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DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING
M.E./MTech. I YEAR (MANUFACTURINGENGINEERING)

Semester- A

IP 82001: METAL CUTTING AND MACHINE TOOLS

Unit No.	NO. OF LECTURES	TOPICS COVERED
(Unit I)	2	Machining Processes and Machine Tools : Motions in Machine Tools
	2	Machine Tools using Single- point Cutting Tools : Single- Point Cutting Tools
	2	Lathe Machines, Vertical- Boring Machining (Vertical borer), Horizontal-Boring Machining (Horizontal borer)
	2	Shaping Machine (Shaper), Planning Machine (Planer)
	2	Machine Tools using Multi-Point Cutting Tools: Multi-Point Cutting Tools
	2	Drilling Machining, Horizontal-Milling Machine, Vertical-Milling Machine
	2	Broaching Machine, and Taps and Dies
	2	Machines Tools Using Abrasive wheels: Abrasive wheels, Horizontal-spindle Surface Grinding Machine
	2	Vertical – Spindle Surface Grinding Machine, Cylindrical-Grinding Machine
	2	Internal Cylindrical- Grinding Machine, and Centreless Grinding Machines
(Unit II)	2	Mechanics of Metal Cutting : Chipping action
	2	Cutting parameters : Orthogonal and Oblique cutting
	1	Mechanism and Types of chips : Cutting forces and stresses
	2	Power and Energy : Heat and Temperature
	1	Mechanics of Turning, Drilling and Milling
(Unit III)	1	Cutting Tool Technology, Chip Control and Economics
	2	Tools Materials
	2	Tool Geometry, Tool Life
	1	Cutting fluids, Economics of Metal Cutting Processes
	2	Surface Roughness Numericals
(Unit IV)	1	Abrasive Machining – Grinding and Finishing
	2	Mechanics of Metal Grinding, Grinding Wheel, its specification, and Chip Formation
	2	Grinding Forces and Power, Grinding Temperature
	1	Conventional Abrasive Finishing Processes (CAFP)
	1	Honing, Lapping, Buffing and Super finishing
(Unit V)	2	Introduction to Conventional Micromachining
	2	Need and Classification
	2	Process Principles and Application of Conventional Micromachining
	1	Abrasive Micromachining
Total	**40**	

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Semester- A

IP 82002: ADVANCED MACHINING PROCESSES

Unit No.	NO. OF LECTURES	TOPICS COVERED
(Unit I)	2	Introduction of Advanced Machining Processes, importance, and their classification
	1	Principles of Abrasive Jet Machining (AJM), its process parameters, applications & limitations
	2	Evaluation of material removal rate (MRR) due to AJM of brittle and ductile materials
	1	Ultrasonic Machining principles, process parameters, transducers, tool feed mechanism, applications & limitations
	2	Mechanics of material removal, evaluation of MRR, Effect of parameters, Economic considerations, and Horn design
(Unit II)	2	Chemical machining types, basic principles, applications and limitations
	2	Chemical milling, chemical engraving, chemical blanking, and their process parameters
	1	Classification of Electro-chemical Machining (ECM), fundamental principles, evaluation of MRR
	2	Dynamics and hydrodynamics of ECM, choice of electrolytes
	1	Fundamental principles of Electrochemical grinding, process parameters, Electrochemical deburring, and honing
(Unit III)	2	Mechanisms of material removal due to Electrical discharge machining, basic circuitry, evaluation of MRR,
	2	basic circuitry, evaluation of MRR,
	2	Machining accuracy, surface finish,
	2	tool material, dielectric fluid, applications & limitations
(Unit IV)	1	Basic principle of material removal due to Laser beam machining (LBM),
	1	thermal analysis, cutting speed, accuracy, applications & limitations, introduction of Micro-drilling by laser beam
	2	Basic principle and process capability of Electron beam machining
	2	Mechanics of material removal due to Plasma arc machining, non-thermal generation of plasma,
	2	various parameters, accuracy, surface finish and applications,
(Unit V)	1	Introduction and classification of Hybrid machining processes
	1	Working principles and processes parameters of Electrical discharge diamond grinding and
	2	Ultrasonic assisted electrical discharge machining
	2	Working principles and processes parameters of Electrolytic magnetic abrasive machining and
	2	Electrochemical discharge grinding
Total	**40**	

