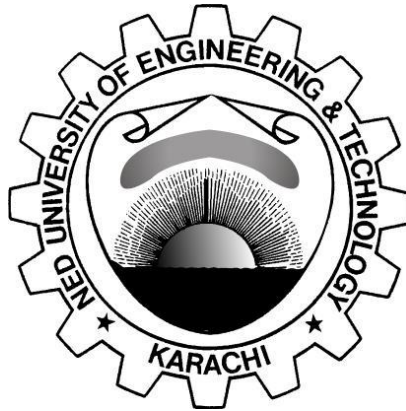


DEPARTMENT OF POLYMER AND PETROCHEMICAL ENGINEERING



SEMESTER SYLLABI OF COURSES FOR B.E. POLYMER AND PETROCHEMICAL ENGINEERING PROGRAMME

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

**DEPARTMENT OF POLYMER AND
PETROCHEMICAL ENGINEERING**

SEMESTER
SYLLABI OF COURSES
FOR
B.E. POLYMER & PETROCHEMICAL ENGINEERING
PROGRAMME

Batch: 2015-2016 onwards

NED UNIVERSITY OF ENGINEERING & TECHNOLOGY, KARACHI-75270
PAKISTAN

DEPARTMENT OF POLYMER & PETROCHEMICAL ENGINEERING

NED University of Engineering and Technology
Karachi, Pakistan

| COURSE OUTLINE FOR FIRST YEAR | | | | | | | | | |
|-------------------------------|--------------------------------|-------|----|-------|-----------------|--|-------|----|-------|
| FALL SEMESTER | | | | | SPRING SEMESTER | | | | |
| Course Code | Course Title | Marks | | | Course Code | Course Title | Marks | | |
| | | Th | Pr | Total | | | Th | Pr | Total |
| PP-105 | Introduction to Petrochemicals | 2 | 0 | 2 | PP-104 | Introduction to Polymers | 3 | 1 | 4 |
| PP-106 | Thermodynamics-I | 2 | 0 | 2 | ME-101 | Engineering Mechanics | 3 | 1 | 4 |
| HS-104 | Functional English | 3 | 0 | 3 | ME-111 | Engineering Drawing | 2 | 1 | 3 |
| PH-122 | Applied Physics | 3 | 1 | 4 | HS-105 / HS-127 | Pakistan Studies / Pakistan Studies (for Foreigners) | 2 | 0 | 2 |
| MT-114 | Calculus | 3 | 0 | 3 | | | | | |
| PP-103 | Workshop Practice | 0 | 1 | 1 | EE-118 | Basic Electricity & Electronics | 3 | 1 | 4 |

| COURSE OUTLINE FOR SECOND YEAR | | | | | | | | | |
|--------------------------------|--------------------------------------|-------|----|-------|-----------------|--|-------|----|-------|
| FALL SEMESTER | | | | | SPRING SEMESTER | | | | |
| Course Code | Course Title | Marks | | | Course Code | Course Title | Marks | | |
| | | Th | Pr | Total | | | Th | Pr | Total |
| PP-203 | Principles of Chemical Processes | 2 | 1 | 3 | PP-202 | Polymer Physics | 3 | 0 | 3 |
| PP-207 | Fluid Mechanics | 3 | 0 | 3 | PP-205 | Petroleum & Petrochemical Products | 2 | 0 | 2 |
| PP-209 | Thermodynamics-II | 3 | 0 | 3 | PP-212 | Polymeric Materials & Their Characterization | 3 | 0 | 3 |
| PP-211 | Computer Programming & Applications | 2 | 1 | 3 | MM-205 | Mechanics of Material | 3 | 1 | 4 |
| MT-330 | Applied Probability & Statistics | 2 | 1 | 3 | MT-215 | Differential Equations & Complex Variables | 3 | 0 | 3 |
| HS-205 or HS-206 | Islamic Studies OR Ethical Behaviour | 2 | 0 | 2 | PP-222 | Polymer & Petrochemical Lab-II | 0 | 1 | 1 |
| PP-221 | Polymer & Petrochemical Lab-I | 0 | 1 | 1 | | | | | |

DEPARTMENT OF POLYMER & PETROCHEMICAL ENGINEERING

NED University of Engineering and Technology
Karachi, Pakistan

| COURSE OUTLINE FOR THIRD YEAR | | | | | | | | | |
|-------------------------------|---------------------------------|-------|----|-------|-----------------|--|-------|----|-------|
| FALL SEMESTER | | | | | SPRING SEMESTER | | | | |
| Course Code | Course Title | Marks | | | Course Code | Course Title | Marks | | |
| | | Th | Pr | Total | | | Th | Pr | Total |
| PP-210 | Polymer Processing | 2 | 0 | 2 | PP-301 | Process Control & Instrumentation | 3 | 0 | 3 |
| PP-307 | Polymer Composites | 3 | 0 | 3 | PP-305 | Fuels & Combustion | 2 | 0 | 2 |
| PP-308 | Heat Transfer | 3 | 0 | 3 | PP-310 | Industrial Organization and Management | 2 | 1 | 3 |
| PP-309 | Mass Transfer | 3 | 0 | 3 | PP-311 | Chemical Reaction Engineering | 3 | 0 | 3 |
| MT-471 | Applied Numerical Method | 2 | 1 | 3 | PF-303 | Applied Economics For Engineers | 3 | 0 | 3 |
| PP-321 | Polymer & Petrochemical Lab-III | 0 | 1 | 1 | HS-304 | Business Communication & Ethics | 3 | 0 | 3 |
| PP-322 | Polymer & Petrochemical Lab-IV | 0 | 1 | 1 | PP-323 | Polymer & Petrochemical Lab-V | 0 | 1 | 1 |

| COURSE OUTLINE FOR FINAL YEAR | | | | | | | | | |
|-------------------------------|--|-------|----|-------|-----------------|--|-------|----|-------|
| FALL SEMESTER | | | | | SPRING SEMESTER | | | | |
| Course Code | Course Title | Marks | | | Course Code | Course Title | Marks | | |
| | | Th | Pr | Total | | | Th | Pr | Total |
| PP-402 | Petrochemical Processes | 3 | 1 | 4 | PP-403 | Plant Utilities & Safety | 2 | 1 | 3 |
| PP-406 | Process Equipment Design | 3 | 0 | 3 | PP-409 | Advance Polymer Engineering | 2 | 0 | 2 |
| PP-410 | Polymer Reaction Engineering | 3 | 0 | 3 | PP-XXX | Elective Course** | 2 | 0 | 2 |
| PP-411 | Separation Processes | 3 | 1 | 4 | PP-414 | Petroleum Refinery Engineering | 2 | 1 | 3 |
| PP-413 | Process Optimization | 3 | 0 | 3 | PP-408 | Polymer and Petrochemical Engineering Project* | 0 | 6 | 6 |
| PP-408 | Polymer & Petrochemical Engineering Project* | - | - | - | MG-481 | Entrepreneurship | 3 | 0 | 3 |
| PP-421 | Polymer & Petrochemical Lab-VI | 0 | 1 | 1 | | | | | |

