DEPARTMENT OF POLYMER AND PETROCHEMICAL ENGINEERING

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

NED UNIVERSITY OF ENGINEERING & TECHNOLOGY, KARACHI-75270
PAKISTAN
SEMESTER
SYLLABI OF COURSES
FOR
B.E. POLYMER & PETROCHEMICAL ENGINEERING PROGRAMME

Batch: 2015-2016

NED UNIVERSITY OF ENGINEERING & TECHNOLOGY, KARACHI-75270
PAKISTAN
# COURSE OUTLINE FOR FIRST YEAR

## SPRING SEMESTER

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Marks</th>
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<th>Course Code</th>
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<tbody>
<tr>
<td>PP-105</td>
<td>Introduction to Petrochemical</td>
<td>2</td>
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<td>PP-104</td>
<td>Introduction to Polymers</td>
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<tr>
<td>PP-106</td>
<td>Thermodynamics-I</td>
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<td>ME-101</td>
<td>Engineering Mechanics</td>
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<td>HS-104</td>
<td>Functional English</td>
<td>3</td>
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<td>ME-111</td>
<td>Engineering Drawing</td>
<td>2</td>
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<td>PH-122</td>
<td>Applied Physics</td>
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<td>HS-105 /</td>
<td>Pakistan Studies /</td>
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<td>MT-114</td>
<td>Calculus</td>
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<td>HS-127</td>
<td>Pakistan Studies (for Foreigners)</td>
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<tr>
<td>PP-103</td>
<td>Workshop Practice</td>
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<td>EE-118</td>
<td>Basic Electricity &amp; Electronics</td>
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## FALL SEMESTER

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<tbody>
<tr>
<td>PP-203</td>
<td>Principles of Chemical Processes</td>
<td>2</td>
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<td>PP-202</td>
<td>Polymer Physics</td>
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<td>PP-207</td>
<td>Fluid Mechanics</td>
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<td>PP-205</td>
<td>Petroleum &amp; Petrochemical Products</td>
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<td>PP-209</td>
<td>Thermodynamics-II</td>
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<td>PP-208</td>
<td>Polymer Materials, Additives &amp; Blending</td>
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<tr>
<td>PP-211</td>
<td>Computer Programming &amp; Applications</td>
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<td>MM-205</td>
<td>Mechanics of Material</td>
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<tr>
<td>MT-330</td>
<td>Applied Probability &amp; Statistics</td>
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<td>MT-215</td>
<td>Differential Equations &amp; Complex Variables</td>
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<td>HS-205 or</td>
<td>Islamic Studies OR Ethical Behaviour</td>
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<td>PP-222</td>
<td>Polymer &amp; Petrochemical Lab-II</td>
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<td>HS-206</td>
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<td>PP-221</td>
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# DEPARTMENT OF POLYMER & PETROCHEMICAL ENGINEERING

*NED University of Engineering and Technology
Karachi, Pakistan*

## COURSE OUTLINE FOR THIRD YEAR

<table>
<thead>
<tr>
<th>SPRING SEMESTER</th>
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<tbody>
<tr>
<td><strong>Course Code</strong></td>
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<tr>
<td>PP-210</td>
<td>Polymer Processing</td>
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<td>PP-307</td>
<td>Polymer Composites</td>
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<tr>
<td>PP-308</td>
<td>Heat Transfer</td>
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<td>PP-309</td>
<td>Mass Transfer</td>
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<td>MT-442</td>
<td>Numerical Method</td>
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<tr>
<td>PP-321</td>
<td>Polymer &amp; Petrochemical Lab-III</td>
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<tr>
<td>PP-322</td>
<td>Polymer &amp; Petrochemical Lab-IV</td>
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## COURSE OUTLINE FOR FINAL YEAR

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<tr>
<td><strong>Course Code</strong></td>
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<tr>
<td>PP-402</td>
<td>Petrochemical Processes</td>
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<td>PP-406</td>
<td>Process Equipment Design</td>
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<td>PP-410</td>
<td>Polymer Reaction Engineering</td>
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<td>PP-411</td>
<td>Separation Processes</td>
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<td>PP-413</td>
<td>Process Optimization</td>
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<tr>
<td>PP-408</td>
<td>Polymer &amp; Petrochemical Engineering Project*</td>
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<tr>
<td>PP-421</td>
<td>Polymer &amp; Petrochemical Lab-VI</td>
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* Duration of one academic year

** Elective Courses
1. PP-412: Environmental Engineering
2. PP-425: Elective-II
3. PP-426: Elective-III
4. PP-427: Elective-IV
5. PP-428: Elective-V
**PP-105 Introduction to Petrochemicals**

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, nitrination, 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.

