Curriculum Structure and Syllabus

for

M.Tech

in

Mechanical Engineering

(R25 Regulation)

Specialization with

Manufacturing Engineering

A.Y 2025-26

Department of Mechanical Engineering
National Institute of Technology Andhra Pradesh
Tadepalligudem, West Godavari Dist., 534 101
Andhra Pradesh (INDIA)

Course Structure
M.tech - Mechanical Engineering 2025-26

Distribution of Total Credits:

Semester	Core Subjects	Dept. Elective	Open * Elective (MOOCs)	Humanities elective course (T/P)	Labs.	Total
I	3 (3*3 = 9)	1 (1*3 =3)	1* (1*2 = 2)	-	1 (1*2=2)	**16**
II	3 (3*3=9)	1 (1*3=3) + (1*2=2) Total = 5	-	1 (1*2=2)	1 (1*2=2)	**18**
III	Dissertation Part-A					**13**
IV	Dissertation Part-B					**13**
	Total					**60**

I - Semester

Code No.	Subject Name		L-T-P	Cr.
25ME625	Metal Forming Technology		3-0-0	3
25ME626	Casting and Welding Technology		3-0-0	3
25ME627	Computer Aided Manufacturing		3-0-0	3
Department Elective-1				
	25ME628	Geometric Dimensioning and Tolerancing	3-0-0	3
	25ME629	Composite Science and Technology		
	25ME630	Design for Manufacture & Assembly		
	25ME631	Industrial Tribology		
	25ME632	Optimization Techniques in Manufacturing		
	25ME633	Geometric Modeling		
	25ME634	Characterization of Materials		
Open elective (MOOCs) * For example, few MOOC courses are given below				
	Online code	Artificial Intelligence Search Methods For Problem Solving	2-0-0	2
	Online code	Data Science for Engineers		
	Online code	Introduction to Machine Learning (IITM)		
	Online code	Business Analytics & Text Mining Modeling Using Python		
	Online code	Entrepreneurship Essentials		
	Online code	Drones systems and control		
25ME635	CAD/CAM/CAE Laboratory		0-0-2	2
Total				**16**

*In open elective apart from given subjects a student can select any other MOOC course listed in Swayam website (https://swayam.gov.in/) and the selected MOOC course must not be identical to or overlap with any course listed in the regular MTech curriculum.

II- Semester

Code No.	Subject Name		L-T-P	Cr.
25ME636	Subtractive Manufacturing		3-0-0	3
25ME637	Additive Manufacturing		3-0-0	3
25ME638	Mechatronics and Robotics		3-0-0	3
Department Elective – II				
	25ME639	Product Design and Development	3-0-0	3
	25ME640	Reverse Engineering		
	25ME641	Design of Experiments		
	25ME642	Tool Design Engineering		
	25ME643	Processing and Design of Materials		
	25ME644	Laser Processing of Materials		
	25ME645	Manufacturing Planning and Control		
Department Elective – III				
	25ME646	Automation and Control	2-0-0	2
	25ME647	Quality Engineering & Management		
	25ME648	Industrial Machine Vision		
	25ME649	Nanoscience and Technology		
	25ME650	Micro-Electro-Mechanical-Systems (MEMS)		
25HS601	Advanced Technical Communication (T/P)		2-0-0	2
25ME651	Mechatronics and Robotics Laboratory		0-0-2	2
Total				**18**

III- Semester

Code No.	Subject Name	L-T-P	Cr.
25ME698	Dissertation –Part A	0-0-26	13
Total			**13**

IV- Semester

Code No.	Subject Name	L-T-P	Cr.
25ME699	Dissertation-Part B	0-0-26	13
Total			**13**

25ME625 **Metal Forming Technology**

Syllabus

Engineering Materials: Classification of materials, Phase diagrams of metals, Heat Treatment.

Essentials of Metal Forming: Classifications and mechanism of metal forming, effect of temperature of metal working, hot working, cold working. Tribology in metal forming and other phenomena (friction and lubricants), Analysis of forming – Lower and Upper bound Analysis, slip line field methods.

Forging: Classification of forging processes, forging of plate, forging of circular discs, open die and closed-die forging, forging defects, and powder metallurgy forging.

Rolling of metals: Rolling processes, forces and geometrical relationship in rolling, simplified analysis, rolling load, rolling variables, theories of cold and hot rolling, problems and defects in rolling, torque and power calculations.

Extrusion & Drawing: Classification, Hot Extrusion, Analysis of Extrusion process, defects in extrusion, extrusion of tubes, and production of seamless pipes. Drawing of tubes, rods, and wires: Wire drawing dies, tube drawing process, analysis of wire, deep drawing and tube drawing.

Sheet Metal forming: Conventional processes, Forces in circular cup drawing, Redrawing, drawing of tubes from annular sheet dies, forming limit diagram, forming with hydrostatic pressure, Explosive forming, electrohydraulic forming, magnetic pulse forming, Forming limit criteria, defect in formed parts, principles and process parameters- Advantages -Limitations and Applications.

Vacuum holding devices: Basic principles, types of devices (such as vacuum chucks, suction cups, and grid plates), key components like vacuum pumps and seals, and their industrial applications in CNC machining, robotics, and delicate material handling.

Advanced Metal Forming Processes: HERF (High Energy Rate Forming), Electromagnetic forming, hydro forming technology, residual stresses, in-process heat treatment, and computer applications in metal forming.

Powder metallurgy: Introduction and feature of powder metallurgy processes. Advanced solidification techniques: directional solidification, single crystal growth and levitation melting.

Text Books:

1. Fundamentals of Metal Forming Processes, B.L. Juneja, International Publishers, New Age Second edition, 2018.
2. Metal Forming: Technology and Process Modelling, U.S. Dixit and R. Ganesh Narayanan McGraw-Hill Education, 2013.
3. Mechanical Metallurgy, Dieter, Mc Graw Hill.

Reference Books

1. An Introduction to Principles of Metal Working, G.W.Rowe
2. Metal Forming: Processes and Analysis, Avitzur (TMH)
3. Principles of Metal Working, Sunder Kumar

25ME626 **Casting and Welding Technology**

Syllabus*:*

Principles of Metal Casting: Pattern Making, Mould and Core Materials, Moulding, Core Making, Gating System and Risers, Metal Melting and Pouring, Shakeout and Cleaning of Castings, Foundry Mechanization and Management, Shell Mould Casting, Investment Casting, Pressure Die Casting, Centrifugal Casting, Continuous Casting, Miscellaneous Special Casting Processes. Solidification and Cooling of Castings, Casting Defects, Principles of Casting Design.

Principles of Metal Joining: Classification, structure and characteristics of welding arc, arc blow, methods of arc initiation and maintenance, arc stability, arc welding power sources, duty cycle, metal transfer.

Different Welding Processes: Shielded Metal Arc Welding (SMAW), Submerged Arc Welding (SAW), Gas Tungsten Arc Welding (GTAW/TIG), Gas Metal Arc Welding (GMAW), Electro-slag and Electro-gas welding, Resistance welding, Solid-state welding processes, Ultrasonic, Electron beam welding, Laser welding, Plasma arc welding, Thermit welding, Weld defects. Brazing and soldering, adhesive bonding.

Friction Stir Welding: Introduction, Fundamental principles Comparison with conventional welding techniques, working principle, Material flow and heat generation mechanism.

Friction Stir Processing: Concept and comparison with FSW**,** Objectives: grain refinement, defect healing, property enhancement, surface modification and nano-composite fabrication, Materials suitable for FSW and FSP.

Welding Metallurgy: Heat flow in welding, Metallurgical transformation in and around weldment, Implication of cooling rates, Heat affected zone (HAZ), Weldability of plain carbon steels, Stainless steels, Cast iron, Aluminium and its alloys. Design of weldments, Joint design, Residual stresses and distortion, Testing of welded joints, Destructive Tests and Non-destructive tests (NDT).