* Duration of one academic year

** **Elective Courses**

1. PP-412: Environmental Engineering
2. PP-425: Polymer Rheology
3. PP-427: Rubber Technology
4. PP-428: Process Modeling & Simulation
5. PP-429: Gas Engineering

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|---------------|---------------------------------------|
| PP-105 | Introduction to Petrochemicals |
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Raw materials for petrochemicals, hydrocarbon groups in petroleum and their structures, sulphur, nitrogen, oxygen, and metallic organic compounds in petroleum, paraffinic, olefinic, and aromatic hydrocarbons, dienes, liquid petroleum fractions and their residues, chemistry of residues such as cracking, electrophilic and nucleophilic substitution, cyclisation, dehydrogenation, hydrogenation, oxidation, nitration, chlorination, alkylation, disproportionation, transalkylation, esterification, and etherification.

World crude oil reserves; crude oil composition; crude oil refining and refinery products, petrochemicals from refinery products, handling and storage of petrochemicals, overview of manufacturing processes, petrochemical process reaction and catalyst types, process equipment overview, petrochemical products and their uses, markets and economics, petrochemical industry in Pakistan.

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|---------------|-------------------------|
| PP-106 | Thermodynamics-1 |
|---------------|-------------------------|

Basic Concepts: Energy and its interactions, Properties of system, Closed and Open systems, heat, work, equilibrium, thermodynamic equilibrium, Macroscopic and Microscopic approaches in thermodynamics, Pressure, Temperature, Zeroth Law of thermodynamic, intensive and extensive properties, state functions and path functions.

Properties of substances: Pure substance, Property diagrams for Phase change processes, specific heat capacity, internal energy; enthalpy; Ideal and Non-ideal gas behaviour, Equations of state (EOS), Polytropic process involving ideal gas, Compressibility factor, Van der Waal EOS, Virial EOS.

First Law of Thermodynamics: Conservation of energy, energy balance for closed and open systems, steady flow energy devices-nozzles, diffusers, compressors, turbines, pumps vapour and combined power cycles.

Second Law of Thermodynamics: Heat engines, Kelvin and Clausius statements, Cyclic processes, Carnot Principle.

Entropy change in a cyclic process, increase of entropy principle Clausius inequality, entropy generation, Isentropic process.

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| HS-104 | Functional English |
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Course Contents

1. **Listening**
 - Types of Listening
 - Problems in listening and coping strategies
 - Listening skills, Sub skills
 - Practice in Listening
2. **Note taking**
 - Techniques for taking notes (from lectures, from books)
 - 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 language
 - Tips / strategies in vocabulary enhancement
 - Practice in vocabulary development

4. **Reading**
 - Reading skills, Sub skills
 - Reading comprehension levels
 - Reading strategies
 - Reading practice through variety of reading texts and comprehension exercises
 - Beyond reading [outline, précis, speech and presentation]
5. **Writing**
 - Process of Writing
 - Informal Writing strategies
6. **Writing Correctly**
 - a. Sentence structure and punctuation
 - b. Error correction
7. **Paragraphs**
 - a. Structure
 - b. Types
 - c. Topic and the topic sentence
 - d. Unity
 - e. Adequate development and coherence in paragraphs
8. **Essays**
 - a. Types
 - b. Five paragraphs, long essays
 - c. Structure (thesis statement and the paragraphs)
9. **Short Reports**
 - a. Structure
 - b. Format and types (informational and analytical)
10. **Letters**
 - a. Elements, Styles
 - b. Formatting (digital letter writing)
 - c. Organization and structure of the letter
 - d. Types (Routine requests and intimation, invitation, thank you and condolence letters etc.)

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| PH-122 | Applied Physics |
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INTRODUCTION

Types of Errors and Error Calculation, Graphical Techniques (Log, semi-log and other non-linear graphs).

VECTORS

Coordinate Systems, Review of vectors, Vector Differentiation (Ordinary and Partial Differentiation), Vector Integrations.

MECHANICS Motion under Constant Acceleration, Newton Laws and their Applications, Frictional Forces, Work-Energy Theorem, Law of Conservation of Mechanical Energy, Angular Momentum.

ELECTROSTATICS AND MAGNETISM

Coulombs Law, Continuous charge distribution, Electrostatic potential energy of discrete charges, Gauss's Law, Electric field around conductors, Magnetic fields, Magnetic force on current, Hall effect, Biot-Savart Law, Ampere's Law, Field 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

Simple Harmonic Oscillator, Damped Harmonic Oscillation, Forced Oscillation and Resonance, Type of Waves and Superposition Principle, Wave Speed on a stretched string.

OPTICS AND LASERS

Huygens Principle, Two-slit interference, Single-Slit Diffraction, Resolving power of Optical Instrument

Principals for laser action, Types of laser, Applications of laser.

MODERN PHYSICS

Planck's explanations of Black Body Radiation Photoelectric Effect, Compton Effect, Bohr's Theory of Hydrogen Atom, Atomic Spectra, Reduced Mass, De-Broglie Hypothesis, Electron Microscope, Atomic Nucleus and Properties of Nucleus, Radioactive Decay and Radioactive Dating, Radiation Detection Instruments, Nuclear Reactions and Nuclear Reactor, Nuclear Fusion

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|---------------|-----------------|
| 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

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).

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| PP-103 | Workshop Practice |
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Carpentry: Exercises in preparing simple joints; Bench-fitting practice; Exercise in marking and fitting; Use of measuring instruments.

Metal Processing: Simple machine shop operation such as Drilling, Milling, Turning.

Polymer Processing Techniques: Injection Moulding, Extrusion, Protrusion Techniques, Blow Moulding, and Vacuum Forming.

Welding of Plastics: Ultrasonic, friction, vibrations, hot plate, hot gas and resistance and inductive implant.

