles of statics, Review of vector addition and subtraction, Cartesian vectors, Position vectors, Force vector directed along a line, Dot product and cross products. Laws of triangle and parallelogram law of forces, Momentum. Conditions of equilibrium of particles, Free-body diagrams, Co-planar force systems. Moment of force, Scalar and vector formulation, Moment of a couple. Conditions of equilibrium of a rigid body in two dimensions, Free body diagrams and equations. Structural Analysis; Methods of joints and sections, Rules for Zero Force members.

B) Dynamics:

Kinematics of particles, Rectilinear and curvilinear motion of particles. Components of velocity and acceleration kinetics of particles, Newton's second law of motion, Dynamic Equilibrium, Work, Energy, Power, Impulse and momentum.

ME-104	Workshop Practice
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Use of carpenter's tools, Exercise in preparing simple joints, Bench fitting practice, Exercise in marking and fittings; Use of measuring instruments.

Smith's forge; Exercise in bending, upsetting and swaging.

Familiarizing the students with the following processes: Soldering and brazing, Welding, Heat treatment, Moulding and casting.

Simple machine shop processes, such as turning, shaping, milling and sheet metal work.

HS-104	Functional English
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Listening Skills

- Introduction to course and OBE requirements.
- Difference between listening and hearing.
- Problems in listening and coping strategies (Lecture).
- Listening skills and sub skills.
- Practice in Listening, active, critical, content and Selective listening followed by worksheets.

Vocabulary Development

- Tips/ strategies in vocabulary enhancement.
- Practice in vocabulary development.
- Word formation.
- Activities from; suffixes, prefixes, roots.
- Inferring meaning from context.
- Idiomatic expressions.
- Note: written assignment will be given.

Reading skills

- A brief lecture on pre-reading, while-reading, and post reading steps
- Skimming and scanning
- Practice of skimming and scanning through worksheets
- Compression exercises.

Spreading skills

- Presentation's

Writing skills

- Note taking and its technique.
- Practice of note taking using listening skills.
- Writing correctly practice through worksheet on: sentence structure and Punctuation, error correction.

Process of writing

- Practice in pre-writing strategies, in revising, and in editing for grammar.

Paragraph writing

- Structure and types
- Topic and the topic sentence
- Unity, adequate development and coherence in paragraphs.

Essays

- Structure of essays: thesis statement and the paragraphs.
- Types of essays: narrative, cause & effect, compare & contrast.

Letters:

- Style, formatting (digital letter writing), organization and structure of the letter (Lecture)

- Types of letters: routine requests and intimation, invitation, thank you and condolence letters etc.

Report writing

Discussion on exam pattern

PH-122	Applied Physics
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Introduction

Types of errors in experimental measurements. Units in different systems. Graphical Techniques (Log, semi-log and other non-linear graphs)

Vectors

Coordinate system, Review of vectors, Vector differentiation,(ordinary and partial differentiation) vector integrations.

Mechanics

Motion under constant acceleration, Newton laws and their applications. Frictional forces. Work and Energy theorem, law of conservation. Of mechanical Energy, Angular momentum.

Electrostatics and Magnetism

Coulombs Law. Electrostatic potential energy of discrete charges. Continuous charge distribution. Gauss's Law. Electric field around conductors. Dielectrics. Dual trace oscilloscope with demonstration.

Magnetic fields. Magnetic force on current. Hall effect. Biot-Savart Law. Ampere's Law, Fields of rings and coils. Magnetic dipole. Diamagnetism, Paramagnetism and Ferromagnetism.

Semiconductor Physics

Energy levels in a semiconductor. Hole concept. Intrinsic and Extrinsic regions. Law of Mass Action. P-N junction, Transistor.

Waves and Oscillations

Free oscillation of systems with one and more degrees of freedom. Solution for Modes. Classical wave equation. Transverse modes for continuous string. Standing waves. Dispersion relation for waves. LC network and coupled pendulums. Plasma oscillations.

Optics and Lasers

Harmonic traveling waves in one dimension. Near and far fields. Two-slit interference. Huygens Principle. Single-slit diffraction. Resolving power of optical instruments. Diffraction Grating. Lasers, Population inversion. Resonant cavities. Quantum efficiency. He-Ne, Ruby and CO₂ lasers. Doppler effect and sonic boom.

Modern Physics

Inadequacy of classical physics, Plank's explanations of black body radiation. Photoelectric effect, Compton effect. Bohr theory of Hydrogen atom, Atomic spectra, Reduce mass, De-Broglie hypothesis Bragg's Law, Electron microscope, Uncertainty relations Modern atomic model, Zeeman effect, Atomic nucleus, Mass energy relation, Binding energy, Nuclear forces and fundamental forces, Exponential decay and half-life. Radioactive equilibrium in a chain, Secular equilibrium, Nuclear stability, Radiation detection instruments. Alpha decay, Beta decay, Gamma decay attenuation, Nuclear radiation hazards and safety, Medical uses of Nuclear Radiation. Fission, Energy release. Nuclear Reactors. Breeder Reactor, Nuclear Fusion.

CH-106	Applied Chemistry
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Introduction to Inorganic Chemistry:

Atomic structures, Reaction types, Structure and bonding of covalent compounds of p-block elements.

Solubility:

Solubility of ionic compounds, nature of solvated ions, and intermolecular Forces, Solubility products.

Inorganic Compounds:

Halides, oxides, hydrides nitrites, sulfides, Amides.

Acid-Base Systems:

Titration curves, buffers, coordination Compounds.

Organic Chemistry:

Molecular Structure, Delocalization, Stereochemistry

Unit Processes:

Types, Agents, Mechanisms, Important Factors and Applications of different unit processes (such as: Sulfonation and Sulfation, Alkylation, Nitration, Amination, Halogenation, Hydrogenation and Dehydrogenation, Oxidation, Esterification and Polymerization)

CH-107	Chemical Engineering Thermodynamics-I
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Introduction to Thermodynamics, application areas of thermodynamics, state and path functions, concept of equilibrium & types, laws of thermodynamics and processes. Specific heat and enthalpy calculations, energy balance to open and closed system and its applications.