Text Books:

1. Metal Casting and Joining, K. C. John, PHI Learning Pvt. Ltd., 2015.
2. Principles of Foundry Technology, P. L. Jain, 5th edition, TMH Publications, 2009.
3. Welding Processes and Technology, R. S. Parmar, 3rd Edition, Khanna Publishers, New Delhi, 2011.

References:

1. Principles of Metal Casting, Richard Heine, Carl Loper, Philip Rosenthal, TMH Publications, 2004.
2. Manufacturing Science, Ghosh and A. K. Mallik, East west press, 2006,
3. Manufacturing Processes for Engineering, Serope Kalpakjian and Steven R. Schmid. Pearson Education; Sixth edition, 2018.

25ME627 **Computer Aided Manufacturing**

Syllabus:

Computer Aided Manufacturing: Manufacturing Processes, Removing, Forming, Deforming and joining Integration equipments. Integrating CAD, NC and CAM Machine Tools Point to point and continuous path machining, NC, CNC and DNC NC Programming, Basics, Languages, G Code, M Code, APT Tool path generation and verification CAD/CAM NC Programming Production Control Cellular Manufacturing.

Computer Aided Process Planning: Role of process planning in CAD/CAM Integration Computer Aided Process Planning, Development, Benefits, Model and Architecture, CAPP Approaches Variant, Generative and Hybrid Process and Planning systems CAM-I, D-CLASS and CMPP Criteria in selecting a CAPP System.

Computer Aided Inspection: Engineering Tolerances, need for Tolerances, Conventional Tolerances, FITS and LIMITS, Tolerance Accumulation and Surface quality, Geometric Tolerances, Tolerances Practices in design, Drafting and manufacturing, Tolerance Analysis, Tolerance synthesis, Computer Aided Quality control, Contact Inspection Methods, Non-Contact Inspection Methods, Non optical.

Reverse Engineering: Scope and tasks of Reverse Engineering, Domain Analysis, Process Duplicating, Tools for RE, Developing Technical data, Digitizing techniques, Construction of surface model, Solid part model, Characteristic evaluation, Software's and its application, CMM and its feature capturing, surface and solid modeling.

Data Management: Strategies for Reverse Engineering Data management, Software application, Finding renewable software components, Recycling real time embedded software, Design experiments to evaluate a RE tools, Rule based detection for RE user interface, RE of assembly programs.

Text Books:

1. CAD/CAM Theory and Practice, Ibrahim Zeid and R. Sivasubramanian, Tata Mc Graw Hill Publication, 2007
2. CAD/CAM: Principles and Applications, P N Rao, Tata McGraw Hill, 3rd Edition, 2010.
3. Computer-Aided Design and Manufacturing, E. Zimmers, M. Groover, 1st Edition, 2003.

References:

1. Reverse Engineering, Linda Wills, Kluwer Academic Press.
2. Reverse Engineering, Catherine A. Ingle, Tata Mc Graw Hill Publication.
3. Computer Integrated Design and manufacturing, David D. Bedworth, Mark R. Henderson, Philp M. Wolfe, Mc Graw Hill International series.

Department Elective-1

25ME628 Geometric Dimensioning and Tolerancing (GD&T)

Syllabus:

Introduction to GD&T and Feature Control Frames: Geometric Dimensioning and Tolerancing, Maximum Material Condition, and Regardless of Feature Size. How to read a Feature Control Frame?

Size Control and Form Characteristics: Rules, concepts, Characteristics, and un-tolerance Dimensions.

Datum Features and Virtual Conditions: Datum's, The Maximum Material Condition symbol and its Ramifications, Relationship between Individual Feature's; Virtual Condition and Resultant Condition Boundaries.

GD&T Controls: Datum Feature of Size Representation; form Controls; Orientation Controls; Profile; Run out; Location.

Dimensional Tolerancing Strategy and Inspection Planning: A Logical Approach to part Tolerancing, Dimensioning and Tolerancing Schemes, Steps for the Development of a Dimensional Inspection Plan. Paper Gauging. Functional Gauging.

Text Books:

1. Measurement of Geometric Tolerancces in Manufacturing, James D Meadows, Marcel Dekker.
2. Geometric Dimensioning and Tolerancing, Gene R. Cogorno, Third Edition, 2023
3. Fundamentals of Geometric Dimensioning and Tolerancing, Alex Krulikowsk, Delmar Cengage Learning; 2012.

References:

1. GD&T: Application and Interpretation, Bruce A. Wilson, Goodheart-Willcox, 2019.
2. Geometric Dimensioning and Tolerancing, P S Gill, S.K. Kataria & Sons; 2013.
3. Geometric Dimensioning and Tolerancing: Applications and Techniques for Use in Design: Manufacturing, and Inspection, 2017

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25ME629 **Composite Science and Technology**

Syllabus:

Introduction to Composite Materials: Classification, reinforcement; Polymer matrix composites, Thermoplastic and thermosetting resins, Common matrix reinforcement system.

Polymer Matrix Composites (PMC): Concept of A stage, B stage and C stage resins; Particulate and fibre filled composites, Short fibre composites.

Continuous Fibre Composites and Mechanical Behavior: Theories of stress transfer; Continuous fibre composites, Failure mechanism and strength, Halpin- Tsai equations, Prediction of Poisson's ratio, Various failure modes.

Advanced Composites and Applications: Specialty composites, Composites for satellites and advanced launch vehicles, Design considerations, PMC- for structural composites, MMC- design, Silicon carbide composites; Carbon-Carbon composites, Matrix precursors, Manufacturing considerations.

Nanocomposites and Modern Developments: Nanocomposites, Nano particle dispersion in polymer matrix, Polymer-nanoclay and carbon nanotubes composites.

Design, Analysis, and Manufacturing of Composites Design: Analysis of composite structures macro mechanics, Micro mechanics, Laminate analysis, FE model and analysis, Manufacturing techniques- hand lay-up, filament winding, pultrusion, resin transfer molding, processing science of reactive polymer composites; Testing of composites, Raw material testing, NDT techniques.

Text Books:

1. Advanced Composites Manufacturing, T. G. Gutowski, John Wiley & Sons, New York.
2. Carbon Reinforcement and Carbon/Carbon Composites, E.Fitzer, L.M. Manocha, SpringerVerlag, Heidelberg, New York.
3. Nano Composite Science and Technology, P.M. Ajayan, L. Schadler, P.V. Braun Wiley VCH, 2003.

References:

1. Metal Matrix Composites, N. Chawla, K.K. Chawla, Springer-Verlag, 2006.
2. Ceramic Matrix Composites, K.K. Chawla, Kluwer Academic Publishers, 2003.
3. The Role of the Polymeric Matrix in the Processing and Structural Properties of Composite Materials J.C. Seferis, L. Nicolais, Plenum Press, New York.

25ME630 **Design for Manufacturing and Assembly**

Syllabus:

Introduction: Design for Manufacture and Assembly, History, Implementation of Design for Assembly, Design for Manufacture, Producibility Guidelines, Advantages of Applying DFMA during Product Design.

Selection of Materials and Processes: General Requirements for Early Materials and Process, Selection, Selection of Manufacturing Processes, Process Capabilities, Selection of Materials, Primary Process/Material Selection, Systematic Selection of Processes and Materials, Problems.

Design for Machining: Machining Using Single-Point Cutting Tools, Machining Using Multipoint Tools, Machining Using Abrasive Wheels, Standardization, Choice of Work Material, Shape of Work Material, Machining Basic Component Shapes, Assembly of Components, Accuracy and Surface Finish, Summary of Design Guidelines, Cost Estimating for Machined Components.

Design for Sheet Metalworking: Dedicated Dies and Press working, Press Selection, Turret Press working, Press Brake Operations, Design Rules.

