# INDUSTRIAL & MANUFACTURING ENGINEERING DEPARTMENT

## SECOND YEAR

### SPRING TERM

| Course Code | Course Title | Credit Hours Th | Pr | Total |
|---|---|---|---|---|
| IM-201 | Metrology & Gauging | 100 | 50 | 150 |
| IM-208 | Materials Engineering | 100 | 50 | 150 |
| ME-202 | Solid Mechanics-I | 100 | 50 | 150 |
| CS-207 | Comp. Arch. & Organization | 100 | 50 | 150 |
| ME-205 | Element of Machine Dynamics & Design | 100 | 0 | 100 |
| HS-205/ HS-209 | Islamic Studies / Ethical Behaviour | 100 | 0 | 100 |
| | | 600 | 200 | 800 |

### FALL TERM

| Course Code | Course Title | Credit Hours Th | Pr | Total |
|---|---|---|---|---|
| MS-225 | Linear Algebra & Ordinary Differential Equations | 100 | 0 | 100 |
| EL-232 | Electronics | 100 | 50 | 150 |
| ME-210 | Fluid Mechanics | 100 | 50 | 150 |
| IM-203 | Manufacturing Processes | 100 | 50 | 150 |
| IM-207 | Computer Programming & Drafting | 100 | 50 | 150 |
| | | 500 | 200 | 700 |

## THIRD YEAR

### SPRING TERM

| Course Code | Course Title | Credit Hours Th | Pr | Total |
|---|---|---|---|---|
| HS-304 | Business Communication & Ethics | 100 | 0 | 100 |
| IM-307 | Advance Manufacturing Processes | 100 | 50 | 150 |
| IM-303 | Production Management | 100 | 50 | 150 |
| MF-303 | Engineering Economics | 100 | 0 | 100 |
| IM-310 | Tool Design | 100 | 50 | 150 |
| IM-311 | Industrial Quality Control | 100 | 50 | 150 |
| | | 600 | 200 | 800 |

### FALL TERM

| Course Code | Course Title | Credit Hours Th | Pr | Total |
|---|---|---|---|---|
| MS-333 | Advance Calculus & Fourier Analysis | 100 | 0 | 100 |
| EE-373 | Machine Control Systems | 100 | 50 | 150 |
| ME-302 | Solid Mechanics-II | 100 | 50 | 150 |
| IM-308 | Operations Research | 100 | 50 | 150 |
| IM-309 | Machine Design & CAD | 100 | 50 | 150 |
| | | 500 | 200 | 700 |

## FINAL YEAR

### SPRING TERM

| Course Code | Course Title | Credit Hours Th | Pr | Total |
|---|---|---|---|---|
| MS-441 | Advance Mathematical Techniques | 100 | 0 | 100 |
| IM-405 | Finite Element Analysis | 100 | 50 | 150 |
| IM-408 | Automation & Robotics | 100 | 50 | 150 |
| IM-411 | Methods Engineering | 100 | 50 | 150 |
| IM-413 | Plant Engineering | 100 | 50 | 150 |
| IM-409 | *Manufacturing Engineering Project | - | - | - |
| | | 500 | 200 | 700 |

### FALL TERM

| Course Code | Course Title | Credit Hours Th | Pr | Total |
|---|---|---|---|---|
| IM-414 | Industrial Safety & Environment | 100 | 50 | 150 |
| IM-415 | Applied Heat Transfer | 100 | 50 | 150 |
| IM-416 | Management Information System | 100 | 50 | 150 |
| IM-402 | Computer Aided Manufacturing | 100 | 50 | 150 |
| IM-409 | *Manufacturing Engineering Project | - | 200 | 200 |
| | | 400 | 400 | 800 |

***Duration one academic year: Requires literature survey and preliminary work during this Semester***

## IM 201 METROLOGY AND GAUGING

**Standardization:**
Introduction, product simplification & diversification, interchangeability, selective assembly, principles, preparation of standards, application of standards in design and manufacturing, applying for patents, international & national standard organizations

### Standards of length:
Light waves as standard of length, design & operation of linear measuring instruments, slip & block gauges, length bars, limits and fits, limit gauges, sine bar, comparators: mechanical, electrical, pneumatic, & optical

### Measurement:
Errors in measurement, sensitivity, accuracy, & variation, economics of measurement, measurement of squareness, flatness, straightness, roundness, gear & screw threads, advanced measuring and inspection, non-contact measurement

### Surface Texture:
Roughness lay waviness, & flaws. CLA, & RMS values, predication of roughness in turning, drilling, milling, & grinding. Measurement of roughness, Average values of roughness for various manufacturing processes.

### Machine Tool Metrology:
Alignment tests, level of installation, spindle straightness, flatness, & squareness.

## IM 203 MANUFACTURING PROCESSES

**Sand Casting:**
Introduction; Sand casting procedures; Patter making; Material types and construction of patterns; Pattern allowances; Moulding process; Moulding materials; Tools and equipment; Testing of sand; Moulding machines; Core making; Types of cores; Core making machines; Shell moulding; Plaster moulding; Centrifugal casting; Trimming and finishing of castings; Seasoning of castings; Inspection of castings.

**Die Casting:**
Pressure die casting; Vacuum die casting; Gravity die casting; Die casting machines; Hot chamber and Cold Chamber methods; Die casting alloys; Die design, construction, and material; Die casting.