PVT relations of pure substances

ideal and real gases, compressibility factor, law of corresponding states and eccentric factor, equations of state and its applications

Introduction to entropy, isentropic process, entropy changes ideal gas, entropy balance to open and closed system and its applications, ideal work, lost work and its applications. Gas Power Cycles, Basic assumptions and analysis of gas power cycles, Carnot cycle, introduction to gas turbine, Rankine cycle, Brayton cycle.

ME-111	Engineering Drawing
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Basics of Engineering Drawing

Drawing instruments and sheets; Importance of conventions and standards in engineering drawing.

Engineering Geometry

Geometrical construction of plane figures, conic sections, cycloidal curves and involute.

Multiview Drawing

Multiview projection and drawing using first and third angle projection methods

Development of Surfaces

Development of prisms, pyramids, cylinders and cones

Sectional Views

Sections of solids and machine components

Pictorial Projections

Types of pictorial views and drawing isometric view

Dimensioning and Tolerancing

Dimensioning techniques, size and geometric tolerance and their symbols, types of fits

Intersection of Surfaces

Construction of curves from intersection of solids such as cones, cylinders, prisms and pyramids

Freehand Sketching of Machine Components

Sketching of temporary and permanent fasteners like bolts, nuts and rivets, shaft couplings, connecting rod, bearings, pulleys, locking devices; Types of thread

Assembly and Detail Drawing

Types of working drawing, construction of views of the assembled objects / components.

System and Process Flow Diagrams

Construction of process flow diagrams; symbols for piping, instruments and equipment

EE-118	Basic Electricity & Electronics
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General Information:

Course Title	Functional English
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Code: HS-104

Year: First Year

Credit Hours: 3+0 (Contact Hours 3)

Pre-Requisite:--

Marks/Distribution: 100 (60 theory, 40 sessional)

Objective of the Course

- The course aims at strengthening the language skills in order for the students to use language effectively as a tool to succeed in academic activities which they will be carrying out as part of their academic actives.
- The enhances the development of all the four language skills but explicitly focuses on listening, reading and writing; and the efforts made in these areas are perceived to implicitly target proficiency and accuracy in the target language, English. The language skills are coincided with study skills which are directly required by students as basic skills to pursue other subjects more meaningfully.

Course contents

1. Listening

- a. Types of listening
- b. Problems in listening and coping strategies
- c. Listening skills, sub skills
- d. Practice in listening

2. Note taking

- a. Techniques for taking notes (from lecturers, from books)
- b. Note taking in different forms paragraphs (points, figures, processes, tables, graphs etc.)

3. Vocabulary Development

- Enhancing current vocabulary to reflect a better usage of words in spoken and written languages.
- Tips/strategies in vocabulary enhancement
- Practice in vocabulary development

4. Reading

- a. Reading skills, sub skills
- b. Reading comprehension levels
- c. Reading strategies
- d. Reading practice through variety of reading texts and comprehension exercises
- e. Beyond reading [outline, précis, speech and presentation]

5. Writing

- a. Process of writing
- b. Informal writing strategies

6. Writing correctly

HS-105	Pakistan studies
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An Outline of Emergence of Pakistan

A brief historical survey of Muslim community in the sub-continent. War of Independence 1857 and aftermath. Sir Syed Ahmed Khan, Development of Two Nation Theory. Formation of Muslim League, Lucknow Pact, Khilafat & Non-cooperation Movement, Political Events from 1924 to 1937. Pakistan Resolution --Struggle for Pakistan from 1940 to 1947. Emergence of Pakistan.

Land of Pakistan

Geophysical conditions, Territorial situation and its importance, Natural Resources: Mineral and water.

Constitutional Process

Early effects to make constitution- Problems and issues. Constitution of 1956 and its abrogation. The constitution of 1962 and its annulment. Constitutional and Political Crisis of 1971; The constitution of 1973, Recent constitutional developments.

Post Independence Development

Education in Pakistan: Planning & Development in the Field of Education. Development of Science and Technology with special reference to Engineering and Architecture. Brief

survey of Pakistan's Economy; Industrial and Agricultural Development. Internal and external trade. Economic Planning and prospects.

Cultural Developments in Pakistan

Definition, Check and contributing factors in culture, Development of Art, Philosophy and Literature.

Foreign Policy

Relations with neighbors, Super powers and the Muslim World.

Land of Pakistan

Land & People, Strategic importance, important beautiful sights, Natural resources.

A brief Historical background

A brief historical survey of Muslim community in the sub-continent. British rule & its impacts – Indian re-action. Two nation theory– Origin & development. Factors leading towards the demand of separate Muslim state. Creation of Pakistan.

Government & Politics in Pakistan

Constitution of Pakistan – a brief outline. Governmental structure – Federal & Provincial – Local Government Institutions. Political history – a brief account.

Pakistan & the Muslim World

Relations with the Muslim countries.

Language and Culture

Origins of Urdu Language. Influence of Arabic and Persian on Urdu Language & Literature. A short history of Urdu literature.

HS-127	Pakistan studies (For Foreigners)
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Land of Pakistan

Land & People, Strategic importance, Important beautiful sights, Natural resources.

A brief Historical background

A brief historical survey of Muslim community in the sub-continent. British rule & its impacts – Indian re-action. Two nation theory– Origin & development. Factors leading towards the demand of separate Muslim state. Creation of Pakistan.

Government & Politics in Pakistan

Constitution of Pakistan – a brief outline. Governmental structure – Federal & Provincial – Local Government Institutions. Political history – a brief account.

Pakistan & the Muslim World

Relations with the Muslim countries.

Language and Culture

Origins of Urdu Language. Influence of Arabic and Persian on Urdu Language & Literature. A short history of Urdu literature.

