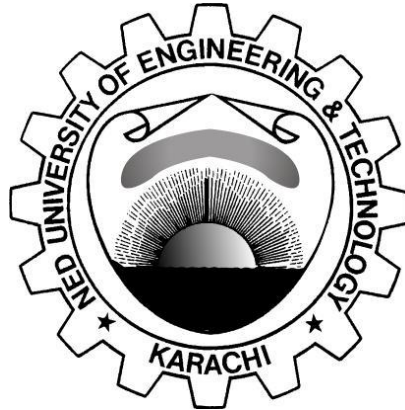


**DEPARTMENT OF POLYMER AND PETROCHEMICAL  
ENGINEERING**



**SEMESTER SYLLABI OF COURSES  
FOR  
B.E. POLYMER AND PETROCHEMICAL ENGINEERING  
PROGRAMME  
(Batch 2024 & Onwards)**

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

**PAKISTAN**

**DEPARTMENT OF POLYMER AND PETROCHEMICAL  
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# DEPARTMENT OF POLYMER & PETROCHEMICAL ENGINEERING

*NED University of Engineering and Technology*  
*Karachi, Pakistan*

<b>POLYMER &amp; PETROCHEMICAL ENGINEERING</b>									
<b>FIRST YEAR</b>									
<b>FALL SEMESTER</b>					<b>SPRING SEMESTER</b>				
Course Code	Course Title	Credit Hrs			Course Code	Course Title	Credit Hrs		
		Th	Pr	Total			Th	Pr	Total
PP-103	Workshop Practice	0	1	1	PP-107	Principles of Chemical Processes	2	1	3
PP-104	Introduction to Polymers	3	1	4	ME-101	Engineering Mechanics	3	1	4
PP-105	Introduction to Petrochemical	2	0	2	ME-111	Engineering Drawing	2	1	3
EA-104	Functional English	3	0	3	ES-105/ES-127	Pakistan Studies / Pakistan Studies (for Foreigners)	2	0	2
PH-122	Applied Physics	3	1	4	EE-118	Basic Electricity & Electronics	3	1	4
MT-114	Calculus	3	0	3					
<b>Total</b>		<b>14</b>	<b>3</b>	<b>17</b>	<b>Total</b>		<b>12</b>	<b>4</b>	<b>16</b>
<b>SECOND YEAR</b>									
<b>FALL SEMESTER</b>					<b>SPRING SEMESTER</b>				
Course Code	Course Title	Credit Hrs			Course Code	Course Title	Credit Hrs		
		Th	Pr	Total			Th	Pr	Total
PP-207	Fluid Mechanics	3	0	3	PP-202	Polymer Physics	3	0	3
PP-211	Computer Programming & Applications	2	1	3	PP-212	Polymeric Materials & Their Characterization	3	0	3
PP-213	Chemical and Petrochemical Industries	2	0	2	PP-215	Fuels and Combustion	2	0	2
PP-214	Thermodynamics	3	0	3	MM-205	Mechanics of Material	3	1	4
ES-205 / ES-209	Islamic Studies/Ethical Behaviour	2	0	2	MT-215	Differential Equations & Complex Variables	3	0	3
MT-330	Applied Probability & Statistics	2	1	3	PP-222	Polymer & Petrochemical Lab-II	0	1	1
PP-221	Polymer & Petrochemical Lab-I	0	1	1	EA-200	Community Service	NC		
<b>Total</b>		<b>14</b>	<b>3</b>	<b>17</b>	<b>Total</b>		<b>14</b>	<b>2</b>	<b>16</b>

THIRD YEAR									
FALL SEMESTER					SPRING SEMESTER				
Course Code	Course Title	Credit Hrs			Course Code	Course Title	Credit Hrs		
		Th	Pr	Total			Th	Pr	Total
PP-307	Polymer Composites	3	0	3	PP-301	Process Control & Instrumentation	3	0	3
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
PP-312	Polymer Processing	2	0	2	PP-313	Mechanical Properties of Polymers	2	0	2
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	EA-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
					##-###	Foreign Language-I	NC		
Total		13	3	16	Total		16	2	18
FINAL YEAR									
FALL SEMESTER					SPRING SEMESTER				
Course Code	Course Title	Credit Hrs			Course Code	Course Title	Credit Hrs		
		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-410	Polymer Reaction Engineering	3	0	3
PP-411	Separation Processes	3	1	4	PP-XXX	Elective Course**	2	0	2
PP-413	Process Optimization	3	0	3	PP-414	Petroleum Refinery Engineering	2	1	3
PP-408	Polymer & Petrochemical Engineering Project*	0	3	3	PP-408	Polymer and Petrochemical Engineering Project*	0	3	3
PP-421	Polymer & Petrochemical Lab-VI	0	1	1	MG-481	Entrepreneurship	3	0	3
##-###	Foreign Language-II	NC							
Total		12	6	18	Total		12	5	17
* Duration one academic year: Requires literature survey and preliminary work during this Semester									
**Elective Courses									
PP-412: Environmental Engineering									
PP-425: Polymer Rheology									
PP-427: Rubber Technology									
PP-428: Process Modeling & Simulation									
PP-429: Gas Engineering									