**Welding Processes:**
Classification of welding processes; Oxyacetylene welding, oxygen torch cutting, and flame straightening; Arc welding; Shielded arc welding, Gas tungsten arc welding, Gas metal arc welding, Flux-cored arc welding, submerged arc welding, plasma arc welding, stud welding, spot welding, Seam welding, Projection welding; Other welding processes: Forge welding, Roll welding, Friction welding, explosion welding, Thermit welding, Electron beam welding, Laser welding and cutting; Brazing and Soldering.

**Fabrication of Plastics:**
Casting; Blow moulding; Compression moulding; Transfer moulding; Cold moulding; Injection moulding; Reaction injection moulding; Vacuum forming; Welding of plastics.

**Machining Processes and Machine Tools:**

Machine tools using single point tools: Description, functions and operation performed on lathe, shaper, Planner, and boring machines; work holding devices.

Machine tools using multiple cutting edge tools: Description, functions, and operations performed on drilling, milling, gear cutting, and broaching machines.

Machine tools using abrasive wheels; description and functions of various types of grinding machines; wheel dressing, and wheel balancing; Honing, lapping, and super finishing operations; thread manufacturing.

Non-traditional machining processes such as EDM, ECM, & ultrasonic machining.

**Machining parameters:**
Determination of machining time and material removal rate for various machining operations. Cutting tools for manufacturing: Cutting tool material characteristics; Cutting tool materials, tool steels, HSS, Cubic Boron Nitrides; Tool Geometry, Tool life, Tool wear, and machinability; Taylor's Tool life model, sharpening and Reconditioning of cutting tools; Basic concept and design of jigs and fixtures.

## IM 207 COMPUTER PROGRAMMING & DRAFTING

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

**Building Blocks:**
Identifiers and keywords, Data-types, Variables and Constants, Statements and Operators, Input and Output Functions.

**Branching Statements:**
Conditional branching and Looping (Counter and condition controlled loops).

**Subroutine:**
A brief overview, Defining a subroutine, Accessing a subroutine, Passing arguments, Returning values and Recursion.

**Arrays & Strings:**
Defining an array, Referring to individual elements of an array, Processing an array, Multidimensional arrays, String handling and Manipulation, Overview of pointers.

**Computer Aided Drafting:**
Introduction, Application of computers in drafting and designing, Methods for creating drawing entities, Common editing features, Dimensioning with variable setting, Printing and Plotting.

## IM 208 MATERIALS ENGINEERING

***Introduction to Materials Engineering:***
Types of materials, sources of materials, material science and engineering crystalline & amorphous materials, application of materials.

***Metallic Materials:***

Pure metals and alloys, nature and properties of metals and alloys, major properties of metallic materials (chemical, physical, mechanical), single crystal and poly-crystalline metals, crystal defects and the mechanisms of deformation and fracture, plastic flow in poly-crystalline materials, structure- property, relationships, macro & micro examinations, structural aspects of solidification & solid phase transformations in binary systems, ferrous and non-ferrous metals, various heat treatments, TTT- diagram.

***Ceramics, Glasses, Rubbers & Refractory Materials:***

Compositions, properties, structures of various non-metallic materials, application of ceramics, glasses, rubber & refractory materials, methods of manufacture.

***Polymers:***

Polymerization, Structural feature of Polymers, Thermoplastic Polymers, Thermo-setting Polymers, Additives, major mechanical properties.

***Composites:***

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

***Environmental Degradation:***

Metal degradation by atmospheric, aqueous & galvanic corrosion; stress corrosion cracking methods of corrosion prevention, behaviors of metal at elevated temperature – pyrometers oxidation, scaling and creep. Chemical degradation of ceramics & polymers, radiation damage, surface improvement against degradation.

## ME 202 SOLID MECHANICS I

**Statically Determinate Frames and Beams:**

Free-body diagrams; Determination of forces in frames; Shear force and bending moment diagrams; Relationships between loading share force and bending moment.

**Statically Determinate Stress Systems:**

Stress; Direct, shear, hydrostatic and complementary shear stresses; Bar and strut or column; Thin ring or cylinder rotating; Stresses in thin shells due to pressure or self-weight.

**Stress-Strain Relations:**

Deformation; strain; elastic stress-strain behavior of materials; Poisson's ratio; elementary thermal stress and strain; General stress-method.

Statically Indeterminate Stress Systems:

Interaction of different materials; Interaction of different stiffness components; Restraint of thermal strain; Volume changes; Constrained materials.

**Bending Stresses:**

Simple bending theory; General case of bending; Composite Beams; Eccentric and load; Shear stresses in bending.

**Bending-Slope and Deflection:**

Equation of the deflection curve of the neutral axis; Double integration method; Method of super-position.

**Theory of Torsion:**

Torsion of thin-walled cylinder; Torsion of a solid circular shaft; Hollow shafts.

Theories of Yielding, Thin Plates and Shells, Stress Concentration.

## ME 205 ELEMENTS OF MACHINE DYNAMICS AND DESIGN

***Machine Dynamics:***

Linkages; Cams; Friction clutches; Brakes and dynamometers; Belt and chain drives; Gear Trains including Epicyclic; couplings for non coaxial shafts; Steering gears; Turning-moment diagrams; balancing of rotating and reciprocating masses.