Design for Die Casting: Die Casting Alloys, The Die Casting Cycle, Die Casting Machines Die Casting Dies, Finishing, Auxiliary Equipment for Automation, Determination of the Optimum Number of Cavities, Determination of Appropriate Machine Size, Die Casting Cycle Time Estimation, Die Cost Estimation, Assembly Techniques, Design Principles.

Design for Hot Forging: Characteristics of the Forging Process, The Role of Flash in Forging, Forging Allowances, Preforming During Forging, Flash Removal, Classification of Forgings, Forging Equipment, Classification of Materials, Forging Costs, Forging Die Costs, Die Life and Tool Replacement Costs, Costs of Flash Removal, Other Forging Costs.

Text Books:

1. Product Design for Manufacture and Assembly, Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight, 3rd Edition, CRC Press, 2010.
2. Manufacturing Processes for Engineering Materials, Kalpakjian, S., Schmid, S.R., 4th ed., Prendice-Hall, N.J., 2003.
3. Plastic Product Design, Beck, Ronald D., 2nd ed., Van Nostrand Reinhold, New York. 2020.

References:

1. Handbook of Products Design for Manufacturing: A Practical Guide to Low- cost Production, Bralla, James G., "McGraw Hill, New York.
2. Selection of Manufacturing Processes for Engineering Design, Farag, Mahmoud M., Prentice-Hall, London.
3. Processes & Materials of Manufacture, Linberg, Roy A., 4th ed., Allyn & Bacon, Boston, U.S.A.

25ME631 **Industrial Tribology**

Syllabus:

Surface topography: Characteristics of surface layers, Roughness parameters, Multi scale characterization of surface topography, Surface roughness measurement, Advanced techniques for surface topography evaluation, Contact of ideally smooth surfaces, contact of rough surfaces.
Types of wear and their mechanisms: Adhesive wear, Abrasive wear, Wear due to surface fatigue, wear due to chemical reactions, sliding contact between surface asperities, the probability of surface asperity contact, Wear in lubricated contacts, Rheological lubrication regime, Functional lubrication regime, Fractional film defect, Load sharing in lubricated contacts, Adhesive wear equation, Fatigue wear equation.
Lubrication and roughness: Introduction, Lubricants, Regimes of lubrication, Reynolds' equation, Applications of hydrodynamic lubrication theory, Hydrodynamic lubrication of roughened surfaces.
Tribology in manufacturing: Friction in manufacturing, Lubrication to control friction in manufacturing, solid lubrication, Tribology of rolling, drawing, extrusion and forging.
Sliding element bearings: Derivation of the Reynolds equation, Hydrostatic bearings, Squeeze-film lubrication bearings, thrust bearings, Journal bearings, air lubricated bearings.

Text Books:

1. Tribology for Engineers: A practical guide, Paulo Davim, Woodhead publishing, 2011.
2. Wear and Lubrication, Kragelski, Friction, Vol. I, II, III, MIR Publishers.
3. Tribology Handbook, Newnes. Butterworth-Heinemann M. J. Neale, U.K.

References:

1. Fundamentals of Tribolgy, Basu, Sen Gupta and Ahuja, PHI, 2000.
2. Applied Tribology, M. M. Khonsari & E. R. Booser, John Willey &Sons, New York, 2001.
3. Friction and Lubrication, E. P. Bowden and Tabor.D, Heinemann Educational Books Ltd.

25ME632 **Optimization Techniques in Manufacturing**

Syllabus:

Problem Solving Methods and Tools: Problem Space, Problem solving, State space, Algorithm's performance and complexity, Search Algorithms, Depth first search method, Breadth first search methods their comparison, A*, AO*, Branch and Bound search techniques, p type, Np complete and Np Hard problems.

Evolutionary Computing Methods: Principles of Evolutionary Processes and genetics, A history of Evolutionary computation and introduction to evolutionary algorithms, Genetic algorithms, Evolutionary strategy, Evolutionary programming, Genetic programming.

Genetic Algorithm and Genetic Programming: Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, applications.

Swarm Optimization: Introduction to Swarm intelligence, Ant colony optimization (ACO), Particle swarm optimization (PSO), Artificial Bee colony algorithm (ABC), Other variants of swarm intelligence algorithms.

Advances in Soft Computing Tools: Fuzzy Logic, Theory and applications, Fuzzy Neural networks, Pattern Recognition, Differential Evolution, Data Mining Concepts, Applications of above algorithms in manufacturing engineering problems.

Artificial Neural Networks: Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Back propagation algorithm, factors affecting back propagation training, applications.

Application of Soft Computing to Mechanical Engineering/Production Engineering Problems: Application to Inventory control, Scheduling problems, Production Distribution, Routing, Transportation, Assignment problems.

Text Books:

1. Soft Computing Integrating Evolutionary, Tettamanzi Andrea, Tomassini and Marco, Neural and Fuzzy Systems, Springer, 2001.
2. Multi-objective Optimization using Evolutionary Algorithms, Kalyanmoy Deb,John Wiley and Sons, 2001.
3. Operations Research, R. Panneerselvam, Prentice Hall of India Private Limited 2005.

References:

1. Operations Research – Theory and Applications, J.K.Sharma, Macmillan India Ltd., 1997
2. Operations Research – An Introduction, Hamdy A. Taha, Prentice Hall of India, 1997
3. Problems in Operations Research, P.K. Guptha and Man-Mohan, Sultan chand & Sons.

25ME633 **Geometric Modeling**

Syllabus:

Fundamentals of Geometric Modeling and Interpolation: Fundamentals, Interpolation, and Curve Modeling: Introduction, Bezier Curves, Lagrange and Hermite Interpolation, Subdivision curves, B-splines, Matrix Forms, Rational Polynomial Curves,

NURBS and Advanced Curve Modeling: Introduction to NURBs (Non-Uniform Rational B-Splines) General form and properties, Advantages over standard B-splines and Bezier, Knot Vector Refinement, Continuity: C0, C1, C2; Use of NURBs in Industrial Applications, CAD/CAM, modeling freeform shapes, Blending and Curve Joining Techniques.

Surface Modeling and Subdivision Techniques: Surface Modeling, Subdivision, and Volumes, Surface topology, Curvature, Bezier Surfaces, B- spline Surfaces, B-spline Subdivision Schemes, Doo-Sabin and Catmull-Clark Subdivision, Triangulation and Loop Subdivision, Surface Interrogation

CAD Elements and Solid Modeling Techniques: B-rep and Boolean Ops, Elements of CAD: Extrusion, Rotation, Lofting, Sweeping, CSG Representations and Euler Ops.

Applications, Advanced Topics: Voronoi Diagrams and Delaunay Triangulations, Curve and Surface Reconstruction, Registration, Simplification and Decimation, Smoothing, Discrete Deferential Geometry, Parameterization, Remeshing, Shape Analysis, Deformation, Segmentation, Spectral Methods.

Software Tools: Rhino, Blender, SolidWorks, CATIA, OpenCascade, Gmsh, MeshLab, Scripting and automation (Python/C++ APIs), Visualization and mesh libraries (VTK, CGAL)

Text Books:

1. Product Design & Development, Karl T Ulrich, Steven D Eppinger, Tata McGrawhill New Delhi 2003.
2. Mechanical Design Process, David G Ullman, "McGrawhill Inc Singapore 1992, N J M Roozenberg, J Ekels, N F M Roozenberg, "Product Design Fundamentals and Methods" John Willey & Sons 1995.
3. Wood Product Design: Techniques in Reverse Engineering and new Product Development, Kevin Otto & Kristin, Pearson Education, 2004.

References:

1. Successful Product Design, Hollins B & Pugh S, Butter worths London.
2. Designing for Production, Baldwin E N & Neibel B W, Edwin Homewood Illinois.
3. Design Methods, Seeds of Human Futures, John Willey New York.

