DEPARTMENT OF POLYMER AND PETROCHEMMICAL ENGINEERING

SEMESTER SYLLABI OF COURSES
FOR
B.E. POLYMER AND PETROCHEMICAL ENGINEERING PROGRAMME
(Batch 2025 & Onwards)

NED UNIVERSITY OF ENGINEERING & TECHOLOGY, KARACHI-75270

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NED University of Engineering and Technology
Karachi, Pakistan

POLYMER & PETROCHEMICAL ENGINEERING

First Year

Fall Semester

Course Code	Course Title	Credit Hrs		
		Th.	Pr.	Total
PP-103	Workshop Practice	0	1	1
PP-104	Introduction to Polymers	3	1	4
PP-109	Introduction to Petrochemicals	3	1	4
MT-116	Calculus & Analytical Geometry	3	0	3
ES-206 /ES-209	Islamic Studies / Ethical Behavior (For Non-Muslims)	2	0	2
ES-108	Ideology and Constitution of Pakistan	2	0	2
CY-100	Essentials of Chemistry (For Computer Science Students)	NC		
	Total	13	3	16

Spring Semester

Course Code	Course Title	Credit Hrs		
		Th.	Pr.	Total
ME-111	Engineering Drawing	2	1	3
ES-105/ ES-127	Pakistan Studies / Pakistan Studies (for Foreigners)	2	0	2
EA-128	Functional English	3	0	3
PF-101	IT Fundamentals and Application	2	1	3
PH-129	Applied Physics	3	0	3
MT-221	Linear Algebra & Ordinary Differential Equations	3	0	3
	Total	15	2	17

Second Year

Fall Semester

Course Code	Course Title	Credit Hrs		
		Th.	Pr.	Total
PP-207	Fluid Mechanics	3	0	3
PP-214	Thermodynamics	3	0	3
PP-221	Polymer & Petrochemical Lab- I	0	1	1
EE-122	Basic Electricity & Electronics	3	0	3
MT-330	Applied Probability & Statistics	2	1	3
PF-201	Civics and Community Engagement	2	0	2
PF-301	Professional Ethics	2	0	2
	Total	15	2	17

Spring Semester

Course Code	Course Title	Credit Hrs		
		Th.	Pr.	Total
PP-202	Polymer Physics	3	0	3
PP-213	Chemical and Petrochemical Industries	2	0	2
PP-216	Polymeric Material & Their Characterization	3	1	4
PP-217	Principles of Chemical Processes	2	1	3
PP-218	Introduction to Artificial Intelligence	2	1	3
XX-XXX	Social Science Elective	2	0	2
PF-205	Community Service	NC		
	Total	14	3	17

Third Year

Fall Semester

Course Code	Course Title	Credit Hrs		
		Th.	Pr.	Total
PP-307	Polymer Composites	3	0	3
PP-312	Polymer Processing	2	0	2
PP-314	Mass Transfer	2	1	3
PP-XXX	Management Elective	2	0	2
PP-321	Polymer & Petrochemical Lab III	0	1	1
EA-218	Business communication	2	1	3
MT-471	Applied Numerical Method	2	1	3
	Total	13	4	17

Spring Semester

Course Code	Course Title	Credit Hrs		
		Th.	Pr.	Total
PP-301	Process Control & Instrumentation	3	0	3
PP-311	Chemical Reaction Engineering	3	0	3
PP-313	Mechanical Properties of Polymers	2	0	2
PP-315	Heat Transfer	2	1	3
PF-303	Applied Economics for Engineers	3	0	3
PP-323	Polymer & Petrochemical Lab V	0	1	1
##-###	Foreign Language-I	NC		
	Total	13	2	15

Final Year

Fall Semester

Course Code	Course Title	Credit Hrs		
		Th.	Pr.	Total
PP-406	Process Equipment Design	3	0	3
PP-411	Separation Processes	3	1	4
PP-413	Process Optimization	3	0	3
PP-XXX*	Engineering Elective I	2	0	2
PP-421	Polymer & Petrochemical Lab VI	0	1	1
PP-408	Polymer & Petrochemical Engineering Project[+]	0	3	3
##-###	Foreign Language-II	NC		
	Total	11	5	16

Spring Semester

Course Code	Course Title	Credit Hrs		
		Th.	Pr.	Total
PP-403	Plant Utility & Safety	2	1	3
PP-410	Polymer Reaction Engineering	3	0	3
PP-XXX	Engineering Elective II	2/1	0/1	2
PP-414	Petroleum Refinery Engineering	2	1	3
PF-401**	Entrepreneurship	2	0	2
PP-408	Polymer & Petrochemical Engineering Project[+]	0	3	3
	Total	11/10	5/6	16

+ Duration one academic year

Management Elective

1. Industrial Organization & Management (PP-316)
2. Project Management (PP-317)

Engineering Elective I

1. Petrochemical Processes (PP-415)
2. Fuels & Combustion (PP-416)

Engineering Elective II

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

Social Sciences

1. Sociology & Development (MG-228)
2. Organizational Behavior (MG-257)

PP-103	Workshop Practice

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, and 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.