MT-114	Calculus
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Set and Functions:

Define rational, irrational and real numbers; rounding off a numerical value to specified value to specified number of decimal places or significant figures; solving quadratic, and rational inequalities in involving modulus with graphical representation; Definition of set, set operations, Venn diagrams, DeMorgan's laws, Cartesian product, Relation, Function and their types (Absolute value, greatest integer and combining functions). Graph of some well-known functions. Limit of functions and continuous and discontinuous functions with graphical representation.

Differential Calculus

Differentiation and Successive differentiation and its application: Leibnitz theorem. Taylor and Maclaurin theorems with remainders in Cauchy and Lagrange form, power series. Taylor and Maclaurin series, L Hopitals rule, extreme values of a function of one variable using first and second derivative test, asymptotes of a function, curvature and radius of curvature of a curve, partial differentiation, exact differential and its application in computing errors, extreme values of a function of two variables with and without constraints. Solution of non-linear equation, using Newton Raphson method. Integral Calculus

Integral Calculus

Indefinite integrals and their computational techniques, reduction formulae, definite integrals and their convergence. Beta and Gamma functions and their identities, applications of integration. Centre of pressure and depth of centre of pressure.

Sequence & Series:

Sequence, Infinite Series, Application of convergence tests such as comparison, Root, Ratio, Raabe's and Gauss tests on the behavior of series.

Complex Number

Argand diagram, De Moivre formula, root of polynomial equations, curve and regions in the complex plane, standard functions and their inverses (exponential, circular and Hyperbolic functions).

Recommended Books

1. Engineering Mathematics.	Anthony Croft	Second Edition
2. Calculus	Thomas & Finney	1994
3. Calculus & Analytical Geometry	Howard Anton	Fifth

CH-208	Analytical Chemistry
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Chemical Analysis and Data Handling:

Sample purification, Sampling techniques, accuracy and precision, errors, calibration methods, standard deviation and tests of significance. Constructing and interpreting quality control plots. The use of computers in data handling

Spectroscopy:

Introduction, Spectroscopic methods such as UV-visible, Infrared, Mass, NMR, Flame, instrumentation, sample handling and data interpretation.

Gravimetry:

Introduction, gravimetric methods such as precipitation, electro-, volatilization, and particulate gravimetry, instrumentation, sample handling and data interpretation.

Electro-analytical Techniques:

Theoretical principles, Electro-analytical techniques such as potentiometry, conductometry, polarography, and voltammetry.

Separation Techniques:

Solvent extraction: Principle, distribution law, and industrial applications in chemical analysis.

Chromatographic methods: Principle, Gas, Liquid and supercritical fluid chromatographic techniques, instrumentation and industrial applications in chemical analysis.

CH-208	Analytical Chemistry
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Chemical Analysis and Data Handling:

Sample purification, Sampling techniques, accuracy and precision, errors, calibration methods, standard deviation, and tests of significance. Constructing and interpreting quality control plots.

The use of computers in data handling.

Spectroscopy:

Introduction, Spectroscopic methods such as UV-visible, Infrared, Mass, NMR, Flame, instrumentation, sample handling and data interpretation.

Gravimetry:

Introduction, gravimetric methods such as precipitation, electro-, volatilization, and particulate gravimetry, instrumentation, sample handling and data interpretation.

Electro-analytical Techniques:

Theoretical principles, Electro-analytical techniques such as potentiometry, conductometry, polarography, and voltammetry.

Separation Techniques:

Solvent extraction: Principle, distribution law, and industrial applications in chemical analysis.

Chromatographic methods: Principle, Gas, Liquid and supercritical fluid chromatographic techniques, instrumentation and industrial applications in chemical analysis.

CH-209	Fluid Mechanics – I
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Introduction: Liquids and gases, properties of fluids, Force, mass and weight, Units and Conversions.

Fluid Statics: Basic equations, pressure forces on surfaces, Pressure vessels, piping, pressure measuring devices.

Bernoulli's equation and its applications; diffusers and sudden expansion: Torricelli's equation, cavitation and unsteady flows.

Fluid Friction: Reynolds Experiment; laminar and turbulent flows; Friction factor method, fitting losses, enlargements and contractions, friction in non-circular channels, economic pipe diameter, Concept of Boundary Layer and its importance in fluid mechanics, flow around submerged objects.

Momentum: Momentum balances; steady flow applications, nozzles and diffusers.

Dimensional Analysis:

Buckingham –Pi Theorem; Reynold's law of Similitude.

CH-210	Chemical Engineering Thermodynamics – II
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Gibbs Phase rule, free energy, thermodynamic property relations, introduction to residual and excess properties, Clausius/Clapeyron equations and their applications.

Joule/Thomson coefficient, Throttling process, expanders, compression process, refrigeration cycle, liquefaction process, Linde and Claude liquefaction processes.

Introduction to VLE, application areas of VLE, boiling point diagram, Raoult's law, Henry's law, activity and activity coefficient, Flash calculations.

Partial properties, ideal and non-ideal solutions, chemical potential, property changes of mixing, fugacity and fugacity coefficient:

Extent of a reaction for single and multiple reactions, relation of Gibbs energy change with equilibrium constant, effect of temperature and pressure, relation of equilibrium constant to composition, equilibrium conversion of single and multiple reactions.

MM-205	Mechanics of Materials
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Review mechanics of materials, Deformation; strain; elastic stress-strain behavior of materials; Introduction to stress-strain diagram, working stresses, unit design, Introduction to elastic and nonlinear continua. Poisson's ratio; Determination of forces in frames; Simple bending theory; general case of bending; Shear force and bending moment diagrams; Relationship between loading; shear force and bending moment. Stress; Skew (antisymmetric) bending Direct, Shear, Hydrostatics and complementary shear stresses; Bar and strut or column; Theory of buckling instability; Thin ring, elementary thermal stress and strain. Theory of elasticity and analytical solution of elasticity problems. Strain energy in tension and compression.