25ME634 **Characterization of Materials**

Syllabus:

Introduction to Materials and Structural Analysis Techniques: Overview of Material Characterization, types of Materials, X-ray diffraction: phase identification, indexing and lattice parameter determination, Analytical line profile fitting using various models, Neutron diffraction, Reflection High Energy Electron Diffraction, and Low Energy Electron Diffraction.

Microscopy and Elemental Analysis Techniques: Optical microscopy, transmission electron microscopy (TEM), energy dispersive X-ray microanalysis (EDS), scanning electron microscopy (SEM), Rutherford backscattering spectrometry (RBS), atomic force microscopy (AFM) and scanning probe microscopy (SPM).

Thermal analysis techniques: Differential thermal analysis (DTA), Differential Scanning Calorimetry (DSC), Thermo-gravimetric analysis (TGA).

Electrical and Magnetic Characterization Techniques: Electrical resistivity, Hall effect, Magneto resistance; Magnetic characterization techniques: Introduction to Magnetism, Measurement Methods, Measuring Magnetization by Force, Measuring Magnetization by Induction method, Types of measurements using magnetometers: M-H loop, temperature dependent magnetization, time dependent magnetization, Measurements using AC susceptibility, Magneto-optical Kerr effect, Nuclear Magnetic Resonance, Electron Spin Resonance.

Optical and Electronic Characterization Techniques: UV-VIS spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy, X-ray photoelectron spectroscopy.

Text Books:

1. Characterization of Materials, Materials Science and Technology: A Comprehensive Treatment, Vol 2A & 2B, VCH.
2. Semiconductor Material and Device Characterization, D. K. Schroder, 3rd Edition, Wiley-IEEE Press 2006.
3. Materials Characterization Techniques, S Zhang, L. Li and shok Kumar, CRC Press 2008.

References:

1. Physical methods for Materials Characterization, P. E. J. Flewitt and R K Wild, IOP Publishing,2003.
2. Characterization of Nanophase materials, Ed. Z L Wang, Willet-VCH, 2000.
3. Microstructural characterization of materials, D Brandon, WD Kaplan, 2013.

Open Elective (MOOCs)

Code No.	Subject Name	Links
Online code	Artificial Intelligence Search Methods For Problem Solving	https://onlinecourses.nptel.ac.in/noc21_cs79/preview
Online code	Data Science for Engineers	https://onlinecourses.nptel.ac.in/noc21_cs69/preview
Online code	Introduction to Machine Learning (IITM)	https://onlinecourses.nptel.ac.in/noc19_cs53/preview
Online code	Business Analytics & Text Mining Modeling Using Python	https://onlinecourses.nptel.ac.in/noc19_mg47/preview
Online code	Entrepreneurship Essentials	https://onlinecourses.nptel.ac.in/noc25_ge11/preview
Online code	Drones systems and control	https://onlinecourses.nptel.ac.in/noc25_ae30/preview

25ME635 **CAD/CAM/CAE Laboratory**

Syllabus

CAD:

Parametric Modeling of Jigs/Fixtures, Dies & Molds: Create 3D CAD models of tooling components (e.g., fixture plates, mold cavities).

Design-for-Manufacturability (DFM) Analysis: Use SolidWorks or CATIA to analyze feature machinability, assembly ease, cost efficiency.

Tolerance Stack-Up & Fit Analysis in Assemblies: Model mating parts and evaluate clearance/interference fits (e.g., shaft-bearing assembly).

Sheet-Metal Design & Unfolding: Design a sheet-metal component (e.g., bracket or enclosure), generate flat patterns.

Reverse Engineering with 3D Scanning (Optional): Scan an existing component and recreate its CAD model to prepare custom tooling.

CAM:

2.5-Axis CNC Milling Toolpath Generation: Program and simulate toolpaths for block parts using NX CAM or Fusion 360.

CNC Lathe Toolpath & G-Code Development: For turning operations, generate toolpaths and POE manually or via CAM software.

CNC Machining Simulation & Verification: Validate toolpaths for collision and errors before real-world machining.

Actual CNC Machining Practice: Use the lab's CNC turning/milling centre to fabricate a simple part, review finished results.

Additive Manufacturing: FDM/SLM Prototyping: Design a functional prototype, print via FDM/SLM, and evaluate dimensional accuracy and material characteristics.

CAE:

FEA of Tooling Components: Perform structural stress analysis on a fixture, die, or mold using ANSYS or Abaqus.

Thermal Simulation in Machining/Welding: Model temperature profiles in a weld zone or cutting front to assess thermal effects.

Sheet Metal Forming (Deep Drawing): Simulate the forming of a cup or container; evaluate thinning, wrinkling, and failure zones.

Injection Moulding Flow, Warpage & Shrinkage: Use Moldflow or similar software to simulate plastic flow and part distortion.

Residual Stress & Distortion Prediction: Conduct post-process stress and deformation analysis of finished machined components.

Semester-2

25ME636 **Subtractive Manufacturing**

Syllabus:

Fundamentals of Metal Cutting and Tool Geometry: Tool geometry; Tool signature and its effect on the performances, Mechanics of metal cutting, strain and strain rate in orthogonal cutting, stress distribution along rake face, theories of Merchant's, Lee and Shaffer's, Oxley's, etc.

Cutting Tool Materials and Design: Inserts-chip groove geometries; Nomenclature, selection and applications in turning, milling, drilling, design concepts; Carbide grade design, carbide coatings, ceramic, super hard grade design, effect of cutting variables on forces, tool failure analysis, theories of tool wear, measurement of tool wear, tool life, process optimization.

Thermal and Force Aspects in Machining: Heat and temperature distribution, modeling of chip formation in metal cutting, modeling of machining characteristics in turning, milling, drilling, grinding, etc., measurement of cutting forces and cutting temperatures.

CNC and Advanced Machining Techniques: CNC machining; Introduction to hardware and software, economic aspects. Advanced machining processes, EDM, ECM, LBM, WJM, USM, AJM etc.

Micro-Machining and Ultra-Precision Processes: Micro machining and super-finishing; micro-turning, micro-milling, micro-drilling, micro EDM, micro-WEDM, micro ECM, etc., ultra-precision machining, electrolytic in-process dressing and grinding, high speed machining, nano surface generation, ductile cutting of silicon wafers, mechanism of ductile cutting, nanometric cutting, chip formation, recent developments.

Text Books:

1. Nontraditional machining, P K Mishra ,Narosa Publishing House 2007.
2. Machining Science and Applications, Kronenberg, Pergamon Press.
3. Fundamentals of Machining and Machine Tools", Geoffrey Boothroyd and W. A. Knight, Marcel Dekkel Inc.

References:

1. Advanced machining process, V K Jain, Allied Publishers Pvt. Ltd.; 1 edition, 2007.
2. Nontraditional Manufacturing Processes, Gary F. Benedict, "Marcel Dekker Inc.
3. Metal Cutting, Theory and Practice, Amitabha Battacharyya, New Central Book Agency,

25ME637 **Additive Manufacturing**

Syllabus:

Additive Manufacturing Process: Basic Principles of the Additive Manufacturing Process, Generation of Layer Information, Physical Principles for Layer Generation. Elements for Generating the Physical Layer, Classification of Additive Manufacturing Processes, Evaluation of the Theoretical Potentials of Rapid Prototyping Processes.

Machines for Additive Manufacturing-Overview of Polymerization: Stereo-lithography (SL), Sintering/Selective Sintering: Melting in the Powder Bed, Layer Laminate Manufacturing (LLM) and Three-Dimensional Printing (3DP).