PP-104	Introduction to Polymers

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

PP-109	Introduction to Petrochemicals

Introduction: Raw materials of petrochemicals, classification of petrochemicals, petrochemical scenario in Pakistan, unit processes utilized in the production of petrochemicals focusing on aspects such as reaction mechanism, solvents, reactors and operating conditions. Natural gas based petrochemicals: Steam reforming, hydrogen production, CO synthesis, Fischer-Tropsch synthesis and oxo synthesis. Production of olefins and their derivatives: hydrocarbon pyrolysis kinetics and mechanism, naptha and gas cracking, separation of ethylene, propylene, C4 and C5 olefins and diolefins, production of the derivatives of ethylene, propylene and C4 hydrocarbons. Production of aromatics and their derivatives: Isolation of aromatics, production of benzene and xylene derivatives. Production of the polymers: Acrylonitrile butadiene styrene, polyethylene, polypropylene, polyester, polyamides, polycarbonate, unsaturated and epoxy resin. Overview of Petrochemical Production: Safety and health, environmental impact, clean technologies and future challenges.

MT-116	MT-116 Calculus & Analytical Geometry

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, De Morgan'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, 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 relevant to the field Sequence & Series: Sequence, Infinite Series, Application of convergence tests such as comparison, Root, Ratio, Raabe's and Gauss tests on the behaviour of series.Analytical Geometry: Review of vectors, scalars and vector products, Three-dimensional coordinate system and equation of straight line and plane and sphere, curve tracing of a function of two and three variables, surface revolutions, coordinate transformation. 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).

ES-206	Islamic Studies

Fundamentals of Islam: Tauheed, Arguments for the Oneness of God; Al-Ambiya-22, Al-Baqarah-163-164, Impact of Tauheed on human life, Place of Man in the Universe: Al Israa/Bani Israil-70; Purpose of creation: Al zariyat-56, Prophethood, Need for Prophet, Characteristics of Prophet, Finality of Prophethood: Al-Imran-79, Al-Hashr-7, Al-Maidah-3, and Faith in Hereafter (Aakhirat), Effects on worldly life: Al-Hajj-5, Al-Baqarah-48, Hadith . Ibadah: Concept of Ibadah, Major Ibadah, Salat, Zakat, Hajj and Jihad. Al-Mu'minun-1-11, Al Anfaal-60, & Two Ahadiths. Basic Sources of Shariah: The Holy Quran, Its revelation and compilation, the authenticity of the Text, Hadith, Its need, Authenticity and Importance, Consensus (Ijmaa), Analogy (Qiyas).Moral and Social Philosophy of Islam: The concept of Good and Evil; A'l e Imran - 110, Al Nahl-125, Akhlaq-e-Hasna with special reference to Surah Al-Hujrat, verses 10, 11, 12, 13, Professional Ethics (Kasb-e-Halal) Al Taha-81, Al Baqar 188, one hadith. Seerat of the Holy Prophet(PBUH): a) Moral and ethical teachings of the Holy Prophet (PBUH) with special reference to Hajjat-ul-Wida, (Fundamentals of Islam, Social aspects, Economics aspects, political aspects, b). Personal Characteristics: perseverance & trust in Allah, honesty & integrity, simplicity & humility, mercy & compassion, clemency & forgiveness, bravery & valor, generosity, patience. c) Engagement and communication with collaborators and foes. Cases Study from Seerah: Charter of Madina, Ghazwa e Khandaq, Treaty of Hudaibya , Ghazwa e Khayber, Najran's Delegation, Victory of Makkah. d) Social values and rights, (peace & harmony, tolerance, solidarity, collaborations, inclusivity & cohesion) , Case Studies from Seerah: Al –Fudoul Confederacy, Placement of Black stone, charter of Medina, Treaty of Hudaibya) leadership skills (Vision, communication, negotiation, conflict management, decision making, relationship building, Integrity, positivity, compassion, empathy, loyalty, accountability, confidence,

delegation, empowerment, problem- solving, foresightedness, openness, gratitude and justice). Teaching of Holy Quran: Translation and tafseer of Surah-e- Fatiha, and The Selected Section of Sura Al-Furqan verses (63-77), Surah-e-Luqman (verses (12-19)). Nazraah and Tajveed of: Suratul Fatiha, Ayatal Kursi, and last 10 surahs of the Holy Quran. (Ghunnah, Qalqalah, Al-Madd, Noon Sakinah & Tanween Rules)

ES-209	**Ethical Behaviour (for Non-Muslims)**

Nature, Scope and Methods of Ethics: Ethics and Religion, Ethical teachings of World Religions. Basic Moral Concepts: Right and Wrong, Good and Evil. Ethical Systems in Philosophy: Hedonism, Utilitarianism, Rationalism & Kant, Self-Realization Theories, Intuitionism. Islamic Moral Theory: Ethics of Qur'an and its Philosophical basis, Ethical precepts from Qur'an and Hadith and Promotion of Moral Values in Society.