Analysis of bi-axial stresses, principal planes, principal stress-strain, stresses in thin walled pressure vessels. Torsion of circular shafts, coiled helical spring, strain energy in shear and torsion of thin walled tubes, torsion of non-circular sections. General case of plane stresses, principal stress in shear stresses due to combined bending and torsion plane strain. Composite materials, Volume dilatation, Theories of Yielding, Thin Plates and Shells Stress Concentration.

IM-207	Computer Programming & Drafting
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Introduction

Introduction to programming concepts & languages, Compilation & Interpretation, Overview of modular programming, ASCII character set.

Building Blocks

Identifiers and keyword, Data-types, Variable and Constant, Statement and Operations, Input and Output Functions.

Branching Statement

Conditional branching and looping (Counter and condition controlled loops)

Subroutines

A brief overview, defining a subroutine, Accessing a subroutine, Passing arguments, Returning values and Recursion.

Arrays & Strings

Defining an array, Referring to individual elements of an array, Processing an array, Multidimensional arrays, Strings handling and Manipulation

Computer Aided Drafting

Introduction, Application of Computers in drafting and designing, methods for creating drawing entities, Common editing features, Dimensioning with variable setting, Printing and Plotting.

CH-213	Chemical Process Industries
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Past, present and future of Chemical Industries in Pakistan.

Types of Chemical Industries; Silicate and allied products, Glass, Ceramics and Cement, Phosphorus, Soap and Detergents, Sugar, Paints and Varnishes; Heavy Chemicals, Sulphuric Acid production, Nitric Acid, Water conditioning and purification for steam and other purposes.

Fermentation Industries, industrial alcohol and industrial solvents, Fertilizers and their types; Explosives their types and manufacture; Refractory types, manufacture and properties.

Industrial Gases, carbon dioxide, nitrogen, and hydrogen etc; Food processing industries, food by products; Plastic industries, types and their properties, manufacture of plastics etc.; Paper and pulp industries, introduction and manufacturing procedures. Industrial Solvents.

ME-209	Materials & Metallurgy
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Introduction to Materials Engineering

Types of materials, source of materials and their extraction, crystalline and amorphous materials, Application and selection of materials (basic criteria for different environments).

Metallic Materials

Pure metals and alloys, nature and properties of metals and alloys, major properties of metal and alloys, single crystal and polycrystalline metals, crystal defects and the mechanism of deformation and fracture, plastic flow in polycrystalline materials, structure property relationship, macro and micro examination, structural aspect of solidification & solid phase transformation in binary systems, ferrous and non ferrous metals, steel making processes, heat treatments, TTT diagram, surface hardening coatings, powder metallurgy, non destructive testing.

Ceramics, Glasses & Refractory Materials

Compositions, properties, structures of various non metallic materials, application of Ceramics, Glasses, refractory materials, methods of manufacture.

Polymers & Rubbers

Polymerization, Structural feature of Polymers, Thermoplastic Polymers, Thermo setting Polymers, Additives, major mechanical properties, rubber (elastomers), synthesis of rubber.

Composites

Introduction to composite materials, types of composite materials, method of fabrication of composite materials, property averaging, major mechanical properties.

Environmental Degradation

Metal degradation by atmosphere, Aqueous & galvanic corrosion, stress corrosion cracking, Methods of corrosion prevention, behavior of metal at elevated temperature pyrometer, oxidation, scalling and creep. Chemical degradation of ceramic & polymers, radiation damage surface. Improvement against degradation.

CH-211	Fluid Mechanics – II
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Two and three dimensional fluid flow, Navier Stokes equations, applications, Euler's equation, transport equations.

Potential Flow: Definition, irrotational flow, stream function, application of Bernoulli's equation to irrotational flow, flow around a cylinder.

Flow through porous media, fluidization.

Non-Newtonian fluid flow, circular pipes, power law, bingham plastic, transition from laminar to turbulent flows.

Boundary layer: laminar and turbulent boundary layers, flow over a flat plate, flow in circular pipes.

Pumps, Compressors and Turbines; positive displacement and centrifugal; stability; fluid engine and turbine efficiency

Introduction to Gas-Liquid Flow

MT-223	Different Equation & Fourier Series
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1st Order Differential Equations

Basic concept; Formation of differential equations and solution of differential equations by direct integration and by separating the variables; Homogenous equations and equations reducible to homogeneous form; Linear differential equations of the order and equations reducible to the linear form; Bernoulli's equations and orthogonal trajectories; Application in relevant Engineering.

2nd and Higher Orders Equations

Special types of n^{th} order differential equations with constant coefficients and their solutions; The operator D ; Inverse operator $1/D$; Solution of differential by operator D methods; Special cases, Cauchy's differential equations; Simultaneous differential equations; simple application of differential equations in relevant Engineering.

Partial Differential Equation

Basic concepts and formation of partial differential equations; Linear homogeneous partial differential equations and relations to ordinary differential equations; Solution of first order linear and special types of second and higher order differential equations; D'Alembert's solution of the wave equation and two dimensional wave equations; Lagrange's solution; Various standard forms.

Laplace Integral & Transformation

Definition, Laplace transforms of some elementary functions, first translation or shifting theorem, second translation or shifting theorem, change of scale property, Laplace transform of the n^{th} order derivative, initial and final value theorem Laplace transform of integrals, Laplace transform of functions $t^n F(t)$ and $F(t)/t$, Laplace transform of periodic function, evaluation of integrals, definition of inverse Laplace transform and inverse transforms convolution theorem, solutions of ordinary differential using Laplace transform.

Fourier series

Periodic functions and expansion of periodic functions in Fourier series and Fourier coefficients; Expansion of function with arbitrary periods. Odd and even functions and their Fourier series; Half range expansions of Fourier series, "DFT and FFT, Fourier Spectrum".

HS-205	Islamic Studies
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Section A	<u>Quranic Verses</u>
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Chapter 01.

Tauheed: Al – Ambiya – 22, Al – Baqarah – 163&164.

Prophet hood: Al – Imran -79, Al – Huda – 7, Al – Maidaoh-3.

Here-After: Al – Baqarah – 48, and one Hadith.