Rapid Prototyping: Classification and Definition, Strategic Aspects for the Use of Prototypes, Applications of Rapid Prototyping in Industrial Product Development. Rapid

Tooling: Classification and Definition of Terms, Properties of Additive Manufactured Tools, Indirect Rapid Tooling Processes: Molding Processes and Follow-up Processes, Indirect Methods for the Manufacture of Tools for Plastic Components, Indirect Methods for the Manufacture of Metal Components.

Rapid Tooling: Prototype Tooling: Tools Based on Plastic Rapid Prototyping Models and Methods, Metal Tools Based on Multilevel AM Processes, Direct Tooling: Tools Based on Metal Rapid Prototype Processes.

Rapid Manufacturing: Feasibility, Cost estimation, Breakeven analysis, sustainability aspects.

Text Books:

1. Additive Manufacturing: 3D Printing for Prototyping and Manufacturing Andreas Gebhardt Jan-Steffen Hötter, Hanser Publications.
2. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David Rosen, Brent Stucker, Second Edition, Springer New York Heidelberg Dordrecht London.
3. Fabricated: The New World of 3D Printing by Hod Lipson & Melba Kurman, 2013.

References:

1. Rapid Prototyping and Engineering applications: A tool box for prototype development, Liou L.W. and Liou F.W, CRC Press, 2007.
2. Rapid Prototyping: Theory and practice, Kamrani A.K. and Nasr E.A, Springer, 2006.
3. Rapid Tooling: Technologies and Industrial Applications", Hilton P.D. and Jacobs P.F., CRC press, 2000.

25ME638 **Mechatronics and Robotics**

Syllabus:

Introduction: History of Mechatronics, Scope and Significance of Mechatronics systems, elements of mechatronic systems, needs and benefits of mechatronics in manufacturing.

Sensors: Classification of sensors, Position, Displacement, Velocity and Acceleration Sensors. Thermal Sensors, Force and Torque Sensors, Smart Sensors.

Actuators: Electrical Actuators: Solenoids, relays, diodes, thyristors, triacs, BJT, FET, DC motor, Servo motor, BLDC Motor, AC Motor, stepper motors. Hydraulic & Pneumatic devices, Design of Hydraulic & Pneumatic circuits. Piezoelectric actuators, Shape memory alloy based actuators. **Digital Electronics and Signal Conditioning**: Number systems, Boolean algebra, Design of circuits. Operational amplifiers, Multiplexer, Analog to digital convertors, digital to analog convertors, Data acquisition – Quantizing theory, Analog to digital conversion, digital to analog conversion.

Robotics: Introduction to Robotics, Robot anatomy physical configurations, Manipulator, Kinematics, Technical features. Programming of Mobile robot, robot programming language, end effecters.

Modelling of Mechatronic and Robotic Systems: Modelling for one and two degrees of freedom systems, Block diagram representations for these systems. Transfer function, Modelling Dynamic systems, first order systems, second order systems.

Controllers for Robots: Classification of control systems, Feedback, closed loop and open loop systems, Continuous and discrete processes, control modes, Two step Proportional, Derivative, Integral, PID controllers.

PLC Programming for Robots: PLC Principles of operation PLC sizes PLC hardware components I/O section Analog I/O section Analog I/O modules, digital I/O modules CPU Processor memory module Programming. Ladder Programming, ladder diagrams, timers, internal relays and counters, data handling, analogue input and output. Application on real time industrial automation systems.

Text Books:

1. Mechatronics, W. Bolton, Addison Wesley Longman Ltd, 5th edition, 2010.
2. Mechatronics System Design, Devdas Shetty & Richard Kolk, PWS Publishing, 3rd edition, 2009.
3. Robotics: Modelling, Planning and Control" by Bruno Siciliano et al.

References:

1. Introduction to Mechatronics and Measurement systems, Alciatore David G & Histand Michael B, Tata McGraw Hill, 4th edition, 2006.
2. Introduction to Robotics: Analysis, Systems, Applications, Saeed B Niku, Pearson Education India, PHI 2nd edition, 2003.
3. Programmable Logic Controllers, Frank D. Petruzella, McGraw-Hill Education, 4th edition, 2010.

Department Elective – II

25ME639 Product Design and Development

Syllabus:

Introduction to Product Design and Development: Introduction, Classification / Specifications of Products, Product life cycle. Product mix, Introduction to product design, Modern product development process, Innovative thinking. Morphology of design. Conceptual Design: Generation, selection & embodiment of concept. Product architecture, Industrial design: process, need.

Robust Design and Design Optimization: Taguchi Designs & DOE, Design Optimization. Design for Manufacturing & Assembly, Methods of designing for Manufacturing and assembly, Designs for Maintainability, Designs for Environment, Product costing, Legal factors and social issues, Engineering ethics and issues of society related to design of products.

Value Engineering and Human Factors: Value Engineering / Value Analysis, Methodology, Case studies, Economic analysis, Qualitative & Quantitative. Ergonomics / Aesthetics, Gross human autonomy, Anthropometry, Man-Machine interaction, Concepts of size and texture, colour. Comfort criteria, Psychological & Physiological considerations,

Creativity and Concept Realization: Creativity Techniques: Creative thinking, conceptualization, brain storming, primary design, drawing, simulation, detail design. Concurrent Engineering, Rapid prototyping,

Tools and Intellectual Property in Product Design: Tools for product design Drafting / Modeling software, CAM Interface, Patents & IP Acts. Overview, Disclosure preparation.

Text Books:

1. Product Design & Development, Karl T Ulrich, Steven D Eppinger, "Tata McGrawhill, 2003.
2. The Mechanical Design Process, David G Ullman, McGrawhill Inc Singapore 1992
3. Product Design Fundamentals and Methods" N J M Roozenberg, J Ekel, N F M Roozenberg "John Willey & Sons 1995.

References:

1. Successful Product Design, Hollins B & Pugh S "Butter worths London.
2. Designing for Production, Baldwin E N & Neibel B W "Edwin Homewood Illinois
3. Seeds of Human Futures, Jones J C "Design Methods." John Willey New York.

25ME640 **Reverse Engineering**

Syllabus:

Introduction: Historical Background, Industrial Evolution, Reinvention of Engineering, Marvels from Nature, Reverse Engineering in Modern Industries, Reverse, Engineering vs. Machine Design, Motivation and Challenge, Analysis and Verification, Accreditation, Part Criticality, Applications of Reverse Engineering.

Geometrical Form: Surface and Solid Model Reconstruction, Scanning Instruments and Technology, Principles of Imaging, Cross-Sectional Scanning, Digital Data, Computational Graphics and Modeling, Data Refinement and Exchangeability, Dimensional Measurement, Case Studies, Part Tolerance, Prototyping, Additive Prototyping Technologies, Subtractive Prototyping Processes, Rapid Injection. Molding, Steps of Geometric Modeling.

Material Characteristics and Analysis: Alloy Structure Equivalency, Phase Formation and Identification, Mechanical Strength, Hardness, Part Durability and Life Limitation, Part Failure Analysis, Fatigue, Creep and Stress Rupture, Environmentally, Induced Failure.

Material Identification and Process Verification: Material Specification, Composition Determination, Microstructure Analysis, Manufacturing Process Verification.

Data Process and Analysis: Statistical Analysis, Data Analysis, Reliability and the Theory of Interference, Weibull Analysis, Data Conformity and Acceptance, Data Report

Part Performance and System Compatibility Performance Criteria, Methodology of Performance Evaluation, System Compatibility.

Acceptance and Legality: Legality of Reverse Engineering, Legal Definition of Reverse Engineering, Legal Precedents on Reverse Engineering, Patent, Copyrights, Copyright Codes, Legal Precedents on Copyrights, Trade Secret, Case Study of Reverse Engineering a Trade Secret, Third-Party Materials.

Text Books:

1. Reverse Engineering: Technology of Reinvention, Wego Wang, CRC Press.
2. Product Design: Techniques in Reverse Engineering and New Product Development", Kevin Otto, Dorling Kindersley.
3. Reversing: Secrets of Reverse Engineering, Eldad Eilam, 1st Edition, 2005.