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Semester- A

IP 82003: COMPUTER AIDED MANUFACTURING (CAM)

Unit No.	NO. OF LECTURES	TOPICS COVERED
(Unit I)	2	Introduction to Control, Open Loop and Closed Loop Control Systems, Drives and Controls Interpolators for CNC Machine Tools
	1	Numerical Control, Types of CNC Systems.
	1	Feedback Devices: Resolvers, Encoders, and Inductosyns
	2	Sensors; Actuation Systems: Hydraulic, Pneumatic and Electromechanical fibers
	2	Computer Control and Adaptive Control System: CNC, DNC and AC.
(Unit II)	2	Components of NC/CNC System, Specification of CNC System, Classification of NC/CNC Machines, Tape
	2	Tape Codes and Tape Readers used in NC Machines Constructional Details of CNC Machines, Axis Designation, NC/CNC Tooling
	1	Fundamentals of Manual Part Programming, Types of Format, Word Address Format Manual Part Programming for Drilling,
	2	Turning and Milling Operations, Subroutines, Do Loops, Canned Cycles, and Parametric Subroutines
	1	Computer Assisted Part Programming: Need List of Computer Assisted Programming Languages
	1	Automated Programmed Tools Language: Its Types of Statement
(Unit III)	1	Introduction of FMS, Need of FMS, General Considerations for FMS,
	1	Types of FMS, Flexibilities, their Measurements, Various Mathematical Techniques for Flexibility Measurements
	1	Computer Aided Process Planning (CAPP): Types of Process Planning System, Advantages of CAPP
	1	Manufacturing Cells, Cellular v/s Flexible Manufacturing,
	1	Just-In-Time and Group Technology to FMS.
(Unit IV)	1	Basic Information of CIMS, Hardware and Software requirement for CIMS, Benefits, Scope and Needs
	2	CIMS Wheel, Elements of CIMS and their Role, Computer Technology and Manufacturing
	1	Database Requirement, Fundamentals of Communication
	2	Data Base Management, Database Models, DBMS Architecture, SQL, Steps to Implement CIM, Its Management, Personnel, Emerging Technologies like Expert Systems
	1	Computer vision, Lasers in Manufacturing (Machinery and Metrology)
	1	Multimedia Communications, etc. CAD/CAM Integration, Programming, Post Processors
(Unit V)	1	Use of Computers in QC, Computer Aided Inspection (CAI)
	1	Contact Inspection Methods, In-Process- Gauging
	1	Online Inspection and Quality Control,
	1	Machine Vision System,
	2	First apply failure theory, Computer Aided Testing (CAT).
Total	**40**	