Chapter 02.

Basic Islamic Practices: Al – Mu’minun – 1 – 11, and two Ahadith

Chapter 03.

Amer – Bil – Ma ‘Roof Wa-Nahi Anil Munkar: The concept of Good & Evil, Importance and necessity of Da’wat-e-Deen Al-Imran – 110 Method of Da’wat-e-Deen An-Nehl-125, Al-Imran-104, and two Ahadith

Chapter 04.

Unity of the Ummah:Al-Imran-103, Al-Hujurat-10, Al-Imran-64, Al-an’am-108, and two Ahadith.

Chapter 05.

Kasb-e-Halal:Ta ha-81, Al-A’raf-32-33, Al-Baqarah-188, and two Ahadith.

Chapter 06.

Haquq-ul-Ibad: Protection of Life Al-Maidah-32 Right to Property Al-Nisa-29 Right to Respect & Dignity Al-H ujurat-11-12. Freedom of Expression: Al-Baqarah-256. Equality: Al-Hujurat-13 Econonmic Security: Al-M a’ arij-24-25 Employment Opportunity on Merit: An-Nisa-58 Access to Justice: An-Nisa-135

Chapter 07.

Women’s Rights:An-Nehl-97, Al-Ahzab-35, An-Nisa-07

Chapter 08.

Relations with Non-Muslims: Al-Mumtahanah-8-9, Al-Anfa’al-61 the last sermon of Hajj of Holy Prophet (PBUH): Relevant extracts.

Section B:**Chapter 09.**

Seerat (life) of the Holy Prophet (PBUH): Birth Life at Makkah Declaration of prophet hood Preaching & its difficulties Migration to Madina Brotherhood (Mawakhat) & Madina Charter The Holy Wars of the Prophet (Ghazwat-eNabawi) Hujjat-ul-Wida The last sermon of Khutbatulwida: Translation and important poin

Section C:

Chapter 10.

Islamic Civilization: a) in the sub-continent: pre-Islamic civilizations. The political, social & moral impacts of Islamic civilization b) in the world: academic, intellectual, social & cultural impact of Islam on the world

Recommended Text Book (s). Thematic study of Holy Quran and Hadith by Dr. Saeedullah Qazi Published by NED. Seerat Ibn-e-Ishaque by Ibn-e-Ishaque, Published by Oxford Press Abdullah Yusuf Ali (The Holy Quran) (2005, 2003) Published by Goodword Books: New Delhi Reference Books/Magazines/Articles The Noble Quran (Quranic Translation) by Dr. Mohsin Khan and Dr. Taqi uddin Hilali. Tafseer Ibn-e-Kaseer (English Translation) Tafseer Abdul Majid Darya Abadi (English) The sealed Nectar by Safi ur Rehman Mubarakpuri (A book on the biography of Holy Prophet (PBUH) Rehmat-ul-Lilalameen by Qazi Suleman Mansoor Puri

Mutaliah Tahzeeb e Islam by Arshad Bhatti. Impact of Islam on India and the World by Musaid Kidwai.

HS-209	Ethical Behavior (for Non-Muslim)
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1. Introduction to Ethics:

- a) Definition of Ethics
- b) Definition between normative and positive science
- c) Problem of freewill
- d) Method of Ethics
- e) Uses of Ethics

2. Ethical Theories:

- a) History of Ethics: Greek Ethics, Medieval, Modern Ethics
- b) Basic concept of right and wrong: good and evil
- c) Utilitarianism, hedonism, self-realization: egoism, intuitionism, rationalism
- d) Kant's moral philosophy

3. Ethics & Religion:

- a) The relation of Ethics to religion
- b) Basic ethical principles of major religions: Hinduism, Judaism, Buddhism, Zoroastrianism, Christianity, Islam

4. Ethics, Society, and moral theory:

- a) Ethical foundation of Rights and Duties
- b) Applied Ethics
- c) Society as the background of moral life
- d) Universalism and Altruism

e) Theories of punishment

CH-212	Particulate Technology
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Introduction to particulate solids, size reduction (Laws of comminution, size reduction equipment: crusher and grinder and its types), solid storage (equipment's: silos, bins designing and application) transportation and handling (types of conveyors pneumatic conveying), mixing and agitation (mixing equipment: tumbling mixer, screw mixer, fluidized bed mixer and power calculation of paddle, turbine and propeller), screening(equipment's :vibratory screens, gyratory screens and stationary screens), filtration(surface and depth filtration)and centrifugal separation(separator sizing).

CH-310	Fuel and Energy
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Introduction to fuels, properties of fuel oil, coal and gas, storage, handling and preparation of fuels, principles of combustion, combustion of oil, coal and gas. Fluidized Bed Combustion Boilers. Furnaces and Waste Heat Recovery: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery.

Energy conversion technologies in industrial energy systems: overview of technologies and engineering thermodynamics for process utility boilers, heat pumps, steam turbine combined heat and power (CHP) and gas turbine CHP. Energy conversion performance of such systems for given energy conversion process parameters and given process head load.

Greenhouse gas emissions consequences of energy efficiency measures in industry. Greenhouse gas emissions from industrial energy systems. Optimization of industrial energy systems considering future costs associated with greenhouse gas emissions. Potential for greenhouse gas emissions reduction in industry. Overview of energy policy instruments and their impact on industrial energy system decision-making.

CH-307	Heat Transfer
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Conduction: Steady state and Unsteady state, Fourier's law, thermal conductivity, one and two dimensional analysis; multi-layer wall, pipe insulation thickness.

Convection: Free and Force convection, convection in laminar and turbulent flows, film and overall heat transfer coefficients, thermal boundary layer and its analogy with momentum boundary layer; flows over flat plate, inside ducts and tubes.

Radiation: Laws of Radiation, Radiation surface behavior and shape factor for black body and non-black body radiation

Heat transfer equipment, types and selection criteria; heat exchanger design; Heat transfer with phase change; Condensation and boiling heat transfer; designing of single phase condensers. Theory and calculations of combustion in furnaces and analysis of evaporators.