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| PP-104 | Introduction to Polymer |
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Basic concepts of polymers: Basic definition and nomenclature; molecular forces and chemical bonding (primary and secondary atomic and molecular bonding) in polymers; different functional groups and their properties; classification of polymers (thermoplastics and thermosets); polymer structure: skeletal structure, copolymers, tacticity, and geometrical isomerism; molar mass and its distribution.

Principles of polymerization: Classification of polymerization reaction, step-growth polymerization; kinetics, chain length regulation, Carothers equation.

Addition / chain growth polymerization, mechanism and kinetics of chain growth polymerization, ionic polymerization, chain transfer, inhibition and retardation, control of molecular weight.

Co polymerization: Principle and Industrial practice

Polymerization techniques: bulk polymerization, solution polymerization, suspension polymerization, and emulsion polymerization.

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| ME-101 | Engineering Mechanics |
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Static's of Particles:

Forces in a plane; Newton's First Law, Free-body diagram; Forces in space (rectangular components); Equilibrium of a particle in space.

Kinematics of Particles:

Rectilinear and curvilinear motion of particles; Components of velocity and acceleration; Motion relative of a frame in translation.

Kinetics of Particles:

Newton's Second Law: Dynamic equilibrium; Rectilinear and curvilinear motion; Work and energy; Kinetic energy of particle; Principle of Work and Energy, Conservation of energy, impulse and momentum; Impulsive forces and conservation of momentum; Impact, direct and oblique; Conservation of angular momentum.

Rigid Bodies:

Equivalent systems of forces; Principle of transmissibility; Moment of a force; Couple; Varignons Theorem. Centre of gravity of a three-dimensional body and centroid of a volume. Moments of inertia, radius of gyration, parallel axis theorem.

Equilibrium of Rigid Bodies:

Free-body diagram; Equilibrium in two and three dimensions; Reaction of supports and connections; Equilibrium of two-forces and three-force bodies.

Kinematics of Rigid Bodies:

General Plane motions; Absolute and relative velocity and acceleration.

Plane Motion of Rigid Bodies:

Forces and acceleration; Energy and momentum; Conservation of linear and angular momentum.

Friction:

Laws of dry friction; Angles of friction; Wedges; Square-threaded screws; Journal and thrust bearings; Belt friction.

Analysis of Structures:

Internal forces and Newton's Third Law; Simple and space trusses; Joints and sections; Frames and machines. Forces in cables.

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| ME-111 | Engineering Drawing |
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Drawing equipment and the use of instruments; Basic drafting techniques and standards; Geometrical curves including plane curves; Cycloid; Hypocycloid and Involute.

Intersections at various positions of geometrical bodies such as prisms, Prisms, cylinders and cones; Development of surfaces of prisms, pyramids, cylinders and cones.

Freehand sketching of machine and engine components, Locking arrangements; Foundation bolts; Stuffing box; Shaft couplings; Foot step bearing; Engine connecting rod.

Concept of working drawing of component parts of machines and engines size description, dimensions and specifications; Limit dimensioning and geometric tolerancing; Limits; Fits and tolerances; Conventional symbols.

Sectioning of machine and engine components; Orthographic projections and standard practices. Isometric views with particular reference to piping and ducting.

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| HS-105 | Pakistan Studies |
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An Out of Emergence of Pakistan: a brief historical survey of Muslim community in the sub-continent. War of independence 1947 and after match. 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 Economy: Industrial and Agricultural Development. Internal and external trade. Economic planning and prospects.

Cultural Development in Pakistan: Definition, Contents and Contributing factors in culture, Development of Art, Philosophy and literature.

Foreign Policy: Relation with neighbors, Super Powers and Muslim World.

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| HS-127 | Pakistan Studies (For Foreigners) |
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Land of Pakistan: Land & People – Strategic importance beautiful sights – Natural resources (some of economics of Pakistan)

A Brief Historical Background: A brief historical survey of Muslim community in the sub-continent – British rule & its impact – Indian reaction – Two nation theory Origin and development – Factors leading towards the demand of a separate Muslim state – Creation of Pakistan.

Government & Political Development in Pakistan: Constitution of Pakistan – A brief outline – Government structure Federal and 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 & Persian on Urdu Language & Literature – A short history of Urdu literature – Dominant Culture features.

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| EE-118 | Basic Electricity & Electronics |
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DC Analysis:

Series and Parallel electric circuits: Kirchhoff's voltage law(KVL) and Kirchhoff's current law (KCL), voltage divider and current divider rules; series parallel circuits; Y-Delta conversions; methods of circuits analysis: mesh analysis and nodal analysis; network theorems: superposition, Thevenin's Norton and maximum power transfer; Magnetic circuits: magnetic fields, flux density, permeability, reluctance, magnetizing force, hysteresis, Ampere's Circuital law; capacitors and inductors: electric field and dielectric strength; charging and discharging phase of capacitor; capacitor types; faraday's law of electromagnetic induction; Lenz's Law; charging and discharging phase of an inductor.

AC Analysis and Poly Phase Systems:

General format of sinusoidal voltage and current; phase relations; average power and power factor, frequency response of basic elements(R, L,C);rectangular and polar form conversions; series-parallel circuits with phase or diagrams; mesh analysis and nodal analysis; Network theorems; passive filters: low pass, high pass, pass band, stop band filters, resonance: series resonant and parallel resonant circuits, poly phase systems.

Electrical Machines:

Introduction to electrical Machines; Transformer: basic construction, operation and types; DC Motors and Generators: construction of DC motors and generators, working principles, equivalent circuits, losses and efficiency calculations; AC motors and generators: construction of AC motors and generators, working principles, Equivalent circuits, losses and efficiency calculations, power and torque curves in generators.

Basic Electronics:

Introduction to Electronic Engineering; P-N Semiconductor theory, doping and energy bands, diode models, diode data sheet understanding, diode applications (half wave, full wave and bridge rectifier, clipper and clamper; BJT and FET construction, operation and characteristics curves. Introduction Digital Electronics; Comparison with Analogue electronics.

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| PP-203 | Principles of Chemical Processes |
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Pressure scales, Composition of mixtures, Equation of State and its Deviations; Dalton's law, Henry's Law and Raoult's. Antoine equation. Relative volatility. Heat capacity, latent heat and enthalpy.

Principles of stoichiometric combination.

Nature of balances: Concept of a balance. Input-output relationships. Steady state considerations. Block box approach. Sub-systems and interconnections. Familiarization with flow sheets. Mass and energy balance diagrams and tables.

Mass balances for items of plant, Choice of basis/datum for balances. Overall and component balances, Limiting and excess reactants. Balances for systems with recycle, purge and bypass streams. Mass balances for unit operations, Tie components. Balances for batch and continuous plant.