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Semester- A

ME 82204: COMPOSITE MATERIALS

Unit No.	NO. OF LECTURES	TOPICS COVERED
(Unit I)	2	Classification and use: Classifications of Engineering, Materials, Concept of composite materials, Matrix materials
	1	Functions of a Matrix, Desired Properties of a Matrix
	1	Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix
	2	Carbon Matrix, Glass Matrix etc, Types of Reinforcements/Fibers: Role and Selection or reinforcement materials, Types of fibres, Glass fibers
	2	Carbon fibers, Aramid fibers, Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz, and Silica fibers
	1	Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres
	2	Material properties that can be improved by forming a composite material, and its engineering potential
(Unit II)	1	Processing of Composite Materials: Overall considerations, Autoclave curing
	2	Other Manufacturing Processes like Lay-up process, Spray up process, filament placement process, resin transfer moulding
	2	Vacuum assisted resin transfer moulding, filament winding, compression molding, sheet moulding
	2	Injection, Moulding, Extrusion, Blow moulding, rotational moulding, Pultrusion, pre-peg layer etc
	1	Manufacturing of Metal Matrix Composites: Layer composites and infiltration method
	1	Manufacturing of Ceramic matrix composites: Hot isostatic processing
(Unit III)	1	Fiber volume fraction
	1	micro-mechanical relations
	1	determination of strength and stiffness
	1	Environmental effects-Hygro-thermal behavior
	1	Selection of tooling
(Unit IV)	1	Basic stress-strain relationships for anisotropic materials
	2	Engineering constants for orthotropic materials
	1	stress-strain relations for a lamina of arbitrary orientation
	2	effective moduli, invariant properties of anorthotropic lamina, special cases of laminate stiffness
	1	laminate strength analysis
	1	concept of inter-laminar stresses and delamination
(Unit V)	1	Failure mechanisms, maximum stress theory
	1	Maximum strain theory, Tsai- Hill theory
	1	Tensor polynomial failure criterion
	1	First ply failure theory
	2	Introduction to damage theory based on continuum damage mechanics
Total	**40**	

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Semester- A

ME 82453: FINITE ELEMENT METHOD

UNIT NO.	NO. OF LECTURES	TOPICS COVERED
(Unit I)	2	Background and Solution to engineering Problems, Mathematical Modeling
	2	Discrete and continuum modeling, Need for Numerical methods of solution
	2	Discrete approach based problems
	2	Basic steps in FEM Formulation
	2	Resistance Network and Truss Systems
(Unit II)	2	Element Matrices and Global Matrix
	2	Imposition of Boundary Condition
	2	Solution of FE Equations using Gauss Elimination based Solvers
	2	Post processing, Convergence requirements
	2	Natural Coordinates and Numerical Integration
(Unit III)	2	Formulation using Galerkin and Raleigh-Ritz Approaches
	2	Derivation of Elemental Equations and their Assembly
	2	Imposition of Boundary Conditions
	2	Solution and its Post Processing
(Unit IV)	2	Plain strain and plain Stress Solid Mechanics Problems
	2	Sub-Parametric, Iso-Parametric and Super-Parametric Elements
	2	Elements with C1 continuity
(Unit V)	2	Eigen value and Time Dependent Problems
	2	Discussion about Pre-Processors
	2	Postprocessors and Finite Element Packages
Total	**40**	

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Semester- B

IP 82501: RAPID PROTOTYPING AND TOOLING

Unit No.	NO. OF LECTURES	TOPICS COVERED
(Unit I)	1	Introduction: Classification of Additive Manufacturing Processes
	1	Additive Manufacturing Based Rapid Prototyping Systems: Stereo-Lithography
	1	Fused Deposition Modeling (FDM)
	1	Selective Laser Sintering (SLS)
	1	Laminated Object Manufacturing (LOM)
	1	3-D Printing, LENS etc.
(Unit II)	2	Role of Additive Manufacturing in Product Design and Development
	2	Role of Rapid Prototyping in Product Design and Development
	2	Solid Modeling Techniques for Additive Manufacturing
	2	Comparison of solid modeling technique with other additive manufacturing techniques
	1	Advantages and Disadvantages of additive manufacturing
(Unit III)	2	Process Planning for Rapid Prototyping
	2	STL File Generation Defects in STL Files
	2	STL File Repairing Algorithms,
	2	Slicing and Various Slicing Procedures
(Unit IV)	1	Accuracy Issues in Additive Manufacturing
	2	Properties of Metallic and Non-Metallic Additive Manufactured Surfaces
	2	Stress Induced in Additive Manufacturing Processes
	2	Surface Roughness Problem in Rapid Prototyping,
	3	Part Deposition Orientation and Issues Like Accuracy, Surface Finish, Build Time, Support Structure, Cost etc.
(Unit V)	1	Introduction to Rapid Tooling Techniques
	2	Laminated Metallic Tooling
	2	Direct Metal Laser Sintering
	2	Vacuum Casting
Total	**40**	