CH-309	Chemical Reaction Engineering
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Kinetics of homogeneous reactions: Rate of reaction, variables affecting the rate of reaction, order of reaction, rate constant; searching for a mechanism of reaction, activation energy and temperature dependency, Interpretation of batch reactor data for single and multiple reactions. Integral method and differential method of analysis for constant volume and variable volume batch reactors, Search for a rate equation.

Design of homogeneous and heterogeneous reactors, Batch, Mixed flow, Plug flow reactors, Comparison of single reactor, multiple reactor systems in parallel/series. Temperature and pressure effects. Adiabatic and non-adiabatic operations.

Surface phenomenon and catalysis, Heterogeneous reaction systems, Rate equations for heterogeneous reactions, Fluid particle reactions, Determination of rate controlling steps, Catalysis desorption Isotherms, Kinetics of solid catalyzed reactions, Design of fluid solid catalytic reactors.

CH-311	Mass Transfer
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Diffusion through gases and liquids, Fick's law, Mechanism of absorption and desorption; Mass transfer at gas liquid interfaces; Mass transfer with chemical reaction; Two film theory, penetration theory, concentration profiles; Calculation of rate of absorption; Resistance to mass transfer; overall and film coefficient; Film dominance and solubility; Schmidt, Sherwood and Stanton Numbers; Counter Current mass transfer and concept of transfer units. Mass transport: Derivation of species conservation equations for binary and multicomponent mixtures. Application to mass transfer problems with and without chemical reaction Introduction to mass transfer operations.

MT-332	Advanced Calculus & Linear Algebra
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Linear Algebra

Linearity and linear dependence of vectors, basis, dimension of a vector space, field matrix and type of matrices (singular, non-singular, symmetric, non-symmetric, upper, lower, diagonal tri-diagonal matrix), Rank of a matrix using row operations and special method, echelon and reduced echelon forms of a matrix, determination of consistency of a system of linear equation using rank, transitions matrix, basic concept of tensors, eigen value and eigen vectors of a matrix, Diagonalization, Cayley-Hamilton theorem. Applications of linear algebra in Engineering.

Euclidean Spaces and Transformation

Geometric representation of vector, norm of vector, Euclidean inner product, projections and orthogonal projections, Euclidean n spaces n properties Cauchy-Schwarz inequality, Euclidean transformations, apply geometric transformations to plane figure, composition of transformations.

Advance Calculus

Define a stationary point of a function of several variables, define local maximum and saddle point for a function of two variables the stationary points of a several variables, obtain higher partial derivatives of simple functions of two or more variables, iterated integrals, double and triple integrations with applications (area, centroids, moment of inertia, surface area and volume, use multiple integrals in solutions of engineering problems).

Vector Calculus

Vector differential operator, directional derivative, gradient, divergence, curl of a vector field and laplacian operators with applications. (Solenoid, conservative, etc).

Vector Integrations; Evaluate line integrals along simple paths, apply line integrals to calculate work done, apply Green's theorem in the plane to simple examples, evaluate surface integrals over simple surface, use the Jacobian to transform a problem a new coordinate system, apply Gauss' divergence theorem to simple problems, apply Stokes' theorem to simple examples.

CH-302	Separation Processes
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Binary Flash Distillation, Multi-component Distillation, Continuous Distillation, McCabe-Thiele Method, Exact Computation Methods for Multi-Component Distillation, Short Cut Methods for Multi-Component Distillation, Batch Distillation, Extractive Distillation

Adsorption and Stripping, Absorption, Solvent Extraction, Leaching methods

CH-306	Chemical Process Control
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Incentives for chemical process control. Feedback and feed-forward control configurations. Design of controllers.

Mathematical modeling of dynamic processes. Linearization of nonlinear systems. Laplace transforms. Solution of linear ordinary differential equations using Laplace transforms.

First-order systems, second-order systems, higher-order systems, time delays, inverse response systems, transfer functions.

Components of a control loop. Closed-loop transfer functions. Transient response of simple closed-loop control systems. Types of controllers. Stability of controller operation. Frequency response methods. Nyquist Stability Theorem.

Feedback control. Feed-forward control. Cascade Control. Multivariable control systems.

HS-304	Business Communication and Ethics
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Part-I Communication Skills (Oral)

Definitions and Conditions.

Modes:- verbal, non-verbal, vocal, non-vocal, sender, receiver, encoding, decoding, noise, context, emotional maturity, relationships, etc.

Language, perception.

Non-verbal, body language, physical appearance, cultural differences etc.

Personal and interpersonal skills/perceptions.

Communication dilemmas and problems.

Public Speaking – speaking situation, persuasion.

Part-II Written Communication

Formal / Business letters.

Memos (brief revision).

Notice and minutes of meetings.

Contracts and agreements (basic theoretical knowledge and comprehension).

Research / scientific reports.

Tenders (basic theoretical knowledge and comprehension).

Participating in seminars, interviews, writing and presenting conference papers, solving IELTS type papers. (Non-examination).

Part-III Engineering / Business Ethics

Course objective.

Need for code of ethics.

Type of ethics, involvement in daily life.

Problems/conflicts/dilemmas in application.

Review of Pakistan Engineering Council Code of Conduct.

MT-331	Probability & Statistics
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Statistics

Introduction, Types of data & variables, presentation to data, object, classifications, Tabulation, Frequency distribution, Graphical representation, Simple & Multiple Bar

diagrams, Sartorial & Pie-Diagram, Histogram, Frequency Polygon, Frequency Curves & their types.

Measure of Central Tendency and Dispersion

Statistics Averages, Median Mode, Quartiles, Range, Moments, Skewness & Kurtosis, Quartile Deviation, Mean Deviation, Standard Deviation, Variance & its coefficient, Practical Significance in related problems.

Probability

Basic concepts, Permutation & Combination, Definitions of probability, Laws of probability, Conditional probability, Baye's rule. Related problems in practical significance.