**PP-106 Thermodynamics-1**

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

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

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

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

**HS-104 Functional English**

**Course Contents**

1. **Listening**
   - Types of Listening
   - Problems in listening and coping strategies
   - Listening skills, Sub skills
   - Practice in Listening
2. **Note taking**
   - Techniques for taking notes (from lectures, from books)
   - Note taking in different forms paragraphs (points, figures, processes, tables, graphs etc.)
3. **Vocabulary development**
   - Enhancing current vocabulary to reflect a better usage of words in spoken and written language
   - Tips / strategies in vocabulary enhancement
   - Practice in vocabulary development
4. **Reading**
   - Reading skills, Sub skills
   - Reading comprehension levels
   - Reading strategies
   - Reading practice through variety of reading texts and comprehension exercises
   - Beyond reading [outline, précis, speech and presentation]

5. **Writing**
   - Process of Writing
   - Informal Writing strategies

6. **Writing Correctly**
   a. Sentence structure and punctuation
   b. Error correction

7. **Paragraphs**
   a. Structure
   b. Types
   c. Topic and the topic sentence
   d. Unity
   e. Adequate development and coherence in paragraphs

8. **Essays**
   a. Types
   b. Five paragraphs, long essays
   c. Structure (thesis statement and the paragraphs)

9. **Short Reports**
   a. Structure
   b. Format and types (informational and analytical)

10. **Letters**
    a. Elements, Styles
    b. Formatting (digital letter writing)
    c. Organization and structure of the letter
    d. Types (Routine requests and intimation, invitation, thank you and condolence letters etc.)

### PH-122 Applied Physics

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

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

**MECHANICS**

**ELECTROSTATICS AND MAGNETISM**
Coulombs Law, Continuous charge distribution, Electrostatic potential energy of discrete charges, Gauss’s Law, Electric field around conductors, Magnetic fields, Magnetic force on current, Hall effect, Biot-Savart Law, Ampere’s Law, Field of rings and coils, Magnetic dipole, Diamagnetism, Paramagnetism and Ferromagnetism.

**SEMICONDUCTOR PHYSICS**
Energy levels in a semiconductor, Hole concept, Intrinsic and Extrinsic regions, Law of Mass Action, p-n junction, Transistor.
WAVES AND OSCILLATIONS
Simple Harmonic Oscillator, Damped Harmonic Oscillation, Forced Oscillation and Resonance, Type of Waves and Superposition Principle, Wave Speed on a stretched string.

OPTICS AND LASERS
Huygens Principle, Two-slit interference, Single-Slit Diffraction, Resolving power of Optical Instrument
Principals for laser action, Types of laser, Applications of laser.

MODERN PHYSICS

MT-114 | Calculus

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

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, Turning.


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

**PP-104  Introduction to Polymer**

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 thermostets); 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.

**ME-101  Engineering Mechanics**

**Statics 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.

<table>
<thead>
<tr>
<th>ME-111</th>
<th>Engineering Drawing</th>
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<tbody>
<tr>
<td>Drawing equipment and the use of instruments; Basic drafting techniques and standards; Geometrical curves including plane curves; Cycloid; Hypocycloid and Involute.</td>
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<tr>
<td>Intersections at various positions of geometrical bodies such as prisms, Prisms, cylinders and cones: Development of surfaces of prisms, pyramids, cylinders and cones.</td>
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<tr>
<td>Freehand sketching of machine and engine components, Locking arrangements; Foundation bolts; Stuffing box; Shaft couplings; Foot step bearing; Engine connecting rod.</td>
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<tr>
<td>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.</td>
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<tr>
<td>Sectioning of machine and engine components; Orthographic projections and standard practices. Isometric views with particular reference to piping and ducting.</td>
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<thead>
<tr>
<th>HS-105</th>
<th>Pakistan Studies</th>
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<tbody>
<tr>
<td>Land of Pakistan: Geophysical conditions, Territorial situation and its importance, Natural Resources – Mineral and Water.</td>
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<tr>
<td>Post Independence Development: Education in Pakistan; Planning &amp; Development in the Field of Education. Development of Science and Technology with special reference to Engineering and Architecture.</td>
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<tr>
<td>Cultural Development in Pakistan: Definition, Contents and Contributing factors in culture, Development of Art, Philosophy and literature.</td>
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</table>
Foreign Policy: Relation with neighbors, Super Powers and Muslim World.