***Principle of Design:***

Mechanical properties of materials; Elasticity; Plasticity; Modules of resilience; Endurance limits Hardness; Creep; Effect of stress concentration; Wear. Analysis of operating conditions; Deflection; Torsion; Shear Center; Thermal Stresses Energy Methods: Composite section; closed and open type; Simple framed structure.

Theories of failures including fatigue failure and Soderberg criterion.

***Introduction to Design of Simple Machine Elements:***

Shaft Materials; Shafts operating under combined loading; Introduction to fluting loads with particular reference to industrial codes of practice such as BSS or DIN or JIS or COST.

Bearings; Methods of Lubrication; Bearing materials; Design of journal bearing; Introduction to design of bass and roller bearings.

Joints; Knuckle, cotter and universal joints; Couplings; Universal, Flanged, flexible, Clutches; Friction and mechanical type.

Springs; Helical and leaf type.

***Working of Torsion:***

Torsion of thin walled cylinder, Torsion of a solid circular shaft, Hollow circular shafts, Non-Uniform and composite shafts, Tapered shaft.

***Theory of Columns:***

Euler's theory of buckling for an eccentric loading of long columns; Behavior of ideal and real struts.

***Governors and Gyroscopes:***

Function, Principle of operations, applications.

Function of gyroscopes, gyroscopic acceleration and couple, application of gyroscopes.

## ME 210 FLUID MECHANICS

***Properties of Liquids and Gases:***
Ideal and real fluids; Fluid Pressure.

***Fluid Statics (Equilibrium):***
Euler's conditions of equilibrium, Pressure in a fluid under the action of gravity, Homogeneous fluid; several fluids of different specific weights, Interconnected vessels; Constant Velocity rotation of a liquid

around fixed axis: Fluid under pressure neglecting gravity; Force on contains wall Force on flat surfaces; Force on curved Surfaces; Buoyancy of Fluid at rest; stability of a floating body; Surface tension and capillary tubes.

***Fluid Dynamics:***

One dimensional inviscid flow (flow filament theory); equation of continuity; Euler's equations of motion; Bernoulli's equation, inputs and momentum. One-dimensional viscous flow; Generalized Bernoulli's equation; laminar and turbulent flow in circular pipes; pipe flow problems.

***Dimensional Analysis:***

Buckingham Pi Theorem; Reynolds's law of similitude.

***Fluid Measurements:***

Measurement of static pressure; stagnation pressure, flow velocity and flow rate.

***Fluid Machinery:***

Pumps, turbines, similarity laws for turbo-machinery.

## EL 232 ELECTRONICS

***Conduction in Solids:***

Introduction, mechanics of conduction, mobility, Bohr's model for the elements, energy level diagrams for solids, conductors, intrinsic and extrinsic semiconductors, electron-hole pairs in an intrinsic semiconductor, distribution of electron and hole in conduction and valence bands, recombination and lifetime.

***Semiconductors and Diodes:***

Donar and acceptor impurities, zero biased, forward biased and reverse biased junction diodes, junction diode current equation, depletion barrier width and junction capacitance, diffusion capacitance, Zener and Avalanche break down, Hall effect, Fabrication of pn junction diodes.

***Electron Emission Devices:***

Type of electron emissions, thermionic diodes, volt ampere characteristics, Child Langmuir Power Law, Gas filled diode, Thermionic triode, Parameters and characteristics, Tetrode, Pentode, And beam power tubes, Parameters and characteristics.

***Simple Diode Circuits and Applications:***

Mathematical and graphical analysis of diode circuits, The ideal and non ideal diodes, Piecewise linear models, Analysis of piecewise linear models of vacuum tube and junction diodes, The half wave rectifier, The inductance filter, The inductance capacitance filter circuits, zenor and gas diode, Voltage regulator circuits, Clamping and DC restorer circuits, Voltage doubler circuits, Clipping and limiting circuits.

***Bipolar and Field Effect Transistors:***

Transistor biasing and thermal stabilization, The operating point, Bias stability, Collector to base bias, Fixed bias, Emitter feedback bias, Stabilization for the self biased circuits, Field effect transistors, Basic principles and theory, Types, FET characteristics, Different configurations-common gate, Common source and common drain, The FET, small signal model, Parameters, Biasing of the FET.

***Amplifier Circuits:***

Introduction "h" parameters, Hybrid model for transistor, Elementary treatment, Low frequency transistor amplifier circuits, Stage cascaded LF.

## CS 207 COMPUTER ARCHITECTURE AND ORGANIZATION

***Introduction:***

Basic computer organization, Arithmetic, Control, Memory and I/O units.

***Architecture and Assembly Language Programming:***

The CPU, Various registers in the processing unit and their functions, Instruction formats, Architecture of an early computer, Contributions of Charles Babbage & Von-Neuman, Instruction, Instruction encoding and execution of early computers, Later trends.

***Data Representation:***

Importance of data representation, Numbers Representation of negative numbers, Radix Complement and diminished radix complement methods, Multiplication and division algorithm, Floating point numbers Codes for character representation, Data structures, Arrays, Stacks and Queues.

***Introduction to Microcomputers:***

Microcomputer architecture and organization, Instruction formats, Addressing modes, Input/Output structure, Single System bus and various interfaces.

***Memory and Storage:***

Types of memory systems and cost/performance gaps, fundamental system requirements for storing and retrieving information, Random access memory, digital magnetic recording principles, Sequential access storage systems.