Simultaneous mass and energy balances. Temperature and pressure dependence. Balances for condensing systems. Dynamic balances.

Balances with reaction: Mass and energy balances for reacting systems. Environmental balances, Sub-systems and interconnections. Concept of integrated pollution control. Case studies on balances for a selection of important industrial processes. Efficiency and conversion. Standard states. Temperature dependence. Heat Effects. Application of Computers in stoichiometric calculations.

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| PP-207 | Fluid Mechanics |
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Fundamentals of fluid mechanics: pressure distribution, buoyancy, head calculations, manometry, use of dimensional analysis, dimensionless groups.

Nature of Fluid Flow: Types, Newtonian / Non-Newtonian, laminar / turbulent flow, Reynolds number, flow profiles / boundary layers.

Fluid Dynamics: continuity equation, momentum equation, Bernoulli equation, flow through circular tubes, parallel plates, inclined plates, nozzles / orifices, over weirs.

Flow Measurement: venturi and orifice meters, Pitot tubes, variable area meters, nozzles

Pipe Flow: Pressure drop relationship, friction factor and its calculation, roughness, basic piping system design, minor losses.

Pumping: positive displacement / centrifugal pumps, principle of operation, cavitation, flow-head characteristics, sizing & specification, compressors and blowers, principles, operation and sizing

Flow through Packed Beds: specific surface and voidage, analogy with pipe flow, Kozeny-Carman equation, Burke-Plummer Equation, modified Reynolds number, wall effects, pressure drop calculations, significance of particle shape and size.

Fluidization: Types, basic principles, applications, Agitation and mixing of liquids.

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| PP-209 | Thermodynamics-II |
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Review of laws of thermodynamics, thermodynamic property relations for one component system, criteria for spontaneity and equilibrium, Maxwell relationships, Determination of thermodynamic properties using Maxwell relations, central role of Gibbs free energy, calculation of entropy change in ideal gas mixing, heating or cooling, phase change, absolute entropy.

Third law of thermodynamics, thermodynamic property relations for multi-component system, chemical potential, phase equilibria of one component, Clausius-Clapeyron equation, Gibbs phase rule, phase equilibria in two-component system, pressure composition and temperature composition diagram, Ideal and non ideal solutions, Intermolecular forces, composition of vapour in equilibrium with liquid, azeotropes, liquid-solid equilibria, eutectic, compound formation, solid solutions.

Chemical equilibria, mean bond energies, bond dissociation energy, enthalpies of formation and reaction, equilibrium constants for gas phase reactions, temperature dependence of Gibbs free energy and equilibrium constants, factors affecting degree of conversions, condensed phase, solution equilibria, liquefaction.

Thermodynamics of Polymers: Thermodynamics of liquid mixtures, low molecular weight mixtures (ideal solutions), polymer-solvent mixtures (Flory-Huggins theory), partial molar

quantities and chemical potential, colligative properties and interaction parameter χ , Virial coefficients; phase equilibria in poor solvents, solubility behaviour of polymers, frictional properties, Flory-Fox equation and Mark-Houwink equation, dilute solution viscometry, intrinsic viscosity, measurement of solution viscosity.

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| PP-211 | Computer Programming and Application |
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Introduction to Computers: Windows, use of graphics, inter language communication & user interfaces, effective use of computer resources & some software tools.

Computer programming: Introduction to programming concept & languages, compilation & interpretation, overview of modular programming, ASCII character set, building blocks: identifiers & keywords, data-types, variables and constants, statements & operations, input & output functions, branches & statements: conditional branching and looping, subroutines: defining a subroutine, accessing a subroutine, passing arguments, returning values and recursion, arrays & strings: defining an array, referring to individual element of an array, processing an array, multi-dimensional array, string handling and manipulation, overview of pointers.

Applications: Introduction to Data Base Management System (DBMs); structured query language, computer data analysis & modelling and application of statistical methods.

Computer Aided Drafting: Introduction and application of computer in drafting & designing, methods for creating drawing entities, common editing features, dimensioning with variable setting, printing & plotting.

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|---------------|--|
| MT-330 | Applied Probability & Statistics (with Practical) |
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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.

MEASURES OF CENTRAL TENDENCY AND DISPERSION:

Statistics Averages, Median Mode, Quartiles, Range, Moments, Skew ness & Kurtosis, Quartile Deviation, Mean Deviation, Standard Deviation, Variance & its coefficient, Practical Significance 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.

SAMPLING AND SAMPLING DISTRIBUTIONS

Introduction, Population, Parameter & Statistic, 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.

PROBABILITY

Basic concepts, Permutation & Combination, Definitions of probability, Laws of probability. Conditional probability, Baye'snile. 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.

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| HS-205 | Islamic Studies |
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Section A Quranic Verses

Chapter 01.

- **Tauheed :** Al – Ambiya – 22, Al – Baqarah - 163&164.
- **Prophet hood:** Al – Imran – 79, Huda – 7, Al- Maidah –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 of Property Al-Nisa-29
- Right to Respect & Dignity Al-Hujurat – 11-12.
- Freedom of Expression Al-Baqarah-256
- Equality: Al-Huyjurat-13.
- Economic Security: Al-Ma’arij – 24 – 25.
- Employment Opportunity on Merit: An-Nisa-58.
- Access to Justice: An-Nisa-135.

Chepter 07.

- **Women's Rights:**

An-Nehl-97, Al-Ahzab-35,
An-Nisa –07.

Chapter 08.

- **Relations with Non-Muslim:**

Al-Mumtahanah-89,
Al-Anfa'al – 61 and
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-e-Nabawi)
- Hujjat-ul-Wida.
- The last sermon of Khutbatulwida: Translation and important points

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.

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| HS-206 | Ethical Behaviour |
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1. Introduction to Ethics:

- i) Definition of Ethics
- ii) Definition between normative and positive science
- iii) Problem of freewill
- iv) Method of Ethics
- v) Uses of Ethics

2. Ethical Theories:

- i) History of Ethics: Greek Ethics, Medieval, Modern Ethics
- ii) Basic concept of right and wrong: good and evil
- iii) Utilitarianism, hedonism, self-realization: egoism, intuitionism, rationalism
- iv) Kant's moral philosophy

3. Ethics & Religion:

- i) The relation of Ethics to religion

- ii) Basic ethical principles of major religion: Hinduism, Judaism, Buddhism, Zoroastrianism, Christianity, Islam

4. Ethics, Society, and moral theory:

- *Society as the background of moral life*
- *Ethical foundation of Rights and Duties*
- *Universalism and Altruism*
- *Applied Ethics*
- *Theories of punishment*

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| PP-202 | Polymer Physics |
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Polymer structure and its relation to engineering properties.