HS-127  Pakistan Studies (For Foreigners)

Land of Pakistan: Land & People – Strategic importance beautiful sights – Natural resources (some of economics of Pakistan)

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


Pakistan & the Muslim World: Relations with the Muslim countries.


EE-118  Basic Electricity & Electronics

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, Theremin's Norton and maximum power transfer; Magnetic circuits: magnetic fields, flux density, permeability, reluctance, magnetizing force, hysteresis, Ampere's Circuitual 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 contraction, operation and types; DC Motors and Generators: construction of DC motors and generators, working principles, equivalent circuits, losses and efficiency calculations; A 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.

PP-203  Principles of Chemical Processes

Principles of stochiometric combination.


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


**PP-207  Fluid Mechanics**

Fundamentals of fluid mechanics: pressure distribution, buoyancy, head calculations, manometry, use of dimensional analysis, dimensionless groups.


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

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

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

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

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

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

**PP-209  Thermodynamics-II**

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

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

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

Thermodynamics of Polymers: Thermodynamics of liquid mixtures, low molecular weight mixtures (ideal solutions), polymer-solvent mixtures (Flory-Huggins theory), partial molar
quantities and chemical potential, colligative properties and interaction parameter \( \chi \), Virial coefficients; phase equilibria in poor solvents, solubility behaviour of polymers, frictional properties, Flory-Fox equation and Mark-Houwink equation, dilute solution viscometry, intrinsic viscosity, measurement of solution viscosity.

**PP-211  Computer Programming and Application**

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.

**MT-330  Applied Probability & Statistics (with Practical)**

**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, Skewness & Kurtosis, Quartile Deviation, Mean Deviation, Standard Deviation, Variance & its coefficient, Practical Significance in related problems.

**CURVE FITTING:**

**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**

**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**
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.

<table>
<thead>
<tr>
<th>HS-205</th>
<th>Islamic Studies</th>
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<tbody>
<tr>
<td>Section A</td>
<td>Quranic Verses</td>
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**Chapter 01.**
- **Tauheed:** Al – Ambiya – 22, Al – Baqarah - 163&164.
- **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, Al- Imran – 110
  - Importance and necessity of Da’wat-e-Deen An-Nehl-125, Al-Imran-104, and two Ahadith
  - Method of Da’wat-e-Deen

**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:** Al-Maidah-32
- **Protection of life:** Al-Nisa-29
- **Right of Property:** Al-Hujurat – 11-12.
- **Right to Respect & Dignity:** Al-Baqarah-256
- **Freedom of Expression:** Al-Hujurat-13.
- **Equality:** Al-Ma`arif – 24 – 25.
- **Economic Security:** An-Nisa-58.
- **Employment Opportunity on Merit:** An-Nisa-135.
- **Access to Justice:**
Chapter 07.


Chapter 08.


Section B:

Chapter 09.

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

Section C:

Chapter 10.

Islamic Civilization:

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

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

4. Ethics, Society, and moral theory:
   • Society as the background of moral life
   • Ethical foundation of Rights and Duties
   • Universalism and Altruism
   • Applied Ethics
   • Theories of punishment

PP-202 | Polymer Physics

Polymer structure and its relation to engineering properties. Chain dimensions: conformation, freely jointed chain, real polymer chains, and reptation and chain motion. Structures: configurational isomerism Crystallinity in polymers: fringed micelle and chain folded models, crystal growth from the melt and crystal lamella stack, spherulites, factors affecting crystallization, degree of crystallinity Thermal transition in polymers: glass transition temperature $T_g$ and melting point $T_m$, non-equilibrium features of glassy polymers and physical ageing; regions of viscoelastic behaviour, factors affecting $T_g$, relation between $T_m$ and $T_g$, the free-volume theory, the WLF equation. Rubber elasticity: thermodynamics of elastomer deformation, statistical theory of rubber elasticity, stress-strain behaviour of cross-linked elastomers, Mooney- Rivlin equation. Oriented polymers: production and characterization, properties of oriented polymers.