References:

1. Reverse Engineering: Mechanisms, Structures, Systems & Materials,' Robert Messler', McGraw Hill Education.
2. Reverse Engineering an Industrial Perspective, Raja, Vinesh, Fernandes, Kiran J, Springer.
3. Practical Reverse Engineering, Bruce Dang, Alexandre Gazet, Elias Bachaalany, Sébastien Josse, 2014.

25ME641 **Design of Experiments**

Syllabus:

Graphical Tools and Data Distribution Analysis: Graphical Data analysis tools - Stem and leaf plot, Dot plot, Box plot, Distribution of sample data Normal distribution, t-distribution, Normal Probability Plotting on ordinary graph paper, Interpretation, testing a new method for improvement - Variability known from past, Variability estimated from the experiment, comparing two methods - Randomised samples, Paired samples, Comparing more than two methods simultaneously-ANOVA.

Fundamentals of Experimental Design: Experimental strategies - Deficiencies of one factor at a time experiments, Problems in analysis of past data, Necessity for randomization, Basics of Experimental Design - Terminology, two level factorials, Estimation of effects and interactions, Yates algorithm, Un-replicated experiments - judging significance, Testing for significance in replicated experiments. Developing mathematical model equations, calculating residuals, checking whether experiment has been conducted satisfactorily.

Advanced Experimentation Techniques: Handling non-normal response, Transformations, Choosing the number of experiments, testing whether linear model is satisfactory, how to handle uncontrollable factors, how to deal with difficult to randomize factors. Dealing with large number of factors, Fractional Factorial experiments and Plackett Burman Designs, how to minimize possible confusion, Design Resolution, Sequential experimentation strategies, Folding over.

Optimization Techniques and Response Surface Methodology: Determining optimum conditions experimentally - Central Composite Designs, D-Optimal Designs, Response Surface methods, Mixture experiments. Experiments to determine variability and minimize it.

Software, Applications, and Projects: Training in Design Expert, software for DoE. Individual Design Project, presentation and discussion. Applications / Case Studies in Research, Quality Improvement, Product Development.

Text Books:

1. Quality Engineering Using Robust Design, by Madhav S. Phadke, Prentice Hall.
2. DoE Simplified: Practical Tools for Effective Experimentation, M. J. Anderson, and P. J. Whitcomb, 3rd ed., Productivity Press, USA, 2015.
3. The Design of Experiments, R.A.Fisher, Hafner Press; 8th edition.

References:

1. Modern Statistics for Engineering and Quality Improvement, J. Lawson, and J. Erjavec Thomson Duxbury, Indian EPZ edition, 2000.
2. Statistics for Experimenters, G. E. P. Box, W. G. Hunter, and S. J. Hunter,", 2nd ed., John Wiley & Sons Inc., 2005.
3. Design of Experiments a Realistic Approach by Virgil L. Anderson, Robert A. McLean CRC Press, 1st edition, 2019.

25ME642 **Tool Design Engineering**

Syllabus:

Cutting tool design: Different tool materials: cemented carbides, coated carbides, cermets, ceramics and polycrystalline tool materials - compositions - properties of tool materials - Selection and treatments - Plastics as tooling materials - New tooling materials Design of single point turning and threading tools - Selection of tool holders and inserts for turning - Chip breakers - Design of twist drill and reamers.

Press tool design: Press working terminology - Presses and press accessories - Computation of capacities and tonnage requirements - Strip layout - Types of dies - Design and development of various types of cutting, forming, bending and drawing dies - Progressive dies, Combination dies and compound dies - Blank development for cylindrical and non-cylindrical shells, Simple problems.

Design of jigs: Principles of jigs and fixtures - Locating elements - Drill bushes - Different types of jigs - Plate, latch, channel, post, angle plate, turn over, and pot jigs - Automatic drill jigs, Design and development of jigs for given components.

Design of fixtures: Design principles of fixtures - Design of fixtures for milling, boring. Design of fixture for assembly, inspection and welding. Design and development of fixtures for given components.

Case study: Case study in Jigs, fixture and press tools.

Text Books:

1. Cutting tools for Productive machining, Sadasivan T.A, and Sarathy D, "1st edition, Widia (India) Ltd, Bangalore, 1999.
2. Tool Design, Donaldson.C, Lecain.G.H and Goold.V.C, Tata McGraw Hill publishing company limited, New Delhi, 2002.
3. Jigs and Fixture design, Edward G. Hoffman, 2nd edition, Galgotia publication Pvt. Ltd., New Delhi.

References:

1. Jigs and Fixtures - Nonstandard clamping device, Hiram E. Grant, "Tata McGraw Hill, New Delhi.
2. Press tool design and construction, Prakash H. Joshi, "1st edition, Wheeler Publishing, New Delhi, 2000.
3. An Introduction to Jig and tool design, Kempster.M.H.A, 3rd edition, ELBS.

25ME643 **Processing and Design of Materials**

Syllabus:

Introduction of advanced materials and its manufacturing processes for engineering applications. Piezoelectric materials (PZT): Dynamic behavior of PZT transducers, piezoelectric materials and manufacturing techniques (stability, poling and depolarization).

Shape memory alloys (SMA): Shape memory effect and the metallurgical phenomenon of SMA, Temperature assisted shape memory effect, Visco-elastic behavior, and magnetic shape memory effect. Various shape memory alloys. Manufacturing technology of SMAs.

Electro rheological (ER) and magneto-rheological (MR) materials: Characteristics of ER and EM fluids. ER and EM materials. Composite materials: Design and manufacturing of polymer matrix, metal matrix and ceramic matrix composites. Various forms and type of reinforcements, fillers and additives. Design of composites for structural, wear resistance and high temperature applications.

MEMS systems. Introduction, characteristics of silicon wafers and other materials for MEMS applications. Various manufacturing techniques of MEMS components Materials for high temperature applications: Ni-Cr alloys, ODS materials, Ni base and Co based super alloys, carbon-carbon composites. Diffusion bond coating of high temperature materials.

NEMS systems: Definition – historical development – properties, design and fabrication Nanosystems, working principle, applications and advantages of nano system. Nanomaterials – ordered oxides – Nano arrays – potential health effects, fabrication and applications.

Smart Materials: Smart materials: Concepts, crystal structure, phase transformation mechanism and characteristics, properties, classification, applications.

Text Books:

1. Smart materials and Structures, Gandhi, M.V. and Thompson, B.S., Chapman and Hall, 1992.
2. Shape memory materials, Otsuka, K. and Wayman, C. M., C.U.P, 1998.
3. Engineering Aspects of Shape Memory Alloys, T W Duerig, K N Melton, D Stockel, and CW Wayman, Butterworth Heinemann, 1990.

References:

1. Pizoelectricity, George Taylor, W.Gorden and Breach Sc. Pub., 1985.
2. Fiber Reinforced Composites Materials, Manufacturing and Design. Mallick, P.K.,
3. Micro Fabrication and Nano machining, J. Jackson Marcel Dekker, 2006.

25ME644 **Laser Processing of Materials**

Syllabus:

Principles of industrial lasers: Principle of Laser Generation, Optical Resonators, Laser Modes, Mode Selection, Line- Broadening Mechanisms, Laser Beam Modifications and Types of Industrials Lasers.

Thermal process- heat and fluid flow: Heat Flow in The Work Piece: Thick Plate with Point Heat Source, Thin Plate with Line Heat Source, Peak Temperature and Cooling Rates Fluid Flow in Molten Pool: Continuity Equation, Navier-Stokes Equation and Surface Tension Effects.

Laser metallurgy: Process Microstructure- Fusion Zone, Zone of Partial Melting, Haz, Discontinuities- Porosity, Cracking, Lack of Fusion, Incomplete Penetration and Undercut.