## MS 225 LINEAR ALGEBRA & ORDINARY DIFFERENTIAL EQUATIONS (C)

***Linear Algebra:***

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

***Euclidean Spaces and Transformation:***

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

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

***Lap lace Integral & Transformation:***

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

## HS 205 ISLAMIC STUDIES

Themetic Study of Holy Quran.

1. *Basic Islamic Believes*

Topics

i) *Tauheed:*

Al-Ambiya-22, Al-Baqarah-163-164

ii) *Prophethood:*

Al-Imran-79, Al-Huda-7 Al-Maidah-3

iii) *Here-After:*

Al-Hajj-5, Al-Baqarah-48

*Two Hadith

**2. *Basic Islamic Practices:***

Al-Mu'minun-l-ll

**3. *Amre-Bil-Ma'Roof Wa-Nahi Anil Munkar***

The Concept of Good & Evil.

i) Importance & necessity of Da'Wat-e-Deen Al-Imran-llO.

ii) Method of Da'Wat-e-Deen. An-Nehl-125, Al-Imran-l04

*Two Hadith

**4. *Unity of the Ummah:***

Al-Imran-l03, Al-Hujurat-l0, Al-Imran-64, AI-An'am-l08

*Two Hadith

**5. *Kasb-e-Halal.***

Taha-8l, Al-A'raf-32-33, Al-Baqarah-188

*Two Hadith.

**6. *Huquq-ul-Ibad:***

i) *Protcetion of Life*

AI-Maidah-32

ii) *Right to Property*

An-Nisa-29

iii) *Right of Respect & Dignity*

AI-Hujurat-11-12

iv) *Freedom of Expression*

AI-Baqarah-256

v) *Right of Equality*

AI-Hujurat-13

vi) *Economic Security*

AI-Ma'arij-24-25

vii) *Exployment Opportunity on Merit*

An-Nisa-58

viii) *Excession Right to Justics*

An-Nisa-135

**7 .*Women Rights:***

An-Nehl-97, AI-Ahzab-35, An-Nisa-O7

**8. *Relations With Non-Muslims:***

AI-Mumtahanah-8-9, AI-Anfal-61.

Last sermon of Hajj at Arafat Translation & the important points of the sermon.

***Serat Life of the Holv Prophet:***

Birth, Life at Makkah.

Declaration of Prophethood, preaching & its difficulties migration to Madina. Brotherhood (Mawakhat) & Madina charter. The Holy War of the prophet

(Ghazwat-e-Nabawi) Hujjat-ul- Wida.

***Islamic Civilization:***

Impacts of Islamic civilization on the sub-continent. The civilization of sub- continent before Islam.

The Political, Social & Moral impacts of Islamic Civilization on sub-continent.

Academic, Intellectual, Social & Cultural Impacts of Islam on the World.

*N .B : As prescribed by UGC. The original Text & complete course plan may

be obtained from the Department of Humanities.

## HS 209 ETHICAL BEHAVIOUR

1. **Introduction to Ethics:**
   i) Definition of Ethics
   ii) Definition between normative and positive science
   iii) Problem of freewill
   iv) Methods of Ethics
   v) Uses of Ethics

2. **Ethical Theories:**
   i) History of Ethics: Greek Ethics, Medieval, Modern Ethics
   ii) Basic Concepts of right & wrong: good & evil
   iii) Utilitarianism, hedonism, self-realization: egoism, intuitionism, rationalism
   iv) Kant's moral philosophy

3. **Ethics & Religion:**
   i) The relation of Ethics to religion
   ii) Basic ethical principles of major religions: Hinduism, Judaism, Buddhism, Zoroastrianism, Christianity, Islam

4. **Ethics, Society and Moral Theory:**
   - Society as the background of moral life
   - **Ethical foundation of rights of moral life**
   - Universalism and Altruism
   - Applied Ethics
   - Theories of punishment

## IM 303 PRODUCTION MANAGEMENT

***Production Management & Systems:***

Introduction to production Management; System concept; Functions of management; Managerial decision making; Models as decision aids.

***Plant Location & Plant Layout:***

Selection of region; Selection of community; Site selection; Location factor dependence; Sources of assistance; Plant location trends; Quantitative analysis; Plant layout; Product & process layout analysis and comparison; Material handling considerations in layout.

***Production Planning & Control:***

Formalized production planning; Production planning methods; Master scheduling; MRP; MRP inputs, MRP outputs; Product structures; Types of MRP; Capacity planning and control; Production control systems; Job shop scheduling; Production control charts; Scheduling techniques; Purchasing and procurement.

***Planning & control Techniques:***

Inventory control; types of inventory; Inventory costs; Independent versus dependent demand; EOQ/EPQ models; Types of control systems; Selective inventory control; Inventory system development; Project planning; CPM/PERT; Network development; Determination of activity times; Establishment of critical path; Probabilistic statements.

***Cost Estimating:***

Element of cost; Material cost, direct and indirect labour cost and Over head cost. Cost structure; Prime cost, Factory cost, Manufacturing cost, Total cost, Selling price; Estimation of cost elements; Methods of estimation; Economics of tooling.

***Maintenance:***

Types of maintenance; Breakdown maintenance; Preventive maintenance; Individual versus group replacement; Internal versus external maintenance.

## IM 307 ADVANCE MANUFACTURING PROCESSES

***Mechanics of Orthogonal Metal Cutting:***

Chip formation; Thin-zone models for analysis; Shear angle relationships; Role of friction in metal cutting; Prediction of forces; Velocity relationships; Force and stress relationships.