## DEPARTMENT OF POLYMER & PETROCHEMICAL ENGINEERING

*NED University of Engineering and Technology*  
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<b>PP-103</b>	<b>Workshop Practice</b>
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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.

<b>PP-104</b>	<b>Introduction to Polymer</b>
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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.

<b>PP-105</b>	<b>Introduction to Petrochemicals</b>
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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.

**EA-104**

**Functional English**

#### Types of Listening

- Problems in listening and coping strategies
- Listening skills, Sub skills
- Practice in Listening
- Note taking
- Techniques for taking notes (from lectures, from books)
- Note taking in different forms paragraphs (points, figures, processes, tables, graphs etc.)

#### 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
- 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]

#### Writing

- Process of Writing
- Informal Writing strategies
- Writing Correctly
- Sentence structure and punctuation
- Error correction

#### Paragraphs

- Structure
- Types
- Topic and the topic sentence
- Unity
- Adequate development and coherence in paragraphs
- Essays
- Types
- Five paragraphs, long essays
- Structure (thesis statement and the paragraphs)

#### Short Reports

- Structure
- Format and types (informational and analytical)
- Letters

- Elements, Styles
- Formatting (digital letter writing)

Organization and structure of the letter

Types (Routine requests and intimation, invitation, thank you and condolence letters etc.)

<b>PH-122</b>	<b>Applied Physics</b>
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**INTRODUCTION:** Types of Errors and Error Calculation, Graphical Techniques (Log, semi-log and other nonlinear 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.

**ELECTROSTATICSand 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 lasers, Applications of laser.

**MODERN PHYSICS:**Planck’s explanations of Black Body Radiation Photoelectric Effect, Compton Effect, Bohr’sTheory 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

<b>MT-114</b>	<b>Calculus</b>
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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).

<b>ME-101</b>	<b>Engineering Mechanics</b>
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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.

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 Involutives.

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

Free hand 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.

ES-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 1957 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.

<b>ES-127</b>	<b>Pakistan Studies for Foreigners</b>
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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 subcontinent – 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.

<b>EE-118</b>	<b>Basic Electricity &amp; Electronics</b>
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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

<b>PP-107</b>	<b>Principles of Chemical Processes</b>
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**Composition of Mixtures:** Chemical compositions, moles, molecular weight, average molecular weight, mass fraction, conversion between mass and mole, concentration

**Pressure Scales:** Fluid pressure and hydrostatic head, head pressure calculation, atmospheric pressure, absolute pressure and gauge pressure, fluid pressure measurement, pressure calculation using manometer

**Equation of State and its deviation, Real gas Relationship:** Dalton's law, Henry's Law and Raoult's, Antoine equation. Relative volatility, Heat capacity, latent heat and enthalpy

**Nature of balances;** Concept of a balance, Input-output relationships. Steady state considerations. Block box approach, Balances for batch and continuous plant. Tie components. Mass balances for unit operations. Mass and energy balance diagrams and tables. Mass balances for items of plant, Choice of basis/datum for balances, Sub-systems and interconnections. Familiarization with flow sheets. Overall and component balances, Limiting and excess reactants. Balances for systems with recycle, purge and bypass streams. Balances for condensing systems. Dynamic balances. Balances with reaction: Mass and energy balances for reacting systems Environmental balances, Sub-systems and interconnections. Case study on balances for a selection of important industrial process: The use of Limestone Slurry Scrubbing to Remove Sulfur Dioxide from Power Plant Flue Gases Concept of integrated pollution control. Efficiency and conversion.

**Balances using MS Excel:** Standard states. Temperature dependence. Heat effects. Applications of computers in stoichiometric calculations.

<b>PP-207</b>	<b>Fluid Mechanics</b>
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Introduction to Fluid Mechanics, Use of dimensional analysis, Analysis of Fluid Behavior, Application of Fluid Mechanics, Specific Gravity, Density, Specific Weight, Reynolds Number, Internal/External Flow, Laminar/Turbulent Flow, Steady/Unsteady flow

**Flow profiles and Concept of boundary layers:** No slip condition, viscosity, Viscosity derivation, Newtonian/Non-Newtonian fluids, shear rates, velocity profiles, Reynolds Number.