PP-205 | Petroleum & Petrochemical Products

Brief introduction to modern exploration, production and processing operations, origin and fluid properties of oil and natural gas reservoir types and basic reservoir engineering concepts. Chemical composition of petroleum and petroleum products and their physical, chemical, thermodynamic and performance characteristics. Interrelation between the chemical structure and characteristics of petroleum products. Major petroleum products like LPG, gasoline, industrial solvents, naphtha, kerosene, aviation turbine fuel (ATF), high speed diesel (HSD), LDO, furnace fuels, lubricants, base oils, tar and bitumen. Introduction to basic refining processes: Physical separation processes such as distillation and extraction. Chemical transformation processes such as thermal cracking, reforming. Molecular rearrangement processes such as isomerisation, alkylation, and polymerization. Molecular rebuilding processes e.g. gas to liquid processes. Methane, natural gas, CNG, rebuilding of hydrocarbons, rubber. Petrochemicals: Methanol, Formaldehyde, Ethylene production by steam cracking of naphtha, Ethylene dichloride, Vinyl chloride monomer, Vinyl acetate monomer, Ethylene oxide, Acetaldehyde, Propylene, Acrylonitrile, Propylene oxide, MTBE, Butadiene, BTX separation, Benzene by dealkylation of toluene. Refinery products, properties, significant tests and standard test methods.

PP-208 | Polymer Materials, Additives & Blending

1. Thermoplastics, thermosets, and elastomers. Properties and applications of: Commodity thermoplastics: polyolefins, vinyl polymers, polymethyl methacrylate,
Engineering thermoplastics ─ acrylonitrile butadiene styrene ABS, polyamides, polycarbonate, thermoplastic polyester (PET), acetal, modified poly (phenylene-oxide), polysulfones, poly(phenylene-sulphide), fluoropolymers
Engineering thermosets: phenol formaldehyde, epoxies, formaldehyde resins, unsaturated polyesters, and polyurethane.
Elastomer: natural rubber, styrene butadiene rubber (SBR), nitrile rubber, polychloroprene, ethylene propylene diene monomer (EPDM), silicone, thermoplastic elastomer
Compounding, vulcanization, and role of different additives in elastomer.
Specialty Polymers: Polyimides, Ionic polymers, polyaryetherketones, specialty polyolefins, inorganic polymers, liquid crystal polymers, conductive polymers, high performance fibers, and dendritic polymers.
2. Polymer additives: Fillers and reinforcements, plasticizers, and other important additives.
Characterisation and Testing of Polymers: NMR, infrared), optical microscopy, physiochemical (melt flow index, intrinsic viscosity, K-value, DSC, DTA, gel permeation chromatography) and scattering (light, x-rays).
3. Tensile, flexural and impact test, abrasion, hardness, long term fracture tests, HDT/ Vicat softening point, stress cracking, dielectric strength.
Various standard specifications ASTM, ISO, BS and DIN

**MM-205 Mechanics of Materials**

Review mechanics of materials, Deformation; strain; elastic stress-strain behaviour of materials; Introduction to stress-strain diagram, working stresses, unit design, Introduction to elastic and nonlinear continua. Poisson’s ratio; Determination of forces in frames; Simple bending theory; general case of bending; Shear force and bending moment diagrams; Relationship between loading; shear force and bending moment. Stress; Skew (antisymmetric) bending Direct, Shear, Hydrostatics and complementary shear stresses; Bar and strut or column; Theory of buckling instability; Thin ring, elementary thermal stress and strain. Theory of elasticity and analytical solution of elasticity problems. Strain energy in tension and compression.
Analysis of bi-axial stresses, principal planes, principal stress-strain, stresses in thin walled pressure vessels. Torsion of circular shafts, coiled helical spring, strain energy in shear and torsion of thin walled tubes, torsion of non-circular sections. General case of plane stresses, principal stress in shear stresses due to combined bending and torsion plane strain. Composite materials, Volume dilatation, Theories of Yielding, Thin Plates and Shells Stress Concentration.

**MT-215 Differential Equations and Complex Variables**

**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:**

**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:**

**Complex Variables:**
Limit, Continuity, zeros and poles, Cauchy-Riemann Equations, conformal transformations, contour integration.