ES-108	**ES-108 Ideology and Constitution of Pakistan**

Two-Nation Theory: Nation and Nationalism in British India. Inclusive nationalism, Exclusive nationalism, Freedom movement in British India, Two-Nation Theory. Ideology: definition and its significance. Difference between Philosophy, Ideology, and Theory. Evolution of Islamic ideology in British India. Pakistan movement: role of ideology. Ideological factors that shaped the Constitution(s) of Pakistan (Objectives Resolution 1949). Introduction to the Constitution of Pakistan .Definition and importance of a constitution. First Constituent Assembly of Pakistan. Main issues that delayed the Constitution-making in Pakistan. Dissolution of the Constituent Assembly. Second Constituent Assembly of Pakistan. Third Constituent Assembly of Pakistan. Constitution and State Structure. Federal form of State. Parliamentary form of government. Structure of Government (executive, legislature, and judiciary). Distribution of powers between federal and provincial governments. Fundamental Rights, Principles of Policy, and Responsibilities. Duty of the citizens of Pakistan (Article 5). Overview of fundamental rights to citizens of Pakistan guaranteed by the Constitution 1973 (Articles 8-28). Overview of Principles of Policy (Articles 29-40). Constitutional Amendments. Procedures for amending the Constitution. Notable constitutional amendments and their implications: 8^{th}, 13^{th}, $17^{th,}$, and $18^{th.}$

ME-111	**Engineering Drawing**

Drawing instruments and sheets; Importance of conventions and standards in engineering drawing. Geometrical construction of plane figures, conic sections, cycloidal curves and involutes. Multi view projection and drawing using first and third angle projection methods. Development of prisms, pyramids, cylinders and cones. Sections of solids and machine components. Types of pictorial views and drawing isometric view. Dimensioning techniques, size and geometric tolerance and their symbols, types of fits. Construction of curves from intersection of solids such as cones, cylinders, prisms and pyramids. Sketching of temporary and permanent fasteners like bolts, nuts and rivets, shaft couplings, connecting rod, bearings, pulleys, locking devices; Types of thread. Types of working drawing, construction of views of the assembled objects / components. Construction of process flow diagrams; symbols for piping, instruments and equipment

ES-105	Pakistan Studies

Historical and Ideological Perspective of Pakistan Movement. Two Nation Theory, Factors leading to the creation of Pakistan, Jinnah and demand for Pakistan. Land of Pakistan Geophysical conditions of Pakistan, Geopolitical and strategic importance of Pakistan, Natural resources of Pakistan: mineral, water and power resources. Constitutional process Early efforts to make a constitution (1947-1956), Salient features of the Constitution of 1956, 1962, Political and Constitutional crisis of 1971, Salient features of the Constitution of 1973, Constitutional amendments from 1973 to date. Contemporary issues of Pakistan. A brief Survey of Pakistan's economy, The Current Economic Situation of Pakistan: Problems & Issues and future perspective, Social Issues: Pakistan's society and culture: broad features, Literacy and education in Pakistan: problems and issues, Scientific and technical development in Pakistan, Citizenship: national and international. Environmental Issues: Environmental pollution: causes, hazards and solutions, National policy, International treaties, conventions and protocols .Pakistan's Foreign Policy Pakistan's Foreign Policy from 1947 to present, Relations with immediate neighbors, Relations with major powers, Relations with the Muslim world. Human Rights Conceptual foundations, Western and Islamic perspective of Human Rights, Human Rights in the Constitution of 1973, Human rights issues in Pakistan.

ES-127	Pakistan Studies (For Foreigners)

Land of Pakistan: Land & People-Strategic importance- Important beautiful sights, Natural resources. A Brief Historical Background: A brief Historical survey of Muslim community in the sub-continent, British rule & its impacts, Indian reaction, Two nation theory, Origin & development, Factors leading towards the demand of a separate Muslim state, Creation of Pakistan Government & Politics in Pakistan: Constitution of Pakistan, A brief outline, Governmental structure, Federal & Provincial, Local Government Institutions, Political History, A brief account. Pakistan & the Muslim World: Relations with the Muslim countries Language and Culture: Origins of Urdu Language, Influence of Arabic & Persian on Urdu Language & Literature, A short history of Urdu literature.