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Semester- B

IP 82512: CASTING AND FORMING PROCESSES

Unit No.	NO. OF LECTURES	TOPICS COVERED
(Unit I)	1	Introduction of Metal Casting: Classification of Casting Processes
	1	Solidification: Solidification of Pure Metals and Al1oys
	1	Nucleation and Growth in Alloys, Solidification of Actual Castings
	1	Progressive and Directional Solidification,
	1	Centerline Feeding Resistance, Rate of Solidification, Chvorinov's Rule
	1	Electrical Analogy of Solidification Problem; Fluidity- Measurement of Fluidity
	1	Effects of Various Parameters on Fluidity
(Unit II)	1	Riser Design, Risering Curves, NRL Method of Riser Design
	1	Feeding Distance, Risering of Complex Casting, Risering of Alloys Other than Steel
	1	Recent Developments in Riser Design by the Application of GeometricalProgramming
	1	Gating System Design and their Characteristics
	1	The Effects of Gates on Aspiration, Turbulence and Dross Trap, Recent Trends
	2	Pattern and Casting Design: Pattern Design, Recent Developments in Pattern Design
	2	Materials and Construction; Casting Design Considerations- Review of Casting Design, Recent Trends.
(Unit III)	2	Low Pressure and Ferrous Die Casting, High Pressure Moulding, Full Mould Process
	1	Flask less Moulding, Hot and Cold Box Moulding, Ceramic Shell Moulding
	1	Casting Defects: Residual Stresses, Hot Tears and Cracks, Stress Relief, Defects and their Causes and Remedies, Parameters Affecting Surface Finish
	1	Inspections: Testing of Sand, Mulling Index, Moldability Index, Compactability
	2	Deformability; Review of X-Ray and Gamma Ray Radiography, Magnetic Particle, Die Penetrant and Ultrasonic Inspection etc.
	1	Advanced Casting Processes: Evaporative Pattern Casting, Vacuum Mould Casting, Investment Casting Process
	1	Continuous Casting, Squeeze Casting, Ceramic Shell Casting
(Unit IV)	1	Introduction of Forming and Process analysis: Stress/Strain, Strain-Rate, Yield Criteria of Metals and Theories of Failure,
	1	C1assification of Metal Forming, Formability
	1	Theories of Friction and Lubrication
	1	Process Analysis: Analysis of Metal Working Processes,Slipline Field Theory
	1	Upper Bound Solution, and Stab Methods
(Unit V)	1	Rolling: Determination of Rolling Pressure, Roll Separating Force, Driving Torque and Power, and Power Loss in Bearings
	1	Forging: Determination of Forces in Strip Forging and Disc Forging
	1	Drawing- Determination of Force and Power, Determination of Maximum Allowable Reduction
	1	Deep Drawing Force Analysis, Analysis of Tube Drawing Process with Fixed and Moving Mandrel, Tandem Tube Drawing;
	2	Extrusion: Determination of Work Load from Stress Analysis and Energy Consideration, Power Loss, Hydrostatic Extrusion;
	1	Bending: Determination of Work Load and Spring Back;
	2	Punching and Blanking: Mode of Metal Deformation and Failure, Two-Dimensional Deformation Model and Fracture Analysis, Determination of Working Force
	1	Advanced Metal Forming Processes: High Energy Rate Forming (HERF), Electro-Magnetic Forming, Explosive Forming
	1	Electro-Hydraulic Forming, Stretch Forming, And Contour Roll Forming
Total	**40**	