***Tool Life & Tool Wear:***

Forms of wear in metal cutting, Tool life criteria, Variables affecting tool life, Taylor's tool life equation, Generalized tool life equation, Methods of tool life testing data. Economics of Metal Cutting: Application of minimum cost per piece, maximum production rate, and maximum profit rate criteria in turning operations.

***Metal Forming:***

Stress: stress tensor, equilibrium equations, stress transformation equations, plane stress, Mohr's circle for stress transformation. Strain: plane strain, strain tensor, strain transformation equations, isotropic elasticity, strain energy. Bulk forming, sheet forming, Yield criteria, Plastic work, Plastic instability, Effective stress, Effective strain, Flow rules for plastic stress-strain relations.

***Work Hardening:***

Tensile test, Mechanical properties, Nominal & true stress-strain curves, Work hardening expression, Behavior after necking, Direct compression, Bulge test, Plane-strain compression test.

***Bulk Forming Analysis:***

Ideal work method, efficiency factors, extrusion and rod drawing, force balance or slab analysis, deformation zone geometry, sheet drawing, flat rolling, direct compression in plane strain, sheet bending, formability.

***Hot & Cold Working of Metals:***

Advantages and limitations of Hot working and Cold working processes; Methods of Forging; Hammer forging; Die forging; Drop, Press and Upset forging; Construction of drop forging hammers; Forging defects and their causes.

## IM 308 OPERATIONS RESEARCH

**Linear Programming:**

*Historical development of Operations Research, Formulation of Model, Linear programming: Graphical Analysis and Solution, Simplex Method of Solution, Equality constraints, Inequality constraints, Big M method, Duality theory, Primal and Dual problems, & Sensitivity Analysis.*

***Special Types of LP Problems:***

The transportation problem, North-west corner rule, Vogel's approximation method, Russell's method, Transshipment problem, Assignment problem.

### *Queuing Theory:*

Basic Queuing process, Assumptions for analysis, Queuing discipline and characteristics, Service mechanism, The birth and death process, Steady-state measures of performance, Single-server models, Multiple-server models, Machine servicing model.

### *Dynamic programming:*

Recursive nature of computations in DP, Forward and backward recursion, Selected DP applications.

### *Simulation:*

Introduction to simulation and its application in manufacturing.

## IM 309 MACHINE DESIGN & CAD

***Design of Machine elements:***

Shafts and columns; Fluctuating and shock loads; Torsional stiffness; Critical speeds; Introduction to flexible shafting; Connecting rods and crank shafts.

Bearing; Details design of journal bearing and roller bearings including spherical and tapered roller bearings; Theory and application of lubrication and its methods.

***Design of Drive Units and Assemblies:***

Gearing; Design of the spur, helical, worm and bevel gear, Design of gear boxes. Chain drives; Design of chains including drag chain conveyor, apron feeders; Belt drives and belt conveyors; Motors and brakes.

***Fundamentals of CAD:***

Introduction, the design process, application of computers for design, creating the manufacturing data base, benefits of CAD.

***Computer Graphics Software and Data Base:***

Constructing the geometry, defining the graphic elements, editing the geometry, display control & windowing functions, data base structure and content, wire-frame versus solid modeling: wire frame models, solid models, other CAD features and CAD/CAM integration.

***Mathematical Elements of CAD:***

Transformation: Two & three dimensional transformations, Translation, Scaling, and Rotation, Concatenation, plane curves, space curves, surface description & generation, various techniques for design optimization.

## IM 310 TOOL DESIGN

***Jigs and Fixtures:***

Basic Design principles and Classification. Materials for jig and fixture development. Lathe, Milling and Broaching fixtures. Detailed discussion of jigs for drilling and drilling related operations. Consideration for mounting jigs and fixtures on machine tools. ***Inspection Jigs and Fixtures.*** Analysis of operation with design examples.

***Locating and Clamping Methods:***

Principles of Location. Pins, plugs, dowels and nests. Conical Locating, adjustable locators. Clamping principles, design of various clamps with typical applications. Pneumatic and Hydraulic clamping.

***Design of Cutting Tools:***

Design of tools for cutting operations. Single point tools for lathe and boring operations. Multiple point tools for milling and drilling operations.

**Design of Dies and Moulds:**

Terminology of Press-Working operations. Mechanical, Hydraulic and Pneumatic presses. Materials for press tools. Design of Piercing, Blanking and Shearing dies. Design of Bending, Forming and Drawing dies. ***Design of Moulds for plastic and Rubber Parts***. Pressure, Die Casting, Injection and Blow moulding.

## IM 311 INDUSTRIAL QUALITY CONTROL

***Fundamentals of Probability & Statistics:***

Set theory & set operations; Venn diagram; Definition of probability; Probability laws; Conditional probability.

Deterministic & probabilistic data; Grouping of data; Measures of central tendency & dispersion; calculation of mean, mode, median; standard deviation, & range, weighted average, & coefficient of variation.

Random variable; discrete & continuous random variable; Mathematical expectation; Laws of expectation.

***Probability Distributions:***

Discrete probability distributions: Uniform, Binomial, Multinomial, Hyper geometric & Poisson distribution.

Continuous probability distributions: Normal & Exponential distributions; Transformation of variables; Random sampling; Sampling distribution of mean; Central limit theorem.