Chain dimensions: conformation, freely jointed chain, real polymer chains, and reptation and chain motion.

Structures: configurational isomerism Crystallinity in polymers: fringed micelle and chain folded models, crystal growth from the melt and crystal lamella stack, spherulites, factors affecting crystallization, degree of crystallinity

Thermal transition in polymers: glass transition temperature T_g and melting point T_m , non-equilibrium features of glassy polymers and physical ageing; regions of viscoelastic behaviour, factors affecting T_g , relation between T_m and T_g , the free-volume theory, the WLF equation.

Rubber elasticity: thermodynamics of elastomer deformation, statistical theory of rubber elasticity, stress-strain behaviour of cross-linked elastomers, Mooney- Rivlin equation.

Oriented polymers: production and characterization, properties of oriented polymers.

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| PP-205 | Petroleum & Petrochemical Products |
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Brief introduction to modern exploration, production and processing operations, origin and fluid properties of oil and natural gas reservoir types and basic reservoir engineering concepts.

Chemical composition of petroleum and petroleum products and their physical, chemical, thermodynamic and performance characteristics. Interrelation between the chemical structure and characteristics of petroleum products. Major petroleum products like LPG, gasoline, industrial solvents, naphtha, kerosene, aviation turbine fuel (ATF), high speed diesel (HSD), LDO, furnace fuels, lubricants, base oils, tar and bitumen. Introduction to basic refining processes: Physical separation processes such as distillation and extraction.

Chemical transformation processes such as thermal cracking, reforming. Molecular rearrangement processes such as isomerisation, alkylation, and polymerization. Molecular rebuilding processes e.g. gas to liquid processes. Methane, natural gas, CNG, rebuilding of hydrocarbons, rubber.

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 dealkylation of toluene.

Refinery products, properties, significant tests and standard test methods

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| PP-212 | Polymeric Materials & Their Characterization |
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Properties and applications: Commodity and engineering thermoplastics, thermosets, High performance engineering polymers.

Thermoplastic Elastomers: Natural and synthetic elastomers, compounding, vulcanization and role of various additives in their preparation and applications. Specialty Polymers: Polyimide, Ionic, conductive, inorganic polymers, High Performance Fibres, Liquid Crystal Polymers.

Polymer additives: Fillers and their reinforcement mechanism, plasticizers, and other important additives.

Principles and methods of polymer blending, factors affecting blend morphology, examples of commercially available polymer blends.

Characterization & Testing of Polymers and Polymer Blends:

Significance of polymer characterization and testing. Molecular Weight Determination: Gel permeation chromatography (GPC), light scattering and viscometry. Molecular Spectroscopy: Overview, UV and visible spectroscopy, vibrational spectroscopy, and nuclear magnetic resonance (NMR). Thermal Characterization: Melt flow index, Differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), dynamic mechanical thermal analysis (DMTA). Microscopy: Optical and electron microscopy. X-ray Diffraction: Wide angle and small angle X-ray diffraction.

Mechanical characterization: Mechanical testing of polymers and blends.

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| MM-205 | Mechanics of Materials |
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Review mechanics of materials, Deformation; strain; elastic stress-strain behaviour 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 (ant symmetric) 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.

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| MT-215 | Differential Equations and Complex Variables |
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Infinite Series:

Applications of simple convergence tests such as comparison, root, ratio, Raabe's and Gauss test on the behavior of series.

Ordinary Differential Equations:

Definitions, formation and solution, Boundary conditions. Homogeneous and Non-Homogeneous linear differential equations with constant coefficients, linear equations with variable coefficients. Cauchy's and Legendre's equations. Equations of second order. System of simultaneous linear equations with constant coefficient. Numerical approximation to solutions. Solution in Series. Simple applications in Engineering. Orthogonal trajectories.

Partial Differential Equations:

Formation of partial differential equations. Solution of first order linear and special types of second and higher differential equations used in engineering problems. Various standard forms.

Laplace Transformations:

Elementary transformations. Shifting Theorems. Heaveside's expansion formula. Simple applications.

Complex Variables:

Limit, Continuity, zeros and poles, Cauchy-Riemann Equations, conformal transformations, contour integration.

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| PP-210 | Polymer Processing |
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The flow properties of polymer melts: Bulk deformation, elongational flow, shear flow, entrance and exit effects, elastic effects in polymer melt flow, die swell, and melt fracture.

Basic processing operations: Extrusion process (Single and twin screw extruder), Injection moulding, Blow moulding (extrusion blow moulding, injection blow moulding, and stretch blow moulding), Mould and dies, Calendaring, Film blowing, Thermoforming, Vacuum forming, Pressure forming, Plug assist forming, Draw forming, Free forming, Drape forming, Snap-back forming, Matched die forming, Mechanical forming, Rotational moulding, Compression and transfer moulding, Reaction injection moulding.

Compounding and mixing of polymers: Two roll mill, Internal mixer (Banbury mixer).

Application of polymer rheology in polymer processing: to extrusion, injection moulding and other processes.

Methods of determination of rheological properties of polymer melts and solutions, capillary rheometer, melt flow index, cone and plate viscometer, torque rheometers.

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| PP-307 | Polymer Composite |
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Types of composite material: particulate strengthened composites, fiber-reinforced composites, sandwich laminate and structural composites, bonding mechanism, specific strength, matrix materials, fiber materials, polymer-matrix fiber-reinforced composites, influence of fiber length (very short fiber, intermediate length fiber, and very long and continuous fiber composites), prediction of composite properties, longitudinal and transversal loading,

Composite material design, fabrication methods: (resin transfer moulding, spray up, hand lay-up, filament winding and fiber placement, pultrusion, sheet moulding compounds and dough moulding compounds), applications of composites

Fracture and fatigue behaviour of composites

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| PP-308 | Heat Transfer |
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Fundamentals: Conduction: Steady state heat conduction in 1D, 2D & 3D geometries, multi-layer wall, overall heat transfer coefficient; transfer with internal heat sources; extended surface heat transfer-Fins. Unsteady heat transfer for simple *geometries*.

Convection: basic concepts; boundary layer fundamentals, laminar and turbulent flows; forced convection external flows: laminar and turbulent flow over: flat plates, across cylinders and spheres, Internal flows: inside tubes and non-circular ducts; *Free convection heat transfer*.