EA-128	Functional English

Listening skills and subskills: Effective listening techniques: listening for gist, details, and specific information in a range of situations (AV lectures, interviews, documentaries etc.)Speaking skills: Speaking with fluency and accuracy in a variety of situations including conversations, group discussion, academic and social interaction, public speaking, presentation skills, and interviews; Pronunciation improvement exercises (through websites, apps, and in class worksheets) Reading and subs kills: Reading strategies: Skimming, scanning, and detailed reading, identifying main ideas, supporting details, and inferences (multiple genres including newspapers, books, stories, documentaries etc). Reading Practice: Reading comprehension tasks. Reading output tasks (notes, summary, discussion, counter argument etc.) Study skills: Effective note-taking strategies for lectures, meetings, and reading texts. Taking in varied forms paragraph, lists, infographics etc.) ; Interpreting

instructions oral and written. Effective examination taking technique (comprehending instructions, planning, and writing answers ensuring relevance and precise

Writing skills: Writing process, Pre-writing strategies (Mind mapping, cubing, outlining, clustering etc.); Writing to describe, argue, compare and contrast, persuade through writing prompts; Writing academic and professional genres: emails, letters, short report, resume, cover letter, building profiles on various job portal; Writing accuracy: Identifying and overcoming grammatical problems. Vocabulary and grammar development: Vocabulary Development strategies. Exposure and practice to develop every day and academic vocabulary and basic grammatical structures applied in the formal contexts.

PF-101	**IT Fundamentals and Applications**

Fundamentals of IT: Introduction to Information and Communication Technologies (ICT), Components and scope of ICT, ICT productivity tools, Emerging technologies and future trends, Ethical Considerations in Use of ICT Platforms and Tools, Applications of ICT in education, healthcare and finance. Digital citizenship. Data Representation and Number Systems: Binary, octal, decimal, hexadecimal systems, data representation: characters, numbers, multimedia. Databases: Fundamentals of databases, organization and storage, introduction to Information Systems (IS) and Management Information Systems (MIS), real world IS and MIS applications. Data Communication and Computer Networking: Network topologies, Types of networks Programming Languages: Evolution and structures: syntax, semantics, special purpose vs. general-purpose languages, comparative study of data types, control structures and algorithms, basics of coding, practical problem solving.

PH-129	**Applied Physics**

Vectors & Mechanics: Review of vectors, Newton Laws and their Applications, Frictional Forces and determination of Co-efficient of Friction, Work-Energy Theorem, applications of law of Conservation of Energy, Angular Momentum, Centre of Mass. Waves and Oscillations: Simple Harmonic Oscillator, Damped Harmonic Oscillation, Forced Oscillation and Resonance, Types of Waves and Superposition Principle

Optics and Lasers: Huygens Principle, Two-slit interference, Single-Slit Diffraction, Types of Lasers, Applications of Laser. Modern Physics: Planck's explanations of Black Body Radiation Photoelectric Effect, De-Broglie Hypothesis, Electron Microscope, Atomic structure, X-rays, Radioactive Decay and Radioactive Dating, Radiation Detection Instruments Electrostatics and Magnetism: Electric field due to different Charge Distribution, Electrostatic Potential Applications of Gauss's Law, Lorentz Force Ampere's Law, Magnetism, Magnetization, Magnetic Materials. Electrical Elements and Circuits: Review of electric current, voltage, power, and energy, Ohm's law, inductance, capacitance, Basic Electrical circuits, Electromechanical systems. Semiconductor Physics and Electronics: Energy levels in a Semiconductor, Hole concept, P-N junction, Diodes, Transistors, Basic Electronic circuits (e.g. rectifier).Thermodynamics: Review of Laws of Thermodynamics, conduction, convection, and radiation. Thermal conductivity, specific heat, and overall heat transfer coefficients. Heating, Ventilation and Air Conditioning (HVAC).

MT-221	**Linear Algebra & Ordinary Differential Equations**

Linear Algebra: Linearity and linear dependence of vectors, basis, dimension of a vector space, field matrix and type of matrices (singular, non- singular, symmetric, non- symmetric, upper, lower, diagonal), Rank of a matrix using row operations and special method, echelon and reduced echelon forms of a matrix, determination of

consistency of a system of linear equation using rank, matrix of linear transformations, eigen value and eigen vectors of a matrix, Diagonalization. Applications of linear algebra in relevant engineering problem.1st Order Differential Equations: Basic concept: Formation of differential equations and solution of differential equations by direct integration and by separating the variables: Homogeneous equations and equations reducible to homogeneous from; Linear differential equations of the order and equations reducible to the linear form; Bernoulli's equations and orthogonal trajectories: Application in relevant Engineering. 2nd and Higher Orders Equations: Special types of IInd order differential equations with constant coefficients and their solutions: The operator D; Inverse operator I/D; Solution of differential by operator D methods; Special cases, Cauchy's differential equations; Simultaneous differential equations; simple application of differential equations in relevant Engineering. Partial Differential Equation: Basic concepts and formation of partial differential equations: Linear homogeneous partial differential equations and relations to ordinary differential equations: Solution of first order linear and special types of second and higher order differential equations; D' Alembert's solution of the wave equation and two dimensional wave equations: Lagrange's solution; Various standard forms. Fourier Series: Periodic functions and expansion of periodic functions in Fourier series and Fourier coefficients: Expansion of function with arbitrary periods. Odd and even functions and their Fourier series; Half range expansions of Fourier series.