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Semester- B

IP 82513: WELDING TECHNOLOGY

Unit No.	NO. OF LECTURES	TOPICS COVERED
(Unit I)	1	EvolutionofWelding,ClassificationofWeldingProcesses
	1	Heat Sources and Shielding Methods
	1	Physics of Welding and Selection of Welding Power Sources
	1	Type of Welds and Weld Joints
	1	Description of Welds: Terminology and Definitions
	1	Weld Symbols, Edge Preparation
(Unit II)	1	Consumable Electrode Welding Processes: Introduction and classification
	1	Manual Metal Arc (MMA) Welding, Gas Metal Arc Welding
	1	Pulsed MIG Welding, Submerged Arc Welding
	1	Significance of Flux-Metal Combination, Electroslag Welding
	1	Non-consumable electrode welding; Introduction and classification
	2	Gas Tungsten Arc Welding: Working Principle and applications
	2	Plasma Arc Welding: Working Principle and applications
	1	Transferred and Non-Transferred Plasma Arc Welding
(Unit III)	1	Introduction to Resistance welding, Arc generation
	2	Spot welding, Seam welding and Stud welding with their applications
	2	Friction Welding Process Variables, Welding of Similar and Dissimilar Materials, Friction Welding of Materials with Inter Layer.
	1	Friction Stir Welding: Processes Parameters, Tool Geometry
	1	Friction Stir Welding of Aluminium Alloys and Magnesium Alloys, Microstructure Analysis.
	1	Advanced Welding Processes: Introduction and working principle
	2	Details of Electron Beam Welding (EBW), Laser Beam Welding (LBW), and Ultrasonic Welding (USW).
(Unit IV)	1	Testing and Inspection of Weld Joints: Introduction and types
	1	Chemical Tests, Metallographic Tests, Hardness Tests
	1	Mechanical Test For Groove and Fillet Welds - Full Section, Reduced Section and All-Weld-Metal
	2	Tensile Tests, Root, Face and Side Bend Tests, Fillet Weld Break Tests, Creep & Fatigue Testing
	1	Non-Destructive Testing of Weldment: Visual Inspection, Magnetic Particle Inspection
	1	Dye-Penetrant Inspection, Ultrasonic Inspection: Principle of Ultrasonic Testing
	1	Radiographic Inspection - Principle of Radiography, X-Ray Tubes, Gamma-Ray Sources.
(Unit V)	1	Solidification of Weld Metal; Heat Affected Zone (HAZ), Factors Affecting Properties of HAZ
	2	Gas-Metal, Slag-Metal and Solid State Reactions in Welding and their Influence on Soundness of Weld Joint
	1	Definition of Weldability, Factor Affecting the Weldability of Steel Carbon Equivalent
	1	Weldability of Steel, Cast Iron and Aluminium Alloys of Commercial Importance
	1	Failure Analysis of Welded Joints.
Total	**40**	

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Semester- B

ME 82504: MATERIALS AND METALLURGY

Unit No.	NO. OF LECTURES	TOPICS COVERED
(Unit I)	1	Introduction to Structure of Materials: Classification and Selection of Engineering Materials
	1	Primary and Secondary Bonds; Crystalline and Non-crystalline materials
	2	Crystal Structure, Space Lattice, Unit Cell, Crystal Systems, Atomic Packing Factor, Co-Ordination Numbers, Crystal Structure for Metallic Elements
	1	Crystal Directions and Planes, Miller Indices, Stacking Sequence in HCP & FCC
	2	Crystal Defects and Non-crystalline Structure; Mechanisms of Plastic Deformation, Slip and Twinning
	2	Cold, Warm and Hot Working of Metals, Strain Hardening.
(Unit II)	1	Types of Phase Changes, Diffusion in Solids, Nucleation and Growth Kinetics
	1	Solidification, Pearlitic, Martensitic and Bainitic Transformation
	2	Recovery, Recrystallization and Grain Growth, Solid Solutions, Solubility Limit
	2	Effect of AlloyElements on Phase Diagram, Phase Rule, Binary Phase Diagrams
	1	Isomorphous System, Intermediate Phases, Intermetallic Compounds
	1	Iron-Iron Carbide Phase Diagram
(Unit III)	2	Heat Treatment of Steels, TTT Diagram, CCT Diagram;
	2	Annealing, Normalizing, Hardening and Tempering
	2	Austempering, Martempering, Hardenability
	2	Precipitation and Age Hardening, Case Hardening, Carburizing, Nitriding, Cyaniding, Carbonitriding
	1	Flame & Induction Hardening, Vacuum & Plasma Hardening.
(Unit IV)	3	Advanced Material and Tools: Smart Materials Exhibiting Ferroelectric, Piezoelectric, Optoelectric, Semiconducting Behavior, Lasers, and Optical Fibres
	2	Photoconductivity and Superconductivity, Nano Materials, Biomaterials
	2	Superalloys, Bearing alloys, Shape Memory Alloys
	2	Composites and its Applications: MMCs, CMCs & PMCs
	2	Metallography (Optical, TEM, and SEM), X Ray Diffraction, Mechanical Properties, Thermal analysis.
(Unit V)	1	Extractive Metallurgy: General Methods of Extraction
	2	Pyro-Metallurgy; Calcinations, Roasting and Smelting
	2	Hydrometallurgy; Leaching, Solvent Extraction, Ion Exchange, Precipitation
	1	Electrometallurgy; Electrolysis and Electro-Refining
Total	**40**	