**Fundamentals of Fluid Mechanics :**Pressure distribution, Head calculations, Manometry , Buoyancy

**Fluid Dynamics:** Derivation and use of continuity equation, Bernoulli equation, Energy equations, Flow through circular tubes, Parallel plates, and Inclined plates.

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

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

**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.

<b>PP-211</b>	<b>Computer Programming &amp; Application</b>
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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

<b>PP-213</b>	<b>Chemical and Petrochemical Industries</b>
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Introduction to chemical & petrochemical industries. Process flow sheeting and line tracing, thermodynamics, reaction kinetics and mechanisms in chemical and petrochemical industries.

**Chemical Industries:** Soaps and detergents, cosmetics, food and food by-products, Sugar and starch, pulp and paper, fertilizers, Surface and coatings, glass, ceramics, cement, water conditioning and purification, industrial solvents.

**Petrochemical Industries:** Vinyl chloride, ethylene dichloride, terephthalate acid, dimethyl terephthalate, ethylene glycol and formaldehyde, poly(vinyl chloride), poly(ethylene terephthalate), polystyrene, and melamine.

<b>PP-214</b>	<b>Thermodynamics</b>
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Introduction to thermodynamics, thermodynamics properties, state functions, intensive and extensive properties, zeroth law and first law of thermodynamics, the reversible process, enthalpy, heat capacity, mass and energy balances for closed and open systems such as nozzels, diffusers, compressors, turbines, pumps vapour and combined power cycles.

Second and third law of thermodynamics, heat engines, Carnot principle, microscopic viewpoint of entropy and its balance for open systems.

PVT behavior of pure substances, virial and cubic equations of state, The nature of vapour/liquid equilibrium (VLE), phase rule, Duhem's theorem, simple models for vapor/liquid equilibrium, VLE by modified Raoult's Law, Henry's law and K-value correlations.

Production of power from steam power plant and internal – combustion engine, refrigeration and liquefaction the Carnot refrigerator, the vapor compression cycle, the choice of refrigeration, heat pump, and liquification processes.

Low molecular weight and polymer solution thermodynamics, chemical potential and phase equilibria, partial molar properties, fugacity and fugacity coefficient of pure species and solution, Flory-Huggins theory, colligative properties and interaction parameter , virial coefficients; phase equilibria in poor solvents, solubility behaviour of polymers, frictional properties, Flory-Fox equation and Mark-Houwink equation, dilute solution viscometry.

<b>ES-205</b>	<b>Islamic Studies/Ethical Behavior</b>
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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.

#### Chapter 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 – 61and  
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.

<b>ES-209</b>	<b>Ethical Behaviour</b>
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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
31. 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

<b>MT-330</b>	<b>Applied Probability &amp; Statistics</b>
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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, ChiSquare 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'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.

PP-221	Polymer & Petrochemical Lab-1
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According to the approved scheme of studies, this lab covers the following contents of PP-207 and PP-209. Investigate the nature of flow, including the different flow behaviours (laminar, turbulent and transition flow). Measurement and Calculation of Pressure losses and distribution in pipes and bends. Head calculation, Power and Efficiency of Throttling devices. Head calculation, Power, Efficiency and Characteristic curves of Centrifugal Pump and Multistage Compressors at different speed.

Thermodynamics physical properties of gas such as heat capacities. Thermodynamic Processes such as Isothermal Expansion process. Relationship between pressure and temperature of vaporization of a fluid. Estimation and Measurements of Saturation Temperature and Pressure at constant volume. Response of Temperature sensitive devices. Pressure Gauge and Thermocouple Calibration. Calorific value via Bomb Calorimeter.



<b>PP-202</b>	<b>Polymer Physics</b>
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Polymer structure and its relation to engineering properties.

**Chain dimensions:** conformation, freely jointed chain, real polymer chains, and behavior 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.

<b>PP-212</b>	<b>Polymeric Materials &amp; Their Characterization</b>
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**Properties and applications:** Commodity and engineering thermoplastics & thermosets, High performance engineering polymers. Elastomers and Thermoplastic Elastomers: Natural and synthetic elastomers, compounding, vulcanization and role of various additives in their preparation and applications. Specialty Polymers: Polyimides, Ionic, conductive, Inorganic polymers, High Performance Fibers, 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

<b>PP-215</b>	<b>Fuels and Combustion</b>
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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.

<b>MM-205</b>	<b>Mechanics of Materials</b>
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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 (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.

<b>MT-215</b>	<b>Differential Equations &amp; Complex Variables</b>
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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.

<b>PP-222</b>	<b>Polymer &amp; Petrochemical Lab-II</b>
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According to the approved scheme of studies, this lab covers the following contents of PP-205 and PP-212.