PP-207	Fluid Mechanics

Introduction to Fluid Mechanics, Use of dimensional analysis, Analysis of Fluid Behaviour, 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.

PP- 214	Thermodynamics

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.

PP-221	Polymer & Petrochemical Lab-I

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.

EE-122	Basic Electricity & Electronics

Fundamentals of Electric Circuits: Charge, Current Voltage, and Power, Voltage and Current Sources, Ohm's Law; Voltage and Current Laws: Nodes, Paths, Loops and Branches, Kirchhoff's Current Law. Kirchhoff's Voltage Law, The single loop Circuits, The single Node-pair Circuits, Series and Parallel connected independent sources, Resistors in Series and Parallel, Voltage and Current Division. Circuit Analysis Techniques: Multi-Nodal Analysis, The super Nopdal, Mesh Analysis, the Super Mesh, Linearity and Superposition, Source Transformation, The venin and Norton Equivalent Circuits, Maximum Power Transfer, Delta-Wye Conversion. Capacitor, Inductor, Inductance and Capacitance C218 combination, The Source-Free RL Circuit, Properties of Exponential Response, the Source- Free RC Circuit. Introduction Machines: Induction Motors, Construction, Types, Rotating file theory, Principle of working, slip and its effect on motor current quantities, overexcited and under-excited motor, power factor and power factor control, starting of synchronous motor, parallel operation of alternators and sharing of load, working of alternator on infinite bus bars. Introduction of Transformer: Construction, Principle of working, emf equation, Transformation rations, No load working and vector diagram, magnetizing current, Vector diagram on load. One line Diagram: Symbols of different components, understanding of one line diagram. Basic Electronics: P-N junction, diode and applications Transistor construction, operation and applications Fundamental concepts of Digital Electronics.

MT-330	Applied Probability & Statistics

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.

PF-201	Civics and Community Engagement

Introduction to Civics and Citizenship: Definition of civics, citizenship, and civic engagement, Historical evolution of civic participation, Types of citizenship: active, participatory, digital etc., The relationships between democracy and citizenship .Civics and Citizenship :Concepts of civics, citizenship, and civic engagement, Foundations of modern society and citizenship, Types of citizenship: active, participatory, digital, etc State, Government and Civil Society . Structure and functions of government in Pakistan, The relationship between democracy and civil society, Right to vote and importance of political participation and representation. Rights and Responsibilities Overview of fundamental rights and liberties of citizens under Constitution of Pakistan 1973, Civic responsibilities and duties, Ethical considerations in civic engagement (accountability, non-violence, peaceful dialogue, civility, etc.) Community Engagement : Concept, nature and characteristics of community, Community development and social cohesion, Approaches to effective community engagement, Case studies of successful community driven initiatives. Advocacy and Activism : Public discourse and public opinion, Role of advocacy in addressing social issues, Social action movements. Digital Citizenship and Technology : The use of digital platforms for civic engagement., Cyber ethics and responsible use of social media, Digital divides and disparities (access, usage, socioeconomic, geographic, etc.) and their impacts on citizenship. Diversity, Inclusion and Social Justice: Understanding diversity in society (ethnic, cultural, economic, political etc.), Youth, women and minorities' engagement in social development, Addressing social inequalities and injustices in Pakistan, Promoting inclusive citizenship and equal rights for societal harmony and peaceful co-existence.

PF-301	Professional Ethics

Introduction to Ethics. Professional Ethics, Engineering Ethics, Business Ethics: Ethics and Professionalism. Need and Scope of Engineering and Professional Ethics, Development of Engineering Ethics, Major issues in Engineering & Professional Ethics. Ethical Dilemma. Resolving Ethical Dilemmas and Making Moral Choices, Techniques to resolve issues, Codes of Ethics, Codes of local and international professional bodies including PEC, Ethical Theories, Utilitarianism, Rights Ethics and Duty Ethics, Moral Theories: Virtue Ethics Self-Realization & Self Interest, Ethical Problem Solving Techniques: Line drawing, flow Charting, Conflict Problems, Professional Responsibilities, Risk and Safety as an Ethical Concern for Engineers, Workplace Responsibilities and Ethics: Teamwork. Confidentiality and Conflicts of Interest. Whistleblowing, Bribe and Gift, Risk and Cost-Benefit Analyses. Gender Discrimination and Sexual Harassment Environmental Ethics. Plagiarism. Hacking. Spamming. Academic and Research Integrity, Honesty: Truthfulness, Trustworthiness.