Laser welding and surface modifications: Process Mechanisms (Key Hole and Plasmas), Operating Characteristics, Process Variations, Imperfections-Industrial Applications, Recent Developments Laser Surface Heat Treatment, Laser Surface Melting- Glazing, Laser Direct Metal Deposition, Laser Surface Alloying, Laser Surface Cladding and Hard Coatings, Laser Physical Vapour Deposition and Laser Shock Peening.

Laser Machining: Laser Instrumentation for Cutting and Drilling, Cut Quality and Process Characteristics, Methods of Cutting, Practical Performance, Process Variations, Industrial Applications of Laser Cutting and Drilling.

Laser Forming: Mechanisms of Laser Forming, Laser Origami, Laser assisted forming.

Text Books:

1. Principles of Laser Materials Processing, Elijah Kannatey-Asibu, Jr., John Wiley & Sons, 2009
2. Recent Advances in Laser Processing of Materials, Jacques Perrière, Eric Millon, Eric Fogarassy, 2006.
3. Laser Fabrication and Machining of Materials" Narendra B. Dahotre, Sandip P. Harimkar, 2008.

References:

1 Laser Processing of Engineering Materials, John C. Ion, Elsevier Butter Worth-Heinemann, Burlington, 2005.

2 Laser Materials Processing, Steen W. M, "3rd Edition, Springer Verlag, U.K., 2003.

3 Laser And Electron Beam Material Processing, Ykalin, Ugloo A, Kokona A.,"Hand Book, MIR Publishers.

25ME645 **Manufacturing Planning and Control**

Syllabus:

Overview of manufacturing systems and various issues of interest: Assembly Line, Repetitive batch manufacturing, Cellular manufacturing, FMS, JIT, CIM.

Preplanning: Forecasting, Economic analysis, Aggregate planning, Capacity planning, Inventory planning.

Decision making in design of manufacturing systems: Group Technology, Line balancing, Plant layout.

Operations planning: MRP, MRP II, Hierarchical planning systems, JIT systems, FMS

Operation and control: Lot sizing decisions, production scheduling, line of balance, quality planning and control, cost planning and control, productivity planning and control and applications of theory of constraints.

Simulation: Simulation analysis of manufacturing systems.

Road map to World Class Manufacturing Systems: Ideal Manufacturing, Intelligent Manufacturing and Agile Manufacturing Systems.

Applications of recent developments in IT: ERP, e-Business, Enterprise Applications Integration (EAI) and Virtual Manufacturing: Concepts, Justification and Status of development and implementation. Case Studies.

Text Books:

1. Integrated Production Control System- Management, Analysis and Design, D. D. Bed worth and J. E. Bailey.
2. Analysis and Control of Production Systems, E. A. Elsayed and T. O. Boucher.
3. Production Planning and Control, J. R. King.

References:

1 Production and Inventory Management, A. C. Hax and D. Candea.

2 O.R. in Production Planning, Scheduling and Inventory Control, L. A. Johnson and D. C. Montgomery, John Wiley and Sons.

3 Quantitative Production Management, P. F. Bestwick and K. Lockyer, Pitman Publications.

Department Elective – III

25ME646 **Automation and Control**

Syllabus:

Introduction: Structure & components Industrial Automation systems. Architectural levels of Industrial controls.

Actuators & sensors: Servomotors, Stepper motors, Process I/O systems. Local & remote I/O systems.

Controllers: Different types of controllers, Single loop and Multiloop controllers and their tunning, Direct controllers and their tunning, Direct controllers and their tunning, Direct controllers and their tunning, Direct controllers and their tunning, Direct controllers and their tunning, Direct controllers and their tunning, Direct Digital Controllers, Software implementation of Multiloop Controllers. Distributed Control Systems.

Sequence Control: Programmable Logic Controllers, Relay Ladder Logic, Programming.

Supervisory Controllers: Functionally of Supervisory Control Level, Process Optimization, Recipe Management Material. Tracking. Man-machine interfaces.

Process Operation Management Systems: Overview of process operation management systems, order, inventory management, process scheduling, quality management.

Industrial Communication Systems: Characteristic features of industrial networks. Low level networks and their features, Field bus architecture. Performance aspects of Industrial Automation Systems.

Text Books:

1. Programmable controllers: Principle and Applications, Webb J.W, 2009.
2. Programmable Controllers: An Engineers' Guide, Parr A., Newnes, Butterworth-HeinnemanLtd.
3. Process Control Handbook, Liptak B.G (ED)-vol-2 Chilton book Co.

References:

1. Handbook for Instrumentation Engineers, Noltinc.
2. Bollinger J.G and Duffie N.A-Computer control of machines and processes, Reading M A, Addison-Wesley.
3. Handbook of research on advanced intelligent control engineering and automation, AT Azar,2014.

25ME647 **Quality Engineering and Management**

Syllabus:

Introduction Quality Management: Indian Companies Monopolize the Deming Awards in 2003, Quality Management- A conceptual frame work, Strategic Quality Management, Benchmarking **Quality Standards and business excellence models:** Quality system Standards, Bureau of Indian Standards, Agmark Grading and standardization, Quality council of India, International Organization for Standardization, Conformance to Specifications, Quality Assurance, Quality Circles, Quality audits, ISO 14000, Customer Operations Performance Centre 2000, Total Quality Management, W. Edwards Deming's Contribution to TQM, Juran's Contribution to TQM, Crosby's contribution to TQM, Ishikawa's contribution to TQM, Comparing the Quality Gurus, Total Productive Maintenance.

Service quality management and Cost of Quality: Measuring Service Quality, Prevention costs, Appraisal Costs, Internal and External failure costs, Cost of quality models, India's Quality Journey so far, Quality management in India, Quality related priorities of Indian companies, Case studies.

Six sigma and Experimental design: Meaning of Six sigma, The seven magnificent Quality tools, Introduction of experimental design, Taguchi Method in Experimental Design, Concept, Application of QFD, Case Study

Statistical Quality Control: Quality control-its introduction and benefits, Variation in processes: factors, process capability & Its analysis, control charts for variables and attributes, Establishing & interpreting control charts, Concept of Acceptance Sampling, sampling by attributes, single and double sampling plans, inspections by samples, AQL, LTPD, consumers and producer's risk, construction and use of operating characteristic curves, use of standard sampling tables and related IS, sampling by variables, Continuous sampling plan, vendor ratings.

Intellectual Properties System: Definition of intellectual property, importance of IPR; TRIPS and its implications, patent, copyright, industrial design and trademark

Text Books:

1. Quality Management, Kanishka Bedi
2. Intellectual Property Rights, Prbuddha Ganguli, TMH
3. Probability and Reliability with Statistics, Trivedi,P

References:

1. Statistical Quality Control, M. Mahajan
2. TQM in Service Sector, R.P.Mohanty and R.R.Lakhe
3. Total Quality Management, Arora, Kataria

25ME648 **Industrial Machine Vision**

Syllabus:

Introduction: Types of inspection tasks, Structure of image processing systems, examples
Image Preprocessing: Gray Scale transformations, Image arithmetic, Linear Filters, Other Filters
Positioning: Positioning of individual object, Orientation of individual object, Robot positioning
Segmentation: Regions of interest, Thresholding, Contour Tracing, Edge based methods, Template matching.
Mark Identification: Bar code identification, Character identification, identifying pin marked digits on metal, Print quality inspection Classification: As function approximation, Instance based classifiers, Function based classifiers, Neural network classifiers Dimension checking: Simple Gauging, Shape checking on punched parts, injection molded parts, High accuracy gauging of threads, Calibration.
Image acquisition and illumination: Solid state sensors, Standard video cameras, other cameras, Transmission to computer, Optics, Lighting
Presence Verification: Simple presence verification, simple gauging for assembly verification, presence verification using classifiers Object Features: Basic Features, Shape Descriptors, Gray Level Features.