***Control Charts:***

Properties of the distribution of sample means, sample range estimation of standard deviation, chance and assignable causes, control charts for mean & range, control charts for mean & standard deviation, control charts for proportion defective & defects per assembly. Tests of significance to compute confidence limits.

***Acceptance Sampling:***

Introduction, OC curve, consumer & producer risks, AQL & LTPD, sampling errors, acceptance sampling for continuous production, acceptance by variables, single, double, & sequential sampling.

***Quality, Reliability, & Maintainability:***

Definitions, management of quality control, total quality control, Taguchi loss function, economic aspects of quality decisions, process capability & variability analysis, various aspects of life testing, reliability, & maintainability, Introduction to ISO 9000.

## ME 302 SOLID MECHANICS - II

***Bending Stress:***

Asymmetrical bending; Shear stress in thin-walled open sections and shear center; General case of bending of a thin-walled open section; Bending of initially curved bars; Beams with small radii of curvature.

***Elastic Strain Energy:***

Strain energy under direct stress and in pure shear; Strain energy in bending and in torsion in bending and in torsion; Maximum stress due to a suddenly applied load and due to impact; Bending deflection of a beam from an impact shear deflection; Theorems of Gastiglians and Maxwell's Reciprocal Theorem.

***Theory of Torsion:***

Torsion of a thin tube of non-circular cross-section; Torsion of thin-rectangular strip; torsion of solid-rectangular and square cross-sections; Helical springs.

***Statically Indeterminate Beams and Frames:***

Double integration method; Superposition method; Virtual work; Compatibility and equilibrium methods.

***Buckling Instability:***

Struts having initial curvature; Empirical formulae; Crinkling; Members subjected to axial and transverse loading.

***Stress and Strain Transformations and Relationships:***

Two-directional stress systems; Mohr's stress circle; principal stresses and planes; combined bending and torsion; Two-directional strain analysis; Normal and shear strain in terms of coordinate and maximum shear strain; Relationship between elastic constants.

***Deformation Symmetrical about an Axis:***

Thick-walled cylinders; Compound cylinders; Shrink fit, Rotating disk of uniform thickness.

## EE 373 MACHINE CONTROL SYSTEMS

Open and closed loop control, feedback simple control system; sequence control, static switching and logic Switching Algebra.

Stability, accuracy, frequency and transient response.

***Time Scale Effects***

Linear control system, determination of system performance and design with reference to stability, Transient response, steady state accuracy and frequency response' Laplace transformation method; Root Locus; Nyquist criteria and Bode plots; Conformal plotting.

Series parallel and feedback techniques of system compensation.

Three term pneumatic controller for chemical plants.

Control system types; regulations, Servomechanism.

Electrical, hydraulic and pneumatic amplifier.

***Instrumentation:***

Analysis of the performance of electro mechanical transducers used in control.

## MS 333 ADVANCED CALCULUS & FOURIER ANALYSIS

***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, " DFT and FFT, Fourier Spectrum".

***Advance calculus:***

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

***Vector Calculus:***

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

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

## MF 303 ENGINEERING ECONOMICS

***Introduction***

Engineering economy defined; Measures of financial effectiveness; Non-monetary factors and multiple objectives; principles of engineering economy.

***The Economic Environment***

Consumer and producer goods; Measures of economic worth; Price, Supply, & Demand relationship; Production; Factors of production; Laws of return.

***Cost Concepts & Analysis***

Sunk & opportunity costs; Fixed, variable, and incremental costs; Recurring & nonrecurring costs; Direct, indirect, and overhead costs; Standard costs; Breakeven analysis; Unit cost of production; Cost-benefit analysis; Feasibility studies; Value analysis in designing & purchasing.

***Time Value of Money***

Simple interest, Compound Interest, Cash flow diagrams, Interest formulas, Nominal versus effective interest rates, continuous compounding.

***Depreciation and Depletion***

Purpose of depreciation, types of depreciation, economic life, what can be depreciated?

***Comparing Alternatives***

Present economy, Selection among machines, materials, processes, and designs, Payback period method, Present worth method, Uniform annual cost method, Rate of return method, Alternatives having identical live, Alternatives having different lives.

***Production Concepts & Mathematical Models***

Manufacturing lead time; Production rate; Capacity; Utilization; Availability; Work in process; WIP and TIP ratios.

***Linear Programming***

Mathematical statement of linear programming problems; Graphic solution; Simplex method; Duality problems.

***Capital Financing and Budgeting***

Types of ownership; types of stock; Partnership & joint stock companies; Banking & specialized credit institutions.

***Industrial Relations***

Labour problems; Labour organizations; Prevention & settlement of disputes.

## HS 304 BUSINESS COMMUNICATION & ETHICS

***Business English:***

Writing formal and business letters and memos: Drafting notices and minutes; Theoretical knowledge and comprehension of contracts and agreements; Preparing proposals and conducting and writing research project reports. Participating in seminars and interviews, and writing and presenting conference papers; Solving IELTS type papers.

***Engineering Ethics:***

Definition of code of ethics: Review of code of ethics of national and international engineering bodies. Relationship between ethics and human rights and their importance in human settlements and societies.

## IM 402 COMPUTER AIDED MANUFACTURING (CAM)

***Conventional Numerical Control:***

Introduction, principles of Numerical Control, Hardware for Numerical Control, NC positioning systems, NC motion control systems, applications of numerical control, economics and justification.