PP-202	Polymer Physics

Polymer structure and its relation to engineering properties.Chain dimensions: conformation, freely jointed chain, real polymer chains, and behaviour 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 Tg and melting point Tm, non-equilibrium features of glassy polymers and physical ageing; regions of viscoelastic behaviour, factors affecting Tg, relation between Tm and Tg, 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.

PP-213	Chemical and Petrochemical Industries

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.

PP-216	Polymeric Materials & their Characterization

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.

PP-217	Principles of Chemical Processes

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.

PP-218	**Introduction to Artificial Intelligence**

Introduction to Artificial Intelligence (AI): Branches of AI, development stages of intelligent machines. Basics of Programming for AI and programming libraries. Data Handling and Preprocessing: Types of Data. Data cleaning. Data transformations. Dimensionality reduction. Introduction to Machine Learning:The concept of learning. Supervised and unsupervised learning. Model parameters vs. hyperparameters. Training, validation and testing. Evaluation metrics. Model selection. Cross validation techniques. Underfitting and Overfitting. Supervised Learning Algorithms: Regression. Classification. K nearest neighbours. Decision Tree Algorithms. Support Vector Machines (SVM). Ensemble Learning (Bagging and Boosting). Neural Networks: Single Layer and Multilayer Perceptron. Activation Functions. Feed forward Propagation. Back propagation. Introduction to deep learning. Application of AI in Polymer and Petrochemical Industries: Predictive maintenance and fault detection.

MG-228	**Sociology & Development**

Introduction to Sociology: Importance and scope, study of social life, exploring the global village, Sociology as a science, relationship with other social sciences, the sociological imagination, development of sociology, pioneers of sociology, Brief historical development of sociology, Society and community, Social interaction processes. Social groups & Social Institutions: Definition, functions and types of social groups, Structure and function of social institutions. Culture and Related Concepts: Definition, Types and Elements of Culture, Role of Culture in Organization, Socialization and Personality. Social Stratification: Factors of Social Stratification, Approach to study Social Stratification, Power, Prestige, and Authority Social mobility, migration. Social and cultural change: Definition and dynamics of social change, Impact of globalization on society and culture, Resistance to change. Sociology of Development: Significant sociological questions, Measures of inequality and development, Modernization theory and explanation of underdevelopment, Education, Industrialization & development.

MG-257	**Organizational Behaviour**

Introduction to Organizational Behavior; What Is Organizational Behavior. The Individual; Diversity in Organizations, Attitudes and Job Satisfaction, Emotions and Moods, Personality and Values, Perception and

Individual Decision Making, Motivation Concepts, Motivation: From Concepts to Applications. The Group; Foundations of Group Behavior, Understanding Work Teams, Communication, Leadership, Power and Politics, Conflict and Negotiation, Foundations of Organization Structuren. The Organization System; Organizational Culture, Human Resource Policies and Practices, Organizational Change and Stress Management.

PF-205	**Community Service**

Community Service: [Taught Component] Introduction to the concept and practice of community service; need, objectives, and benefits of community service. Foundational theories (educational, undergraduate curriculum, humanities, social sciences, corporate social responsibility, etc.). Tools and skills required in community service. Contextual illustrations and case examples. Professional and ethical conduct during community service. Community Service Attachment: Completion of 30–35 hours of formal assignment at an organization. Community Service Experience Documentation: Preparation of a report documenting the experience and submission in the prescribed format.

Note: Total contact hours for theory (taught component 8 + documentation activity 6) will be 14 hours.

PP-307	Polymer Composite

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-312	Polymer Processing

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.

PP-314	Mass Transfer

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 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, 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.

PP-316	Organization and Management

Foundations of Organization Theory: Historical evolution of management thought, Classical and neoclassical approaches, Systems and contingency theories. Organizational Structure and Design: Functional, divisional and matrix structures, Hybrid and networked organizations, Factors influencing structure (size, technology, environment) Strategic Planning and Competitive Analysis: Vision, mission and corporate objectives, Strength Weakness Opportunity Threat (SWOT) analyses, Porter's Five Forces and generic strategies. Operations Management in Industry: Process types (job, batch, continuous), Capacity planning and utilization, Facility layout and workflow optimization Project Management Fundamentals: Project life cycle and stakeholder management, Work breakdown structure (WBS) and Gantt charts, Critical Path Method (CPM) and risk assessment. Human Resource Management and Leadership: Recruitment, selection and training, Motivational theories, Leadership styles and team dynamics. Quality Management and Continuous Improvement : Quality tools (Pareto, fishbone, control charts),ISO 9001 principles and certification process, Lean, Six Sigma and Kaizen methodologies Supply-Chain and Inventory Control: Sourcing strategies and supplier evaluation, Inventory models (EOQ, safety stock, ABC analysis),Just in-Time (JIT) and Vendor-Managed Inventory (VMI) Emerging Trends in Industrial Management: Industry 4.0 and smart manufacturing, Sustainability and circular economy in the chemical industries, Digital transformation and data-driven decision making.