Thermal radiation: Basic concepts; surface characteristics blackbody; grey body, emission in defined wave band; radiation intensity; energy exchange in black and grey bodies. Phase Change Heat transfer: Boiling; pool boiling, boiling curve, forced convection boiling, external and internal forced convection boiling. Condensation: laminar / turbulent film condensation, drop-wise condensation.

Applications: Heat Exchangers: Types of heat transfer equipment, classification, Heat Exchanger Standards & Codes, Tubes and Shell Arrangements, Finned Heat Exchanger, Fouling, LMTD, The Effectiveness-NTU method, Heat Exchanger design & selection.

Evaporators: classification, applications, performance, single-effect, double, multiple-effect problems, optimum number of effect, feeding systems in multiple effect evaporators, selection of evaporator type and criteria.
Pinch analysis

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| PP-309 | Mass Transfer |
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Basic concepts of mass transfer theories; diffusion and mass transfer - mass transfer operations, applications and significance. Dimensional analysis in mass transfer, boundary-layer flow and turbulence in mass transfer. Molecular diffusion in gases, Fick's law, diffusion in liquids: dilute and concentrated solutions, rotating disk, steady state molecular diffusion in binary mixtures of gases, liquids and solids, Eddy diffusion, mass transfer in laminar flow, mass transfer in turbulent flow, correlations for mass transfer coefficients: Reynolds-Chilton - Colburn analogies. Concept of resistance to mass transfer: film dominance and solubility, Schmidt, Sherwood, Stanton and Marshall numbers, film mass transfer coefficients for the cases of equimolar counter diffusion and diffusion of one component (A) in stagnant component (B). Counter current mass transfer and concept of transfer units. Molecular diffusion in biological solutions and gels. Molecular diffusion in solids, types of diffusion in solids. Numerical methods for steady-state molecular diffusion in two dimensions.

Transient Diffusion and Diffusion with Reaction: unsteady convective mass transfer, unsteady diffusion, convective mass-transfer, mass-transfer coefficients for various geometries, mass transfer to suspensions of small particles, mass transfer coefficients for tower packings, mass transfer coefficients in agitated vessels, molecular diffusion - convection and chemical reaction, diffusion of gases in porous solids and capillaries, numerical methods for unsteady-state molecular diffusion.

Simultaneous mass and heat transfer, air-water system: humidification and dehumidification, evaporative cooling, drying operations, heat effects in a catalyst pellet and the nonisothermal effectiveness factor

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| MT-471 | Applied Numerical Methods |
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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 Problems.

Linear Operators:

Functions of operators, difference operators and the derivative operators, identities.

Difference Equations:

Linear homogeneous and non homogeneous difference equations

Solution of Non-linear Equation:

Numerical methods for finding the roots of transcendental and polynomial equations (Secant, Newton – Raphson Chebyshev and Graeffe's root squaring methods), rate of convergence and stability of an iterative method.

Solution of Linear Equation:

Numerical methods for finding the solutions of system of linear equations (Gauss-Elimination, Gauss-Jordan Elimination, triangularization, Cholesky, Jacobi and Gauss – Seidel).

Interpolation & Curve Fitting:

Lagrange's, Newton, Hermit, Spline, least squares approximation. (Linear and non-linear curves).

Numerical Integration & Differentiation:

Computation of integrals using simple Trapezoidal rule 1/3 th Simpson's rule, 3/8 th 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).

Linear programming:

Formulating problems, linear programming models, graphical methods simplex method.

Improper Integrals:

Definitions, types of improper integrals and their convergence.

Elliptic Integrals:

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

Simple applications.

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| PP-301 | Process Control and Instrumentation |
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Introduction: Block diagrams, closed-loop and open-loop control systems, Basic control actions. Open loop response of simple systems: Dynamics of first order systems using transfer functions, Response of thermometer bulb, General responses to step, ramp, impulse and sinusoidal inputs. Concentration and temperature responses of a stirred tank, Linearization of liquid level systems, Response of pressure systems.

Second order systems, the manometer, Response of interacting and non-interacting systems. Transient response of control systems; Servo and regulator operation, general equations for transient response, proportional control of a single capacity process, Integral control, Proportional-integral control, and derivative action.

Stability and root Locus: Concept of stability, Stability criterion, and Routh test for stability, Root Locus diagrams

Frequency response analysis: First order systems, Bode diagram, and Complex numbers to get frequency response. Controller selection and tuning. Control valve characteristics and sizing. Cascade control. Feed forward control. Introduction of Digital control principle.

Measurements: Elements of measuring systems and their functions. Single transmission. Transmitters-electronic, pneumatic

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| PP-305 | Fuels and Combustion |
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Introduction and survey of locally available fuels, quality, quantity, prices and uses. Industrial fuels. Classification and storage of solid, liquids and gaseous fuels. Criteria for the selection of fuels for industrial purposes; Coke and its industrial manufacture and uses; Petroleum and its distillation products; Synthetic fuels, testing of fuels. Principles of combustion, combustion of oil, coal and gas. Fluidized Bed Combustion Boilers. Combustion calculations; Furnaces, Burners and their performance, theoretical and actual requirement of primary, secondary and excess air during the combustion, heat distribution, temperature control, draft control, waste heat recovery.

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| PP-310 | Industrial Organization and Management |
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Industrial Management & Systems: introduction to industrial management and administration, system concept, function of management; managerial decision making, models as decision aids.

Plant Location: factors affecting location, multi plant location, location analysis, plant layout, types of layout, material handling consideration in layout, internal and external balancing, product and process layout analysis, layout comparison.

Production Planning and Control: product design, pre-production planning, production control for intermittent and continuous process, production control charts machine arrangements problems, control for maximum profit, scheduling techniques.

Quality Control: sampling risk and economics of sampling, OC curve and sampling plan, average outgoing quality. sampling methods, attribute and variable sampling, concept of control charts, process variability; X-bar and R charts.

Methods Analysis: process chart; man-material flow charts, work station flow charts, man-machine charts. motion study, principles of motion economy, applications, Simo chart.

Planning & Control Techniques: inventory control, forecasting, moving average and weight moving average, functions of inventory, economic order quantity model, its limitations, economics lot size. Safety stock, stock out cost; inventory systems, inventory systems under uncertainty, quantity discount; queuing theory, CPM/PERT

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| PP-311 | 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 reactor; 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 system, rate equations for heterogeneous reactions, fluid particle reactions, determination of rate controlling steps, catalysis desorption Isotherm, kinetics of solid catalyzed reactions, design of fluid-solid catalytic reactors.