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Semester- B (Elective-I)

IP 82201: EXPERIMENTAL DESIGN, DATA ANALYSIS AND QUALITY CONTROL

Unit No.	NO. OF LECTURES	TOPICS COVERED
(Unit I)	1	Introduction and Basic Statistical Concepts: Strategy of Experimentation, Typical applications of Experimental design
	1	Basic Principles: Randomization, Repetition, Replication, Blocking, and Confounding
	2	Guidelines for Designing Experiments; Concepts of Random Variable, Probability, Density Function, Cumulative Distribution Function; Sample and Population
	1	Measure of Central Tendency and dispersion: Mean, Median, Mode, Standard Deviation, Variance, and Measures of Variability; Concept of Confidence Level
	1	Statistical Distributions: Poisson, Gauss, Normal, Log Normal, & Weibull Distributions
	2	Other Continuous Probability Distributions (t-Distribution, Chi-squared Distribution, & F-Probability Distribution)
	1	Hypothesis Testing, Probability Plots, Choice of Sample Size
(Unit II)	1	Experimental Design: Classical Experiments, Terminology: Factors, Levels, Interactions, Treatment Combination
	1	Completely Randomized Design, Randomized Block Design,
	1	Latin Square Designs; Factorial Experimental Designs
	1	Two-level Experimental Designs for TwoFactors & Three Factors
	1	Three-level Experimental Designs for Two Factors & Three Factors
	2	Factor Effects, Factor Interactions, Fractional Factorial Design, Saturated Designs, Central Composite Designs
(Unit III)	1	Analysis and Interpretation Methods: Measures of Variability, Ranking Method
	1	Column Effect Method & Plotting Method
	2	Analysis of Variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis
	1	Fitting Regression Models: Linear Regression Models
	2	Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression,
	1	Prediction of New Response Observations, Regression Model Diagnostics
	1	Testing for Lack of Fit, and Model Adequacy Checking
(Unit IV)	1	Introduction to Response Surface Methodology
	1	The Method of Steepest Ascent, Analysis of a First & Second Order Response Surfaces
	1	Experimental Designs for Fitting Response Surfaces
	1	Designs for Fitting the First & Second Order Models.
(Unit V)	2	Quality by Experimental Design: Quality, Western and Taguchi's Quality Philosophy
	2	Elements of Cost, Noise Factors Causes of Variation, Quadratic Loss Function & Variations of Quadratic Loss Function
	2	Linear graphs and Interaction assignment, Types of Orthogonal Arrays, Selection of Standard Orthogonal Arrays
	2	Evaluation of Sensitivity to Noise, Signal to Noise Ratios for Static & Dynamic Problems
	2	Robust Design: Steps in Robust Design, Parameter Design and Tolerance Design
	1	Reliability Improvement through Experiments
Total	**40**	