Random Variables

Introduction, Discrete & Continuous random variables, Random Sequences and transformations, Probability distribution, Probability density function, Distribution function, Mathematical expectations, Moment Generating Function (M.G.F.), Markove random walks chain/Related problems.

Probability Distributions

Introduction, Discrete probability distributions, Binomial, Poisson, Hyper geometric & Negative binomial distributions. Continuous probability distribution, Uniform, Exponential & Normal distributions & their practical significance.

Sampling and Sampling Distributions

Introduction, Population, Parameter & Statistics, Objects of sampling, Sampling distribution of Mean, Standard errors, Sampling & Non-Sampling Errors, Random Sampling, Sampling with & without replacement, Sequential Sampling, Central limit theorem with practical significance in related problems.

Statistical Inference and Testing of Hypothesis

Introduction, Estimation, Types of Estimates, Confidence interval, Tests of Hypothesis, Chi-Square distribution/test, one tails & two tails tests. Application in related problems.

Curve Fitting

Introduction, fitting of a first and second degree curve, fitting of exponential and logarithmic curves related problems, Principle of least squares, Second order Statistics & Time series not in bit detail.

Simple Regression & Correlation

Introduction, Scatter diagrams, Correlation & its Coefficient, Regression lines, Rank Correlation & its Coefficient, Probable Error (P.E), Related problems.

PF-303	Applied Economics for Engineers
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1. Introduction:

Basic concept and principles of Economics, Micro-Economics theory, the problems of scarcity. Basic concept of Engineering Economy

2. Economic Environment:

Consumer and producer good, Goods and services. Demand & Supply concept Equilibrium, Elasticity of demand, Elasticity of Supply, Measures of Economics worth, Price-supply-demand-relationship. Theory of Production, Factors of production, Laws of returns, break-even charts and relationships. Perfect competition, monopoly, monopolistic competition and oligopoly.

3. Element Financial Analysis:

Basic accounting equation. Development and interpretation of financial statements – Income Statement, Balance Sheet and Cash flow. Working capital management.

4. Break Even Analysis:

Revenue / cost terminologies, Behavior of Costs. Determination of Costs / Revenue. Numerical and graphical presentations. Practical applications. BEA as a management tool for achieving financial / operational efficiency.

5. Selection Between Alternatives:

Time value of money and financial internal rate of return. Present value, Future value and Annuities. Cost-benefit analysis, Selection amongst materials, techniques, designs etc. Investment philosophy. Investment alternatives having identical lives. Alternatives having different lives. Make or buy decisions and replacement decisions.

6. Value Analysis / Value Engineering:

Value analysis procedures. Value engineering procedures. Value analysis versus value engineering. Advantages and applications in different areas. Value analysis in designing and purchasing.

7. Linear Programming:

Mathematical statement of linear programming problems, Graphic solution Simplex procedure. Duality problem.

8. Depreciation and Taxes:

Depreciation Concept. Economic life. Methods of depreciations. Profit and returns on capital, productivity of capital. Gain (loss) on the disposal of an asset. Depreciation as a tax shield.

9. Business Organization:

Type of ownership, single ownership, partnership, corporation, type of stocks and joint stock companies. Banking and specialized credit institutions.

10. Capital Financing & Allocation:

Capital Budgeting. Allocation of capital among independent projects. Financing with debt capital. Financing with equity capital. Trading on equity. Financial leveraging.

CH-401	Process Modeling and Simulation
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This course introduces process modeling, simulation and analysis techniques. Development of process flow diagrams for various process industries and de-bottlenecking using simulation software such as HYSIS or ASPEN.

Economic evaluation of processes. Strategies for decision making, troubleshooting to fault, safety and failure analysis. The selection and specification of engineering materials using computer methods. Process synthesis and design strategy

CH-414	Chemical Plant Design
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Introduction; process design development, general design consideration; Computer-aided. Design, Essential flow diagrams, block flow diagrams (BFD), process flow diagrams (PFD), piping & instrumentation diagrams (P&ID), Equipment descriptions and standard notations, engineering ethics; Start of plant design project; Definition of project Establishment of design basis; Physical properties needed

General Design Factors and Specifications; Rules of thumb in design; Materials of construction.

Principles of engineering economy cost estimation and its techniques cash flow for industrial operations. Factors affecting investment and production cost. Profitability Evaluation, Alternative Investments, Replacements, Markets Survey and Plant Location, Application will be in the areas such as Cement, Petroleum, Petrochemical, Water desalination and Emerging Chemical Industries. Design topics will be assigned as mini-projects to group of students.

CH-404	Chemical Process Optimization
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The nature and organization of optimization problems; Formulation of objective function; Basic concepts of optimization; One dimensional search; Multivariable optimization; Linear programming; Nonlinear programming; Optimization of staged and discrete processes; Energy conservation applications; Unit operations; Optimization of large scale chemical plants.

CH-416	Petroleum Refining & Petrochemicals
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Origin & formation of petroleum, Composition of petroleum, Petroleum processing, Crude classification, Crude evaluation, Thermal properties of crude, Crude analysis, Crude fraction properties, Pretreatment of crude, Distillation of petroleum (ADU & VDU), Pipe still heater of crude, Arrangement of towers, Treatment techniques, Thermal and catalytic processes

Petrochemicals: Methanol, Formaldehyde, Ethylene production by steam cracking of naphtha, Ethylene dichloride, Vinyl chloride monomer, Vinyl acetate monomer, Ethylene oxide, Acetaldehyde

Propylene, Acrylonitrile, Propylene oxide, MTBE, Butadiene, BTX separation, Benzene by DE alkylation of toluene

MT-441	Advanced Mathematical Techniques
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Complex Variable

Limit, continuity, zeros and poles of a complex function, Cauchy-Reimann equations, conformal transformation, contour integration.

Error Analysis

Types of errors (relative, Absolute, inherent, round off, truncation), significant digits and numerical instability, flow chart. Use any Computational tools to Analysis the Numerical Solutions.