Design, energy balance equation, non-isothermal CSTR, equilibrium conversion, non-adiabatic reactor operation.

Catalysis and Catalytic Reactions: steps in catalytic reactions, rate law, mechanism and rate limiting step, gas- solid reactions, heterogeneous data analysis, catalyst deactivation.

External diffusion effects on catalytic reactions, mass transfer and resistance to mass transfer, shrinking core model, catalyst regeneration, diffusion and reaction inside porous catalysts, concept of effectiveness factor, mass transfer and reaction in packed beds, fluidization, determination of limiting situation, diffusion and reaction limited regimes, residence time distribution in reactors, concept of non-ideal reactors.

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| 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, Behaviour 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.

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| HS-304 | Business Communication and Ethics |
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Part-1 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.

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| PP-402 | Petrochemical Processes |
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Scenario of Petrochemical Industries and its feed stock. Product pattern of paraffins, olefins, dienes and acetylene. Manufacturing of important paraffins, olefins, acetylene, butadiene, oligomers and aromatics: techniques, equipment Reactions, Catalyst, Solvents, Operation conditions, Separation and purification and developments in these areas.

Production of synthesis gas: various routes, reactions, mechanisms, conditions thermodynamics, kinetics, coal gasification and hydrogenation.

Conversion: Ethylene to ethylene glycol, ethanolamines, Propylene to acrylic acid, methyl ethyl ketone, acrylonitrile. Butanes to, iso and n-butanols, MIBK, Aromatics to maleic and phthalic anhydride, DMT, and acetones, Cyclohexane to caprolactum, adipic acid, succinic acid.

Hydration: Technology for the production of alcohols such as ethanol, isobutyl alcohol.

Esterification: Process for production of paraffinic esters such as esters.

Chlorination: chlorination of paraffin, olefins and aromatic hydrocarbons. Technology involved in production of vinyl chloride, chlorobenzenes, Benzoylchloride, Precaution and safety for handling chlorine and fluorine compounds.

Nitration: Nitrobenzene, Aniline, Nitrotoluenes.

Sulphonation: Sulphonation of benzene and discussion in the context of detergent industries.

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| PP-406 | Process Equipment Design |
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Physical, Mechanical & Thermal properties and characterization of the applicable materials, Classification and utilization of the applicable materials.

Corrosion: Electrochemical series and corrosion potential. Nature, types and rate of corrosion. Selection criteria for material, International standards for materials.

Optimum design; Design codes & standards. Vessel design: Low, medium and high pressure storage and transportation vessels. Cryogenic vessels.

Design of mass transfer equipment such as dryer, crystallizer, dehumidifier, packed tower, distillation column, scrubber and absorber, material transport, material handling and heat transfer including furnaces and refrigeration units. Piping and pipeline design.

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| PP-410 | Polymer Reaction Engineering |
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Engineering principles applied to the analysis and design of polymerization processes

Polymerization Reaction Kinetics:

Step growth and radical polymerization, copolymerization, Ziegler-Natta polymerization, Emulsion polymerization, Control of molecular weight and distributions.

Polymerization Reactor Design:

Batch reactors, Plug flow reactors, Continuous stirred tank reactors, Viscosity build up, Heat & mass transfer effects in polymer reactors. Effect of reactor types on MW and MWD of polymers.

Case Studies of Reactors used in Important Industrial Processes.

E.g. Polyolefins, Polystyrene, PVC, Nylon 6, PET.

Process control (brief outline), cleaning, maintenance of reactors and pipelines.

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| PP-411 | Separation Processes |
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Introduction to separation process.

Evaporation and Drying: methods and equipment, rate of drying curves, calculation methods for constant rate and falling rate drying period.

Stage and Continuous Gas-Liquid Separation Processes: types and method, single and multiple equilibrium contact stages, continuous humidification processes, absorption in plate and packed towers, absorption of concentrated mixtures in packed towers, heat effects and temperature variations in absorption.

Vapour-Liquid Separation Processes: vapour-liquid equilibrium relations, simple distillation, fractional distillation using McCabe-Thiele and enthalpy-concentration method, distillation of multi-component mixtures.

Liquid-Liquid and Fluid-Solid Separation Processes: single-stage liquid-liquid extraction, types of equipment, continuous multistage counter current extraction, types and equipment for liquid-solid leaching, equilibrium relations and single-stage leaching, counter current multistage leaching.

Crystallization: introduction and equipment for crystallization, crystallization theory.

Membrane Separation Processes:

Introduction and types of membrane separation processes; liquid permeation (Dialysis) and gas permeation membrane processes; reverse osmosis, ultra filtration and microfiltration membrane processes.

Mechanical-physical separation processes: classification, filtration in solid-liquid separation, settling and sedimentation in particle-fluid separation, centrifugal separation processes.

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| PP-413 | 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.

The application of optimization techniques in the design and operation of: *fluid flow systems* (Optimal Pipe Diameter), *Heat transfer and Energy Conservation* (Optimizing Recovery of Waste Heat, Optimal Shell-and-Tube Heat Exchanger Design, Optimization of a Multi-Effect Evaporator), *Separation Processes* (Optimal Design and Operation of a Conventional Staged-Distillation Column, Optimization of Flow Rates in a Liquid-Liquid Column, Determination of the Optimal Reflux Ratio for a Staged-Distillation Column) and *Reactor Design and Operation* (Optimization of a Thermal Cracker Via Linear Programming, Optimal Design of an Ammonia Reactor).

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| PP-403 | Plant Utilities and Safety |
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Introduction to various process utilities; their role and importance in process plant operations. Water systems: raw, potable, fire, process, cooling and waste water systems and treatments. Steam and Power: Types of boilers, their operation, thermic fluid heater, complete boiler house, steam distribution and utilization, condensate recovery system, waste heat recovery, Power distribution system: start-up and emergency power system. Compressed air system: air from blowers and compressor, plant air, instrument air systems and breathing air, compressors, vacuum pumps, and ejectors. Inert Gases: nitrogen. Fuel: natural gas system. Refrigeration: vapour compression refrigeration, absorption refrigeration, multi-stage refrigeration, cascade refrigeration, vacuum refrigeration, refrigerants and their types. Flaring and Venting: relief system, hot flares and cold flares, equipments and their types used in relief and flare system, types of flares, Thermal Oxidizer; regenerative and recuperation thermal oxidizers.