**PP-210 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-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 lay-up, 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**
Fundamentals: Conduction: Steady state heat conduction in 1D, 2D & 3D geometries, multi-layer wall, overall heat transfer coefficient; transfer with internal heat sources; extended surface heat transfer-Fins. Unsteady heat transfer for simple geometries.
Convection: basic concepts; boundary layer fundamentals, laminar and turbulent flows; forced convection external flows: laminar and turbulent flow over: flat plates, across cylinders and spheres, Internal flows: inside tubes and non-circular ducts; Free convection heat transfer.
Thermal radiation: Basic concepts; surface characteristics blackbody; grey body, emission in defined wave band; radiation intensity; energy exchange in black and grey bodies. Phase Change Heat transfer: Boiling; pool boiling, boiling curve, forced convection boiling, external and internal forced convection boiling. Condensation: laminar / turbulent film condensation, drop-wise condensation.
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


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

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

### MT-442 Numerical Methods

**Error Analysis:**
Types of errors (relative, Absolute, inherent, round off, truncation), significant digits and numerical instability, flow chart.

Use any Computational tools to analysis the Numerical Solutions.

**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 Equations:**
Numerical methods of 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 interactive method.

**Solution of Linear Equations:**
**Interpolation & Curve Fitting:**
Lagrange’s Newton, Hermit, Spline, least squares approximation. (Linear and non-linear curves).

**Numerical Integration & Differentiation:**

**PP-301 Process Control and Instrumentation**


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


**PP-305 Fuels and Combustion**


**PP-310 Industrial Organization and Management**

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, control for maximum profit, scheduling techniques.

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

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

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

### 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 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.


Surface phenomenon and catalysis. heterogeneous reaction system, rate equations for heterogeneous reactions, fluid particle reactions, determination of rate controlling steps, catalysis desorption Isotherm, kinetics of solid catalyzed reactions, design of fluid-solid catalytic reactors.

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

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

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

### PF-304 Applied Economics for Engineers

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


Cost Estimation: Element of cost, Material cost, direct and indirect labour cost and overhead cost, Cost structure, Prime cost, Factory Cost, Processing cost, Total Cost, Selling price, Estimation of cost elements, Methods of estimation.


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


**HS-304 Business Communication and Ethics**

**Part-I 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.

**PP-402 Petrochemical Processes**
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 roots, 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-butanol, 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, chlorobenzene, 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.

**PP-406 Process Equipment Design**

Physical, Mechanical & Thermal properties and characterization of the applicable materials, Classification and utilization of the applicable 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-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-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.
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.

**PP-403 Plant Utilities and 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, equipments and their types used in relief and flare system, types of flares, Thermal Oxidizer; regenerative and recuperation thermal oxidizers.
Safety: Hazards and Plant Safety, importance of safety, overall safety of plant and personnel, accident analysis and prevention, types of accidents in industry. Regulations for industrial safety: OSHA, accident rate calculations; OSHA incidence rate, Fatal accident rate (FAR), and Fatality rate, economics of accident prevention. Safety management. Hazard and risk assessment; hazard analysis methodologies: what-if, checklist, what-if/checklist, HAZOP. Accident investigation and case histories. Fires and Explosions. Health and Safety; Personal Protective Equipments; fire-fighting equipments and their uses. Occupational diseases related to polymer and petrochemical industry

**PP-409 Advanced Polymer Engineering**

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.

**PP-XXX**  Elective Courses*

**PP-412**  Environmental Engineering*

Environmental Monitoring (Air, Water & Soil): Objectives of sampling and monitoring programme. Design and types of samples; pre-sampling requirements/information, sampling and design purposes. Pollution concept, types of pollution, air, water, soil, noise pollution control technologies, Biotechnology for environment, industrial pollution control, Occupational safety devices. Marine pollution; oil spills, waste water discharge. Waste Management: Liquid and Solid waste management, waste minimization; reuse, recycle and disposal. Case studies of industrial waste treatment: petroleum, petrochemical, polymer, packaging and pharmaceutical industries.


**PP-425**  Elective-II*

**PP-426**  Elective-III*

**PP-427**  Elective-IV*

**PP-428**  Elective-V*

**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.
• Understanding the Entrepreneurship Mind-set
  • The revolution impact of Entrepreneurship
  • The individual Entrepreneurship Mind-set
  • Corporate Entrepreneurship Mind-set
  • The Social and Ethical perspectives of Entrepreneurship

• Launching Entrepreneurship Ventures
  • Creativity and innovations
  • Methods to initiate ventures
  • Legal challenges in Entrepreneurship
  • The search for Entrepreneurship Capital

• Formulation of Entrepreneurship Plan
  • The assessment of function with opportunities
  • The marketing aspects of new ventures
  • Financial statements in new ventures
  • Business plan preparation for new ventures

• Strategic Perspectives in Entrepreneurship
  • Strategies growth in Entrepreneurship
  • Valuation challenges in Entrepreneurship
  • Final harvest of a new venture