PP-317	Project Management

Project Management Framework: Definition of Projects & Project Management, Projects vs. Operations , Project Management vs. Classical/Operations Management, Evolution of Project Management, Project Life Cycle and its distinction from the Product Life Cycle, Organizational Structures (functional, matrix) and their impact on project execution. Project Management Methodologies (PMBOK, Agile) Project Initiation, developing the Project Charter and identifying stakeholders Project Planning: Project Planning Process overview, Project Scope Management, Work Breakdown Structure (WBS). Project Scheduling: Activity Definition, Network Development, precedence relationships, network Diagram Types- Activity-on-Node (AON), Activity-on Arrow (AOA), Duration Estimation Techniques, Deterministic vs. probabilistic scheduling, Constructing & Analyzing the Critical Path, Gantt Charts for visual schedule representation, Schedule. Compression Project Budgeting: Budget Development, aggregating cost estimates, Top-Down vs. Bottom-Up Budgeting, Activity-Based Costing (ABC) principles, Baseline & Contingency Reserves. Execution, Monitoring & Control, and Closing: Project Execution Process, organizing teams and resources, Performance Monitoring, tracking progress against schedule and budget, Issue & Risk Management during execution, Project Control Techniques: earned value management (EVM) basics, Project Closing, formal acceptance, documentation, and handover, Lessons Learned

PP-321	Polymer and Petrochemical lab - III

According to the approved scheme of studies, this lab covers the following contents of PP-210 and PP-307. Fundamental processing techniques, including the extrusion process via single and twin-screw extruders, blown film, vacuum forming, and process cycle of injection molding process. The compounding, mixing and curing characteristics of elastomers by using Two Roll Mill and Hot Press. Fabricate the Composite using hand layup techniques and investigate mechanical properties and Safety involved in process.

EA-218	Business Communication

Definitions: communication, organization, business; understanding the need and scope of business, professional and organizational communication. Conditions, properties, process, tools, modes, levels, types of communication. Principles of Effective Communication & Building Goodwill (You-attitude, positive emphasis and unbiased language).Listening; non-verbal communication, Communication dilemmas and problems, Feedback and its types, audience analysis. Oral Communication: Group discussions and interpersonal skills, Meetings, Interviews and Making presentations. Business & Technical: Types of messages: formats (letter and memorandum); letter and memorandum elements and formats, Three types of business messages (routine, negative and persuasive communications),Organizational plans: direct, indirect & AIDA approach, Writing business messages (e-mails, inquiries, requests, replies, regrets, declining offers, letters, routine messages, etc.),Meetings: notice, agenda and minutes , Job applications and resumes and Research/scientific reports (structure, layout, writing process).

MT-471	Applied Numerical Method

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 (GaussElimination, 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.

PP-301	Process Control & Instrumentation

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.

PP-311	Chemical Reaction Engineering

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 dad 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.

PP-313	Mechanical Properties of Polymers

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 Consider 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.

PP-315	Heat Transfer

Introduction to Heat Transfer: Modes of heat transfer: conduction, convection, radiation and their governing principles. Conduction Heat Transfer: Steady-State 1D Conduction: Fourier's Law, conduction through various geometries, thermal resistance, multilayer systems. Multidimensional & Internal Heat Generation: 2D/3D conduction, internal heat sources, overall heat transfer coefficient. Extended Surfaces Transient (Unsteady). Conduction Heat Transfer Fundamentals: Boundary layer theory, flow regimes, dimensionless numbers. Forced Convection – External and Internal: Laminar/turbulent flow over flat plates, cylinders, and inside ducts; correlations and heat transfer coefficients. Natural (Free) Convection Thermal Radiation: Blackbody and grey body radiation, emissivity, absorptivity. Radiation laws. Phase Change Heat Transfer: Boiling: Pool and forced convection boiling. Condensation: Film and drop wise condensation.Heat Exchangers: Types (shell & tube, plate, finned, compact), standards and configurations. Fouling, LMTD and Effectiveness-NTU analysis methods. Design and selection principles. Evaporators & Pinch Analysis: Evaporator types and applications. Introduction to pinch technology and process heat integration.