Finite Difference

Functions of operators, difference operators and the derivative operators, identities. Linear homogeneous and non-homogeneous difference equations. Numerical Differentiation, Forward Difference Method, Backward Difference Method, Central Difference Method.

Interpolation & Curve Fitting

Lagrange's Newton, Hermit, Spline, least squares approximation. (Linear and non-linear curves). With numerical problem in engineering.

Numerical Integration & Differentiation

Computation of integrals using simple Trapezoidal rule, 1/3th Simpson's rule, 1/8th Simpson's rule, Composite Simpson's and Trapezoidal rules, computation of solutions of differential equations using (Euler method, Euler modified method, Runge Kutta method of order 4).

Improper Integrals

Definitions, Types of improper integral and their convergence.

Elliptic Integrals

Introduction and identification of elementary elliptic integrals of first, second and third kinds. Simple applications.

CH-417	Industrial Safety and Maintenance Management
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Introduction: Accident and loss statistics, public perception of chemical industry, the accident process, some significant disasters as case studies; Toxicology: how toxicants enter and are eliminated from biological organisms, effects of toxicants, dose versus response models, threshold limit values.

Industrial Hygiene: Government regulations, identification and evaluation and control of various exposures in chemical industry. Fires and explosions: fire triangle, flammability characteristics of liquids and vapors. Design to prevent fires and explosions. Hazard identification and risk assessment. Accident investigations and case histories.

Forms of maintenance, scheduling of maintenance. Computerized Maintenance. Non destructive testing techniques. Forms of corrosion, prevention and inhibition,; Preparation for startup and shutdown. Preventive and predictive maintenance.

CH-418	Industrial Organization and Management
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Introduction and History, Company and Organization, Facility Location and Layout Planning, Operation Planning and Control, Marketing and Distribution, Total Quality Management, Project Management, Maintenance Management, Financial Management, Human Resources, Other Topics and Recent Trends in Management

CH-408 (a)	Polymer Technology
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Introduction: Classification of polymers, bonding in polymers, stereoisomerism, Polymer synthesis: Condensation, addition polymerization, copolymerization, bulk, solution, suspension and emulsion polymerization, Molecular weight and molecular weight determination, Polymer solutions and polymer solution thermodynamics, Physical states

and transitions in polymers, Crystallinity and morphology of polymers, Introduction to rheology: elasticity, purely viscous flow, linear viscoelasticity, Polymer processing: extrusion, calendaring, coating, casting, injection molding, blow molding, melt spinning, Mechanical properties of polymers, Commercial polymers, additives

CH-411 (b)	Environment Pollution Control
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Introduction, hydrological cycle, water quality parameters, acid/base chemistry, reaction kinetics, mass flux of pollutants, water quality management, water treatment processes, coagulation and flocculation, softening, settling and Sedimentation, filtration. Waste water treatment, Wastewater Characteristics, Effluent Standards, Primary Treatment (Screening, Communiting, Grit Removal, Flow Measurement, Primary Sedimentation), Secondary Treatment, Activated Sludge Treatment, BOD (Biological Oxygen Demand), COD (Chemical Oxygen Demand), Disinfection of Effluents, Growth and Food Utilization, Attached-Culture System. Sludge Treatment and Disposal, Advanced Waste Water Treatment, Nutrient Removal, Solid Removal, Waste water Disposal and Reuse. Air pollutants and standards, modeling air pollutants dispersions, air pollution control devices Solids waste management, hazardous wastes

CH-410 (c)	Water Purification Processes
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Description of methods of water purification and treatment. Fundamentals involved in Multi Stage Flash Distillation, reverse osmosis, electro dialysis etc. Study of properties of water and aqueous solutions. Detailed discussion and analysis of design maintenance, energy requirements and economics of the major process of purification.

CH-412	Biochemical Engineering
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Basic of Microbiology; Enzyme Classification; Enzyme reaction kinetics (Singlesubstrate Reactions) and energy patterns in biological system; Enzyme Inhibition; Nonideal Enzyme Kinetics, Isolation of enzymes and immobilized enzyme technology; Applications of Enzyme Catalysis (Biocatalysis); Transport phenomenon in microbial system; Design and analysis of biochemical reactors (fermentators); Anaerobic and aerobic metabolism photosynthesis and bio synthesis; biochemical and microbiological application to commercial and engineering.

CH-413	Gas Engineering
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Introduction to natural gas industry; gas production. Testing of well fluid; Test separator, Multiphase flow meters, establishing GOR; Gas-liquid separation - Design and

configurations. Acid gas sweetening, Chemical and Physical, solvent processes. Membrane/molecular sieve processes, Cryogenic separation, solvent regeneration. Dehydration of Natural Gas, LPG recovery and condensate stabilization. Gas processing facilities, process flow schemes and product specifications. Disposal of gas field emissions, effluent, produced water (EOR, Re-injection, flaring) Design, metallurgy and corrosion protection of gas pipelines and equipment's. Slug handling. Gas compression; compressors types, selection between centrifugal and reciprocating compressor, design considerations. Heat conservation in gas processing facilities. Flare system design; PSVs, blow down, flare/vent stack sizing. Project design using computer software's.

CH-415	Transport Phenomena
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Transfer processes: A review of the mechanisms of momentum, energy and mass transport.

Momentum transport: Derivation of equations of continuity and motion (NavierStoke's equation). Application in laminar and turbulent flow problems.

Energy transport: Derivation of energy equation. Application to heat transfer problems involving conduction, forced and free convection. Application in laminar and turbulent flow problems.

Mass transport: Derivation of species conservation equations for binary and multicomponent mixtures. Application to mass transfer problems with and without chemical reaction. Application in laminar and turbulent flow problems.

CH-499	Chemical Engineering Project
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Selected problems requiring design and improvement of process equipment or process industry, development of problem specific software, preparation of drawings, prototype models and laboratory experimentation shall be assigned to individual student or group of students. Grading shall be done based on design reports written by students and critical evaluation through oral examination.