Text Books:

1. Industrial Image Processing – Visual Quality Control in Manufacturing, Demant, 2nd ed., Springer, 2013.
2. Digital Image Processing Using MATLAB, Gonzalez, 2nd ed., Pearson Education, 2010.
3. Machine vision for industrial applications, BG Batchelor, 2012.

References:

1. Digital Image Processing, Gonzalez, and Woods, 3rd edition, Pearson Education, 2008.
2. Intelligent Vision Systems for Industry, Batchelor and Whelan, Springer Verlag.
3. Machine Vision for Industry 4.0: Applications and Case Studies, R Raut, S Krit, P Chatterjee, 2022.

25ME649 **Nanoscience and Technology**

Syllabus

Over View of Nanotechnology: Definition, historical development, properties, design and fabrication Nanosystems, working principle, applications and advantages of nano system. Nanomaterials, ordered oxides, Nano arrays, potential health effects

Nanodefects, Nano Partiles and Nanolayers: Nanodefects in crystals, applications, Nuclear Track nano defects. Fabrication of nano particles, Epitaxy and ion implantation, formation of Silicon oxide-chemical composition, doping properties, optical properties

Nanostructuring: Nanophotolithography, techniques, optical, electron beam, ion beam, X-ray and Synchrotron, nanolithography for microelectronic industry, nanopolishign of Diamond, Etching of Nano structures, Nano imprinting technology, Focused ion beams, LASER interference Lithography nanoarrays, Near-Field Optics - case studies and Trends

Science and Synthesis of Nano Materials: Classification of nano structures – Effects of nano scale dimensions on various properties, structural, thermal, chemical, magnetic, optical and electronic properties fluid dynamics, Effect of nano scale dimensions on mechanical properties - vibration, bending, fracture Nanoparticles, Sol-Gel Synthesis, Inert Gas Condensation, High energy Ball Milling, Plasma Synthesis, Electro deposition and other techniques. Synthesis of Carbon Nanotubes Solid carbon source based production techniques, Gaseous carbon source based production techniques, Diamond like carbon coating. Top down and bottom up processes.

Characterization of Nano Materials: Nano-processing systems, Nano measuring systems, characterization, analytical imaging techniques, microscopy techniques, electron microscopy scanning electron microscopy, confocal LASER scanning microscopy - transmission electron microscopy, transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, diffraction techniques, spectroscopy techniques, Raman spectroscopy, 3D surface analysis, Mechanical, Magnetic and thermal properties, Nano positioning systems.

Text Books:

1. MEMS and Microsystems Design and Manufacture, Tai Ran Hsu, Tata-McGraw Hill, New Delhi, 2002.
2. Nanotechnology and Nano electronics, Fahrner W.R., Springer (India) Private Ltd., 2011.
3. Fundamentals of Micro fabrication, Mark Madou, CRC Press, New York, 1997.

References:

1. Nanostructures and Nanomaterials Synthesis, Properties, and Applications, Cao G., Imperial College Press, 2004.
2. Characterization of nanophase materials, Wang, Z. L., (Ed.), Wiley-VCH Verlag, GmbH, 2000.
3. Handbook of Nanoscience, Engineering, and Technology, Goddard III W.A., Taylor & Francis Group, 2007.

25ME650 Micro Electro Mechanical Systems (MEMS)

Syllabus

Over View of MEMS and Microsystems: Definition, properties, design and fabrication micro-system, microelectronics, working principle, applications and advantages of micro system. Substrates and wafers, silicon as substrate material, mechanical properties of Si, Silicon Compounds - silicon piezo resistors, Galium arsenide, quartz, polymers for MEMS, conductive polymers.

Fabrication Processes and Micro System Packaging: Photolithography, photo resist applications, light sources, ion implantation, diffusion, Oxidation - thermal oxidation, silicon dioxide, chemical vapour deposition, sputtering - deposition by epitaxy, etching bulk and surface machining, LIGA process, LASER, Electron beam, Ion beam processes, Mask less lithography. Micro system packaging, packaging design, levels of micro system packaging -die level, device level and system level, interfaces in packaging, packaging technologies- Assembly of Microsystems.

Micro Devices: Sensors, classification, signal conversion ideal characterization of sensors micro actuators, mechanical sensors, measurands - displacement sensors, pressure sensor, flow sensors, Accelerometer, chemical and bio sensor - sensitivity, reliability and response of micro-sensor - micro actuators, applications.

Science and Synthesis of Nano Materials: Classification of nano structures, Effects of nano scale dimensions on various properties, structural, thermal, chemical, magnetic, optical and electronic properties fluid dynamics, Effect of nano scale dimensions on mechanical properties - vibration, bending, fracture Nanoparticles, Sol-Gel Synthesis, Inert Gas Condensation, High energy Ball Milling, Plasma Synthesis, Electro deposition and other techniques. Synthesis of Carbon nanotubes, Solid carbon source based production techniques, Gaseous carbon source based production techniques, Diamond like carbon coating. Top down and bottom up processes.

Characterization of Nano Materials: Nano-processing systems, Nano measuring systems, characterization, analytical imaging techniques, microscopy techniques, electron microscopy scanning electron microscopy, confocal LASER scanning microscopy - transmission electron microscopy, transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, diffraction techniques, spectroscopy techniques, Raman spectroscopy, 3D surface analysis, Mechanical, Magnetic and thermal properties, Nano positioning systems.

Text Books:

1. Introduction to Micro fabrication, Sami Franssila, John Wiley & sons Ltd, 2004.
2. Nano Technology, Norio Taniguchi, Oxford University Press, New York, 2003
3. Introduction to Nano technology, Charles P Poole, Frank J Owens, John Wiley and Sons, 2003

References:

1. Foundations of MEMS, C. Liu'.
2. An Introduction to Microelectromechanical Systems Engineering, N. Maluf.
3. Modeling MEMS and NEMS, J. Pelesko & D. Bernstein.

25HS601 Advanced Technical Communication (T/P)

Course Objectives:

· To gain foundational understanding of science communication

· To critically analyze and communicate scientific ideas

· To conceptualize and refine a research topic using scientific process

Syllabus

Module 1

Key characteristics of scientific writing- types of documents (journal articles, conference papers, reports, thesis) IMRAD structure in detail (Introduction, Methods, Results, Discussion)-abstract-drafting titles

Module 2

Scientific language- (clarity, brevity, precision)-common errors and how to fix them (grammar, style, tone)-organizing and synthesizing information-literature review and referencing-citation styles- using reference managers

Module 3

Research paper writing and its constituents-research publication and ethics

Module 4

Writing proposals (grants, research, project)- presenting research

References:

1. Bagla, Pallava, and V. V. Binoy, editors. Bridging the Communication Gap in Science and Technology: Lessons from India. Springer Nature, 2017

2. Dean, Cornelia. Am I Making Myself Clear? A Scientist's Guide to Talking to the Public. Harvard University Press, 2009.

3. Gastel, Barbara, and Robert A. Day. How to Write and Publish a Scientific Paper. 8th ed., Cambridge University Press, 2016.

25ME651 **Mechatronics and Robotics Laboratory**

Syllabus

Intro to mechatronic test-beds; interfacing sensors & actuators Hands-on sensor calibration & data acquisition (IR, ultrasonic, touch, pressure).

Actuators & controllers: motor control, pneumatics, PID via microcontrollers

Vision systems: image capture, thresholding, basic object tracking.

Robot kinematics: programming linkage motion, trajectory control.

Robotic behavior labs: pick-and-place, line following, automation tasks.

Embedded integration: controllable mechatronic work cells.

Mini-project: e.g., autonomous sensor-driven mobile robot or vision-guided manipulator