PF-303	Applied Economics for Engineers

Introduction: Basic concept and principles of Economics, Micro-Economics theory, the problems of scarcity. Basic concept of Engineering Economy 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. Element Financial Analysis: Basic accounting equation. Development and interpretation of financial statements – Income Statement, Balance Sheet and Cash flow. Working capital management. 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. 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. 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. Linear Programming: Mathematical statement of liner programming problems, Graphic solution Simplex procedure. Duality problem Depreciation and Taxes: Depreciation Concept. Economic life. 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. Business Organization: Type of ownership, single ownership, partnership, corporation, type of stocks and joint stock companies. Banking and specialized credit institutions. Capital Financing & Allocation: Capital Budgeting. Allocation of capital among independent projects. Financing with debt capital. Financing with equity capital. Trading on equity. Financial leveraging.

PP-323	**Polymer and Petrochemical lab - V**

According to the approved scheme, this lab covers the following contents of PP-301 and PP-311.

Performance of homogeneous reactors: batch, mixed flow, plugs flow reactors. Effect of temperature on reaction kinetics. Multiple reactor systems in series. Introduction to Process Control System, closed–loop and open-loop control systems, Basic control actions. Concentration and temperature responses of a stirred tank, Linearization of liquid level systems, Response of pressure systems. Cascade, Feed-forward and Feed-backward control.

PP- 406	Process Equipment Design

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.

PP-411	Separation Processes

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.

PP-413	Process Optimization

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).

PP-415	Petrochemical Processes

Advanced reaction pathways and kinetics in petrochemical processes, Complex reaction networks in steam cracking and reforming, detailed kinetic models for olefins and aromatics production, coke formation and reactor fouling kinetics. Synthesis Gas and Derivatives: Reforming and partial oxidation (POX, ATR), water-gas shift reactor design, Ammonia, methanol, GTL (gas-to-liquids) technologies, Fischer-Tropsch synthesis and downstream processing. Conversion: Cryogenic separation for olefins, ethylene to ethylene glycol, ethanolamine, Propylene to acrylic acid, methyl ethyl ketone, acrylonitrile. Butanes to, iso and n-butanol, MIBK, azeotropic and extractive distillation of aromatics, Aromatics to maleic and phathalic anhydride, DMT, and acetones, Cyclohexane to caprolactum, adipic acid, succinic acid, purity control and specification compliance, precursor quality impact on final product. Technology involved in production of alcohol and vinyl chloride. Precaution and safety for handling halogenated compounds.

PP-416	Fuels & Combustion

Introduction to fuels: Conventional and non-conventional fuels, classification, storage, handling and preparation of fuels, fuels composition and quality testing methods and characterization, novel fuels. Fuel selection and up gradation: Criteria and characterization for the selection of fuels for industrial purposes, carbonization, liquefaction and gasification of coal, petroleum and its distillation products, synthetic fuels produced from coal, natural gas and biomass. Combustion and combustion technology: Nature and types of combustion processes, mechanism, kinetics and combustion calculations, oil & gas burners, fluidized bed combustion boiler, furnaces and waste heat recovery; classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control. Health and safety in fuel combustion and handling: Health and safety hazards related to unintended releases, fires, and explosions during the production, storage, and use of conventional and alternative fuels.

PP-421	Polymer and Petrochemical lab - VI

According to the approved scheme, this lab covers the following contents of PP-406 and PP-413.
This course introduces process modeling, simulation and analysis techniques. Development of process flow diagrams for various process equipment, synthesis and refinery processes using process simulation software such as ASPEN Plus. Economic evaluation and optimization of chemical processes using modelling software such as MATLAB. Data regression and Parameter Estimation.

PP-403	Plant Utilities & Safety

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.

PP-410	Polymer Reaction Engineering

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.

PP-414	Petroleum Refinery Engineering

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

PF-401:	Entrepreneurship

Introduction to Entrepreneurship: Definition and concept of entrepreneurship; Why to become an entrepreneur? Entrepreneurial process; Role of entrepreneurship in economic development. Entrepreneurial Skills: Characteristics and qualities of successful entrepreneurs (including stories of successes and failures); Areas of essential entrepreneurial skills and ability areas such as creative and critical thinking, innovation and risk taking. Opportunity Recognition and Idea Generation: Opportunity identification, evaluation and exploitation; Idea generation techniques for entrepreneurial ventures. Marketing and Sales: Target market identification and segmentation; Four P's of Marketing; Developing a marketing strategy; Branding. Financial Literacy: Basic concepts of income, savings and investments; Basic concepts of assets, liabilities and equity; Basic concepts of revenue and expenses; Overview of cash-flows; Overview of banking products including Islamic modes of financing: Sources of funding for startups (angel financing, debt financing, equity financing etc.) Team Building for Startups: Characteristics and features of effective teams; Team building and effective leadership for startups. Regulatory Requirements to Establish Enterprises in Pakistan: Types of enterprises (e.g., sole proprietorship; partnership; private limited companies etc.); Intellectual property rights and protection; Regulatory requirements to register an enterprise in Pakistan, with special emphasis on export firms; Taxation and financial reporting obligation.

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 Modelling & 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.

PP-429	Gas Engineering

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.