***NC Part Programming:***

Manual part programming, computer assisted part programming, Lathe CAM Designer, Mill CAM, NC programming with interactive graphics.

***Computer Controls in NC:***

Problems with conventional NC, NC controller of technology, computer numerical control, direct numerical control, adaptive control machining systems, trends and new developments in NC.

***Group Technology and Process Planning:***

Part families, methods for developing part families; parts classification and coding, Hierarchical code, Attribute code, Hybrid code, introduction to various available classification and coding systems, Selecting a coding system, production flow analysis, benefits of group technology, machining cells. The role of process planning in CAD / CAM integration, Approaches to process planning: Manual approach, Variant approach, Generative approach; introduction to various process planning systems.

***Programmable Logic Controllers (PLC's):***

Functions of controllers, control devices, Programmable Logic Controllers: relay device components, switch, relay, counters, timers, relay logic, Programmable Controller Architecture: processor, memory, input /output, power supply, peripherals, Programming a Programmable Logic Controller: ladder diagram, ladder logic, timers and counters, programming examples.

***Design for Manufacturing (DFM):***

The meaning of DFM, schemes for DFM, axiomatic design, DFM guidelines, design for assembly, Taguchi method for Robust design, manufacturing process design rules, failure mode and effects analysis, summary of DFM tools.

## IM 405 FINITE ELEMENT ANALYSIS

***Introduction:***

The early use of Finite Elements, matrix forces method, matrix stiffness method, interim period, variational principles and Finite Elements, recent developments.

***Variational Formulation and Approximation:***

Boundary and Initial-Value problems, gradient and divergence theorems, functional, variational symbol. Variational formulation of boundary-value problem, Variational Method of Approximation, Ritz method, method of weighted residuals, time-dependent problems.

***Finite Element Analysis of One-dimensional Problems:***

Basic Steps in FEA; Modeling, Discretization, Connectivity of Elements, Imposition of Boundary Conditions, Solutions & Post Processing; Applications to Heat Transfer, Fluid Mechanics, & solid Mechanics Problems.

***Finite Element Error Analysis:***

Approximation Errors, Various Measures of Errors, Convergence of Solutions, Accuracy of Solutions.

***Numerical Integration & Computer Implementation:***

Isoparameteric Formulations, Numerical Integration, Natural Coordinates, Computer Implementation (Pre-processor, Processor, and Post-processor)

***Interpolating Functions, Numerical Integration & Modeling Considerations:***

Interpolating Techniques; Triangular, Rectangular, & Serendipity Elements; Coordinate Transformation; Integration on a Master Element; Modeling, Mesh Generation, Load Representation.

***Plane Elasticity:***

Assumptions of Plane Elasticity; Basic Equations, Weak Formulations; Principle of Virtual Displacement in Matrix Form; Finite Element Model, Matrix & Weak Form Model; Evaluation of Integrals.

## IM 408 AUTOMATION & ROBOTICS

***Production Operations & Automation Strategies:***

Automation defined; Types of automation; Reasons for automation; Arguments for & against automation. Manufacturing industries; Types of production; Functions in manufacturing; Organization & information processing in manufacturing; Plant layout; Production concepts & mathematical models; *CIM*, *FMS/FMC*, Automation strategies.

***Automotive Type Automation***

Automated flow lines; Methods of work-part transport; Transfer mechanism; Buffer storage; Control functions; Automation for machining operations; Design & fabrication considerations.

***Analysis of Automated Flow Lines & Line Balancing:***

General terminology & analysis, Analysis of transfer lines without storage, Partial automation. The assembly process, Assembly systems, Manual assembly lines, The line balancing problem; Methods of line balancing: Largest candidate rule, Kilbridge & Wester's method, Ranked positional weights method.

***Automatic Control Systems and Components:***

*Basic elements of automatic control system, Levels of automation, Analysis of regulated and servo control systems, Sensors, Actuators, Data conversion, Mechanical components of automation.*

***Robotics Technology & Applications***

Robot anatomy, Robot Configurations, Accuracy & Repeatability, Robot specifications, End effectors, *Kinematics and Dynamics of a 2-link Manipulator,* Characteristics of Robot applications, Robot cell design, Types of Robot applications.

## IM 409 MANUFACTURING ENGINEERING PROJECT

Selected problems requiring design, manufacturing, development of problem specific software, preparation of drawings, fabrication of prototype / models and laboratory experimentation shall be assigned to individual students or groups of students. Grading shall be based on the reports produced by individual students and their critical evaluation through an oral examination.

## IM 411 METHODS ENGINEERING

***Work Study:***

Introduction to work study, Techniques of work study and their relationship, Basic procedure of work study.

***Method Study:***

Definition; Objectives; Procedure; Process chart symbols; Outline process chart; Flow process charts; Multiple activity chart; Two handed chart; Critical Examination; Case studies & Application.

***Methods and movements at the workplace:***

General considerations, The principles of motion economy, Classification of movements, Re-organization of a workplace by means of a two-handed process chart, Micro-motion study, Simo chart, Use of films in methods analysis, The development of improved methods.

***Work Measurement:***

Definition; Objectives; Techniques of work measurement; Stop watch time study; Timing methods; Performance rating; Standard timing; Allowance factors. Work sampling; Confidence level; Determination of sample size; Making random observations; Scope of work sampling. Predetermined time standards; Definition; Advantages and criticisms; Motion classification; TMU; Use of PTS systems.