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Semester- B(Elective-II)

ME 82701: MECHATRONICS AND AUTOMATION

Unit No.	NO. OF LECTURES	TOPICS COVERED
(Unit I)	1	Introduction: Definition of mechatronics
	2	Mechatronics in Manufacturing, Products and Design
	2	Review of Fundamentals of Electronics
	1	Open Loop and Closed Loop Control Systems
(Unit II)	1	Mechatronics Elements: Feedback Devices
	1	Introduction of Sensors and Transducers, Performance Terminology,
	2	Displacement, Position and Proximity, Velocity and Motion, Fluid Pressure
	2	Temperature Sensors, Light Sensors, Selection of Sensors, Micro-Sensors, Signal Processing
	2	Servo Systems; Data Conversion Devices, Signal Processing Devices,
	2	Relays, Contactors and Timers
(Unit III)	2	Processors /Controllers: Microprocessors
	2	Microcontrollers
	2	PID Controllers and PLCs
(Unit IV)	1	Electro-Mechanical System: Drives and Their Controlling
	3	AC Motors, DC Motors, Stepper Motors, Servo Motors
	1	Ball Screws, Linear Motion Bearings
	2	Cams, Systems Controlled by Camshafts, Electronic Cams
	1	Indexing Mechanisms
	2	Tool Magazines, and Transfer Systems.
(Unit V)	2	Electro-Hydraulic System: Hydraulic Systems: Flow, Pressure and Direction Control Valves
	2	Actuators, and Supporting Elements, Hydraulic Power Packs, Pumps, Design of Hydraulic Circuits
	2	Electro-Pneumatic System: Pneumatics: Production, Distribution and Conditioning of Compressed Air
	2	System Components and Graphic Representations, Design of Systems.
Total	**40**	

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(Semester- A)

IP 8XXXX: RESEARCH METHODOLOGY

Unit No.	NO. OF LECTURES	TOPICS COVERED
(Unit I)	2	Introduction to Research: Objectives, Significance, Types of Research, Motivation in Research
	2	Research Approaches, Research Methods v/s Methodology
	2	Research and Scientific Methods, Research Process. Criteria of Good Research,
	1	Ethical issues in Research
	1	Problem encountered by researchers in India1
(Unit II)	1	Defining the Research Problem: Concept and need, Identification
	1	Defining of Research problem, Sampling Design
	2	Characteristics Types and Measurement in Research, Scaling Techniques
	1	Research Design: Need, Features of Good Design
	1	Concepts and Types of Research design
	2	Principles of Experimental Design, Developing a Research Plan
(Unit III)	1	Tools for Data Collection: Collections of Primary Data and Secondary Data
	1	Method for data collection, Data Sources
	1	Importance of Literature Review in defining a problem
	2	Guidelines for constructing Questionnaire, Interviewing, Survey and Experiment
	1	Reliability and Validity of Research tools, MCDM Techniques
	1	Approaches to qualitative and quantitative research
	1	Case study research
	1	Visual aids in qualitative data analysis
(Unit IV)	1	Sampling: Sampling theory, Sample size, concept of hypothesis and its testing
	2	Analysis of Variance (ANOVA)- concept principle and techniques
	2	Analysis of covariance (ANCOVA) and techniques, assumption in ANCOVA
	1	Chi Square test and its steps
	1	Relationship between chi square and phi correlation
	1	Statistical software- SPSS, SYSTAT
(Unit V)	1	Interpretation of Data and Report Writing – Research Report Format, analyzing data and presenting results, Tables, and figures
	1	Layout of a Research Paper, Journals in Industrial Engineering
	2	Impact factor of Journals, Reference Management Software such Zotero/Mendeley
	1	Citation of references and bibliography
	1	Software for paper formatting like LaTeX/MS Office/Endnote
	1	Software for detection of Plagiarism, IPR
Total	**40**	