Safety: Hazards and Plant Safety, importance of safety, overall safety of plant and personnel, accident analysis and prevention, types of accidents in industry. Regulations for industrial safety: OSHA, accident rate calculations; OSHA incidence rate, Fatal accident rate (FAR), and Fatality rate, economics of accident prevention. Safety management. Hazard and risk assessment; hazard analysis methodologies: what-if, checklist, what-if/checklist, HAZOP. Accident investigation and case histories. Fires and Explosions. Health and Safety; Personal

Protective Equipments; fire-fighting equipments and their uses. Occupational diseases related to polymer and petrochemical industry

Ergonomics: Human and working interaction, lighting, Illumination design, Noise and Vibration, Temperature, Dust, Humidity, Comfort level, Machine controls and displays of dials, Scope of Ergonomics and its practice in Pakistan.

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| PP-409 | Advanced Polymer Engineering |
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Mechanical properties of polymer materials as related to polymer structure and composition. Elastic properties of isotropic polymers: elastic constants and their relationships, simple bending and torsion equation.

Visco-elastic behaviour: creep and stress relaxation behaviour, isochronous and isometric graphs, linear viscoelasticity, mathematical models of viscoelastic behaviour (Maxwell, Kelvin-Voigt, and standard linear solid), Boltzmann superposition principle, dynamic measurements – the complex modulus and compliance, time-temperature superposition, WLF equation.

Yield and Fracture: Cold drawing and Considère construction yield criteria, temperature and strain-rate dependences of yield; fracture behaviour: the concept of stress concentration, energy approach to fracture, stress intensity factor, irreversible deformation processes.

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| PP-414 | Petroleum Refinery Engineering |
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Introduction: Origin, formation and composition of petroleum; world resource potential. Characterization and evaluation of crude oil stocks. Generation of crude processing data, crude pre-heating and preliminary treatment, pipe still heaters; desalting, chemical treatment of refinery distillation, atmospheric and vacuum distillation; steam stripping, various arrangements of distillation towers. Number of trays calculation by various methods; various types of reflux employed, Packie's approach, processing plans' schemes and product patterns of refineries, refinery corrosion and metals; blending plants, product design and marketing. Site selection techniques.

Cracking: Thermal and Catalytic.

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| HS-403 | Entrepreneurship |
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Understanding the Entrepreneurship Mind-Set:

The revolution impact of Entrepreneurship; The individual Entrepreneurship Mind-set; Corporate Entrepreneurship Mind-set; The Social and Ethical perspective of Entrepreneurship.

Conceptualizing Entrepreneurship:

Definitions and perspective; Four dimensions of an entrepreneurship venture-individuals, organization, environmental and process.

Formulation of Entrepreneurship:

The assessment of function with opportunities; The marketing aspects of new ventures; Financial statements in new ventures; Business plan preparation for new ventures.

Launching Entrepreneurship Ventures:

Creativity and innovations; Methods to initiate ventures; Legal challenges in Entrepreneurship; The search for Entrepreneurship.

Strategies perspectives in Entrepreneurship:

Strategies growth in Entrepreneurship; Valuation challenges in Entrepreneurship; Final harvest of a new venture.

Elective Courses

PP-412 Environmental Engineering**

Environmental Monitoring (Air, Water & Soil): Objectives of sampling and monitoring programme. Design and types of samples; pre-sampling requirements/information, sampling and design purposes. Pollution concept, types of pollution, air, water, soil, noise pollution control technologies, Biotechnology for environment, industrial pollution control, Occupational safety devices. Marine pollution; oil spills, waste water discharge.

Waste Management: Liquid and Solid waste management, waste minimization; reuse, recycle and disposal. Case studies of industrial waste treatment: petroleum, petrochemical, polymer, packaging and pharmaceutical industries.

Polymer Waste Disposal & Recycling: management of polymer waste in view of energy consumption, air pollution, water pollution, and waste pollution with some specific legislation at worldwide level. Disposing of post customer plastics, mechanical recycling, reprocessing of mixed plastics wastes, and energy recovery by incineration, liquid fuel and feedstock recovery and biodegradable polymers.

Environmental Policies and Laws: principles and purposes of IEE and EIA, main stages in EIA process, significance, cost and benefits, public consultation and participation, EIA methods and techniques for impact prediction and evaluation. Statutory requirements of pollution control, framework and implementing strategies in Pakistan.

Application of environmental management and ISO-14000 standards

PP-425 Polymer Rheology**

Kinematic and Stress Tensor: The velocity gradient tensor, the deformation gradient, finger tensor, and the stress tensor.

Molecular and phenomenological models of polymer rheology.

Rheological Measurements and Properties: Shearing, extensional, and mixed flows. Viscometers and rheometers.

Mathematical treatment of test results for non-Newtonian fluids, single integral and differential constitutive equation, modelling of rheological data.

PP-427 Rubber Technology**

Material Properties and Selection: Effects of molecular structure of natural and synthetic rubbers on the properties of final products and ultimate selection.

Vulcanization: Sulphur and non-sulphur vulcanization and curing techniques, cure kinetics through rheological measurements.

Compounding: Materials for compounding and reinforcement, principles of compounding.

Processing: Mastication and mixing, extruding, calendering, coating of textiles, moulding and finishing of rubber products.

Manufacturing Techniques: Tires, belting, rubber to metal bonded components, vibration isolators and mounts, bridge bearing pads, etc. Recycling and re-use of waste rubber.

PP-428 Process Modeling & Simulation**

Petrochemical Process Simulation:

Introduction to process modeling, simulation and analysis techniques. Process synthesis and design strategy. Flash and phase separation. Chemical reaction equilibria. Development of process flow diagrams in Aspen Plus™. Sensitivity analyses Optimization / debottlenecking. Economic evaluation.

Polymer Process Simulation:

Extrusion. Injection molding types. Simulation of polymer processing operations (SolidWorks Plastics, Moldflow).

Polymer flow in injection molds. Molding conditions and injection pressure. Filling pattern. Product design principles, Gate design overview, Runner system design, Cooling System design Shrinkage and Warpage.

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| PP-429 | Gas Engineering** |
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Introduction to gas industry. Gas processing facilities, process flow schemes and product. Testing of well fluid; test separator, multiphase flow meters.

Gas-liquid separation design and configurations; membrane/molecular sieve processes, cryogenic separation, solvent regeneration. Dehydration of natural gas, LPG recovery and condensate stabilization.

Disposal of gas field emissions, effluents and flaring, gas distribution network. Gas compression equipment and types.

Flare system design; Pressure safety valves, blow down, flare/vent stack sizing.