***Ergonomics:***

Human and working environment 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.

## IM 413 PLANT ENGINEERING

***Thermal Power Plants:***

Basic principles and cycles used; Steam power plants; Diesel power plants; gas power plants; combined heat and power generation.

***Internal Combustion Engines:***

Basic Internal Engine Types: Spark ignition engines; Compression Ignition engines; speed and load control; supercharging. Idealized cycle and processes; Otto cycle; Diesel cycle. Fuels, high and heavy fuel oil.

***Steam Generators and Turbines:***

Properties of Steam; Enthalpy and entropy diagram; Rankine cycle, Steam Power Plant: Boilers; Feedwater pump; Air Pre-heaters; Economizers; Super-heaters; Condensers. Boiler Types: Fire tube and water tube designs. Steam turbines; impulse and reaction types; back-pressure and extractive turbines.

***Air-conditioning and Ventilation:***

Principles of air-conditioning; Comfort and industrial air-conditioning; refrigeration equipment; primary and secondary refrigerants; ventilation equipment. Psychometric chart and its use; calculation of the simple air-conditioning system. Temperature and humidity control; pneumatic, electric and hydraulic systems.

## IM 414 INDUSTRIAL SAFETY & ENVIRONMENT

***Safety Management:***

Understanding accident and hazard, Hazard control and loss control, Company policy and management responsibilities, Direct and indirect cost, Accident causes and their control, Principles and processes of lost control, Knowledge of existing safety codes and standards.

***Accident Prevention and Control:***

Fire safety, Electrical Safety, Safety in boilers and unfired pressure vessels and high pressure systems, Safety in material handling and storage, Safety in production operations (hand portable power tools, Wood working machinery, welding and cutting, metal working machinery, cold and hot forming of metals, automated lines system and processes).

***Process Safety Management:***

Development of facility operation and procedures, Analysis of process hazard, Permit to work systems, Hazard communication (Material safety data sheet), Chemical inventory record, Accident reporting and investigation, Ensuring mechanical integrity,

***Industrial Hygiene and Workers Protection:***

Understanding industrial hygiene, Various hazards encountered in workplace, Types of personal protective equipment (PPE), Availability in market their design standards and selection criteria.

***Environment Management:***

Environment pollution, Air emission management, Waste management, Waste water treatment and control, Soil and ground water protection, Introduction to Pakistan Environment Protection Act 1997 and National Environmental Quality Standards, Key elements of ISO 14000.

## IM 415 APPLIED HEAT TRANSFER

***Introduction****:*

Modes of heat transfer, conservation of energy.

***Conduction Heat Transfer****:*

Fourier's law, thermal conductivity, 3-d heat diffusion equation and its 1-d and 2-d simplifications. Application of heat equation to plane walls, long cylinders and spheres. Extended surface heat transfer,

transient conduction, lumped capacitance method. Solution of 2-d conduction problems using Heisler Charts.

***Convection Heat Transfer:***

Newton's law of cooling, convection heat transfer coefficient, momentum and thermal boundary layer development, derivation of continuity, momentum and energy equations, dimensional analysis.

Dimensionless numbers, laminar and turbulent flow. Flow over flat plate, internal and external flow in tubes, empirical correlations for laminar and turbulent flows. Overall heat transfer coefficient; application in heat exchanger.

***Radiation Heat Transfer:***

Stefan-Boltzman Law, electromagnetic radiation, band spectrum, radiation properties, greenhouse effect, black and gray bodies, emissive power, radiation shape factors, radiation shields.

***Diffusion Mass Transfer:***

Fick's Law of diffusion, the mass diffusion equation, concentration boundary layer.

***Heat Transfer with Phase Change:***

Melting and solidification.

***Materials Processing and Manufacturing Applications:***

Surface heating and quenching. Die, sand and strip casting. Heat treatment of plates, cylinders and spheres. Welding, fibre melt spinning, laser heating, powder processing, crystal growth.

## IM 416 MANAGEMENT INFORMATION SYSTEMS

***Introduction;***

Overview of System and Sub-systems, Information Systems, Relevance of Information Systems to organizational decision making, Information Systems and Manufacturing Environment Responsibilities of an Industrial Engineer from MRP to ERP and beyond.

***Tools and Technologies;***

Data Flow Diagrams, Functional Flow Diagrams, System Flow Charting, UML Diagrams, Bar Coding Technology, RFIDs, Formal Documentation and Presentation Formats.

***Information and Data Base Management Systems;***

Data Handling Procedures, Database; their Types and Design Issues including Modeling (ER Diagram etc.) and Normalization, Data Base Management Systems, Data Base Software, Client-Server vs. Distributed

Computing, Methods of Data Collection, System Development Life Cycle (SDLC), Feasibility Study Considerations, Effects and Usages of Internet in Manufacturing Industry.

## MS 441 ADVANCED MATHEMATICAL TECHNIQUES

***Complex Variable:***

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

***Error Analysis:***

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

Use any Computational tools to Analysis the Numerical Solutions.

***Finite Difference:***

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

***Interpolation & Curve Fitting:***

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

***Numerical Integration & Differentiation:***

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

***Improper integrals:***

Definitions, Types of improper integral and their convergence.

***Elliptic Integrals:***

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