Mechanical properties of plastics; Tensile, Compression, Flexural and Impact properties of polymer products such as films, rubbers, sheets etc. Refinery products, properties, significant tests and standard test methods such as hydrometer, Flash Point, Smoke Point, Pour point, Aniline Point and Calorific Value

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 layup, filament winding and fiber placement, pultrusion, sheet moulding compounds and dough moulding compounds), applications of composites.

Fracture and fatigue behaviour of composites.

PP-308	Heat Transfer
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**Fundamentals:** Conduction: Steady state heat conduction in 1D, 2D & 3D geometries, multilayer 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**

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 equi-molar 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 non-isothermal effectiveness factor.

<b>PP-312</b>	<b>Polymer Processing</b>
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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.

<b>MT-471</b>	<b>Applied Numerical Method</b>
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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 1/3th Simpson's rule, 3/8th 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).

**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.

<b>PP-321</b>	<b>Polymer &amp; Petrochemical Lab III</b>
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This Lab covers the following contents of PP-210 and PP-307.

Fundamentals processing techniques , including the extrusion process via single and twin screw extruders, blown films, vacuum forming and process cycle of injection moulding process.

The compounding, mixing and curing characteristics of elastomers by using two roll mill and Hot press. Fabricate the composite using hand layup technique and investigate mechanical properties and safety involved in process.

<b>PP-322</b>	<b>Polymer &amp; Petrochemical Lab IV</b>
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This Lab covers the following contents of PP-308 and PP-309

Steady state heat conduction, Fourier Law of heat conduction, Film wise condensation, Relation of Temperature and pressure, Heat Exchanger, Heat transfer coefficient , free convection, forced convection, separation on basis of density using centrifuge, effect of temperature on increasing power.

<b>PP-301</b>	<b>Process Control &amp; Instrumentation</b>
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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.

<b>PP-310</b>	<b>Industrial Organization and Management</b>
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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 flowcharts, 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

<b>PP-311</b>	<b>Chemical Reaction Engineering</b>
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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, nonadiabatic 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.

<b>PP-313</b>	<b>Mechanical Properties of Polymers</b>
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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.

<b>PF-303</b>	<b>Applied Economics for Engineers</b>
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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 and demand-relationship. Theory of Production, Factors of production, Laws of returns, breakeven 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.

EA-304	Business Communication & Ethics
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### Part-1 Communication Skills (Oral)

Definitions and Conditions: Modes:- verbal, non-verbal, vocal, non-vocal, sender, receiver, en-loading, 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.

<b>PP-323</b>	<b>Polymer and Petrochemical Lab V</b>
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The lab covers the following contents of PP-301 and PP-311

Performance of homogeneous reactors, batch, mixed flow reactors. Effects of temperature on reaction kinetics. Multiple reactor system in series.

Introduction to process control system , closed system , closed-loop system , Basic control actions. Contraction and temperature response of a stirred tank. Linearization of liquid level system, responses of pressure systems. Cascade , feed forward and feed backward control.

<b>PP-402</b>	<b>Petrochemical Processes</b>
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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.

<b>PP- 406</b>	<b>Process Equipment Design</b>
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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.

<b>PP-411</b>	<b>Separation Processes</b>
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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.

<b>PP-413</b>	<b>Process Optimization</b>
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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).

<b>PP-421</b>	<b>Polymer and Petrochemical Lab VI</b>
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The course covers the following course content of PP-406 and PP-413

The course introduce the process modelling , simulation technique, Development of process flow diagram for various process equipment, synthesis and refinery processes using simulation software such as ASPEN Plus<sup>®</sup>.

Economic evaluation and optimization of chemical processes using modelling software such as MATLAB<sup>®</sup>. Data regression and parameter estimation.

<b>PP-403</b>	<b>Plant Utilities &amp; Safety</b>
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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, equipment 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 Equipment; fire-fighting equipment 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.

<b>PP-410</b>	<b>Polymer Reaction Engineering</b>
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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

<b>PP-414</b>	<b>Petroleum Refinery Engineering</b>
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**Cracking:** Thermal and Catalyst 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

<b>MG-481</b>	<b>Entrepreneurship</b>
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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.

<b>PP-412</b>	<b>Environmental Engineering</b>
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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.

<b>PP-425</b>	<b>Polymer Rheology</b>
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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.

<b>PP-427</b>	<b>Rubber Technology</b>
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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, calendaring, 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.

<b>PP-428</b>	<b>Process Modelling &amp; Simulation</b>
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**Petrochemical Process Simulation:**

Introduction to process modelling, 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.

<b>PP-429</b>	<b>Gas Engineering</b>
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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.