CURRICULUM FOR
M.TECH. (MANUFACTURING ENGINEERING)

SEMESTER - I

Code No.	Name of Subject	L	T	P	Credits
ME 615	Metal Casting and Joining Processes	3	0	2	4
ME 617	Metal Cutting and Tool Design	3	0	2	4
ME 619	Metal Forming	3	1	0	4
ME 621	Operations Planning and Control	3	1	0	4
ME 623	Manufacturing Lab	0	0	4	2
ME 625 ME 627 ME 629 ME 650 ME 771 ME 776	**Elective –** I Advanced Manufacturing Systems Advanced Metrology and Computer Aided Inspection Industrial Tribology Optimization Techniques Rapid Prototyping and Tooling Design for Manufacturing, Assembly and Environment	3	0	0	3
	Semester Total	**25 Hrs**			**21**

SEMESTER - II

Code No.	Name of Subject	L	T	P	Credit
ME 618	Modern Manufacturing Processes	3	0	2	4
ME 622	Computer Integrated Manufacturing	3	0	2	4
ME 624	Computer Aided Engineering	3	1	0	4
ME 626	Quality Engineering and Management	3	1	0	4
ME 628	Digital Prototyping Lab	0	0	4	2
ME 632 ME 634 ME 636 ME 638 ME 640 ME 770	**Elective – II** Materials and Metallurgy Composites : Design and Manufacturing Intelligent Manufacturing Systems Logistics and Supply Chain Management Industrial safety, Laws and Patent Acts Industrial Robotics	3	0	0	3
	Semester Total	**25 Hrs**			**21**

SEMESTER - III

Code No.	Name of Subject	L	T	P	Credit
ME 801	Dissertation Preliminaries	0	0	10	5
ME 803	Seminar	0	0	4	2
	Semester Total	**14 Hrs**			**7**

SEMESTER - IV

Code No.	Name of Subject	L	T	P	Credit
ME 802	Dissertation	0	0	20	10
	Semester Total	**20 Hrs**			**10**

M. Tech. (Manufacturing Engineering), Semester - I
ME 615: Metal Casting and Joining Processes

L	T	P	Credits
3	0	2	4

Casting: Patterns, pattern allowances, mould and core making, melting practice and furnaces, cooling and solidification, Elements of gating system, design of gating system – Theoretical consideration – Directional solidification – Design of risers – Modulus –Caine's and shape factor methods, application of chills. **[08 Hours]**

Different moulding and casting processes: permanent mould casting, shell moulding, die casting, vacuum die casting, squeeze casting, centrifugal casting, investment casting-die casting-continuous casting-low pressure casting, Casting defects and their remedies, Fettling and testing of casting. **[12 Hours]**

Welding and Allied Processes: 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, Selection of Welding process, 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. **[17 Hours]**

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) **[08 Hours]**

[Total Teaching Hours – 45]

Text Books:

1. P. L. Jain, Principles of Foundry Technology, 5th edition, TMH Publications, 2009.
2. R. S. Parmar, Welding Processes and Technology, 3rd Edition, Khanna Publishers, New Delhi, 2011.

References:

1. Richard Heine, Carl Loper, Philip Rosenthal, Principles of Metal Casting, TMH Publications, 2004.
2. A. Ghosh and A. K. Mallik, Manufacturing Science, East west press, New Delhi, 2006,
3. H.S.Bawa, Manufacturing Technology-I, TMH Publications, New Delhi, 2007.
4. S.V.Nadkarni, Modern Arc Welding Technology, Oxford and IBH Publishing Co. Pvt. Ltd., 2010.
5. Serope Kalpakjian and Steven R. Schmid, Manufacturing Processes for Engineering Materials, 4th edition, Pearson Education, 2007.

M. Tech. (Manufacturing Engineering), Semester - I
ME 617: Metal Cutting and Tool Design

L	T	P	Credits
3	0	2	4

Mechanics of metal cutting **[15 hours]**

Metal cutting principles, classification and mechanism of chip formation, types of chips, chip breakers, chip thickness ratio, shear plane, shear angle, shear strain, shear strain rate, shear angle relationships, velocity relationships, force analysis in orthogonal cutting; force analysis in drilling and milling process, types of tool dynamometer.

Thermal aspects in machining **[05 hours]**

Thermal aspects in machining, temperature distribution, temperatures in primary deformation zone, temperatures in secondary deformation zone, the measurement of cutting temperatures.

Tool life **[05 hours]**

Forms of wear in metal cutting, tool life criteria for different tool materials, tool life, factors affecting tool life, tool failure, Basic requirements of tool materials and major classes of tool materials, cutting fluids, economics of machining.

Machine vibration and stability analysis **[02 hours]**

Classification of vibration in machining, stability analysis for machining process, diagnosis and reduction of chatter.

Design of cutting tools **[10 hours]**

Properties required for tooling materials, various tool materials, Jigs and fixtures, Design of cutting tools, Selection of carbide cutting tools.

Design of press tools **[08 hours]**

Die-design fundamentals; Material of die components, Design of Blanking and Piercing die, Progressive die, Strip-layout, Deep drawing die.

[Total Lecture Hours – 45]

Text Books:

1. G. Boothroyd and W. A. Knight, Fundamentals of machining and machine tools, Taylor and Francis, 3rd Edition, 2006.
2. M. C. Shaw, Metal Cutting Principles, Oxford University Press, 2nd edition, 2008.
3. Cyril Donaldson, George H. Lecain and V. C. Goold, Tool design, 4th edition, Tata-McGraw Hills, 2010.

References:

1. Ghosh and A. K. Malik, Manufacturing Science, Affiliated East West Press Pvt. Ltd., New Delhi, 2008.
2. H. El Hofy, Fundamentals of Machining Processes, Taylor and Francis, 2006.
3. G. C. Sen and A. Bhattacharyya, Principles of Machine Tools, New Central Book Agency (P) Ltd., Calcutta, 2nd Revised Edition, 2009.

M. Tech. (Manufacturing Engineering), Semester - I
ME 619: Metal Forming

L	T	P	Credits
3	1	0	4

Introduction **[02 Hours]**

Advantages of metal forming, cold and hot forming, various metal forming processes.

Theory of Elasticity and Plasticity **[14 Hours]**

Review of theory of elasticity, Stress tensor, stress transformations, principal stresses, differential equations of equilibrium, spherical and deviatoric stress tensors, octahedral stresses, infinitesimal and affine transformation for deformation, rotation and strain tensors, strain transformations, principal strains, spherical and deviator strain tensors, octahedral strains, finite deformations, Mohr's circles for state of stress and state of strain, generalized Hooke's law, Hooke's law for isotropic and homogeneous materials, plane stress and plane strain.

Introduction to the theory of plasticity, stress space, yield criterion for metals, Von- Mises' yield criterion, Tresca's yield criterion, representation of the above in stress space, yield surface. Basic considerations of plasticity theory, simple models of material behaviour, Levy-Mises (flow rule) and Prandtl-Reuss stress strain relations.

Slip Line Field Theory **[04 Hours]**

Slip Line Field Theory, Incompressible two-dimensional flow, slip lines, equilibrium equations (referred to slip lines), Henkey's theorems, hodograph, simplest slip line fields, application in forming processes – extrusion and forging.

Metal forming processes **[25 Hours]**

Rolling – types of rolling, determination of rolling pressure, driving torque and power, power loss in bearings, defects, Wire-drawing - determination of drawing force and power, maximum allowable reduction, defects, Extrusion - determination of work load, defects, Forging – types of forging, determination of maximum force required for forging a strip and a disc between two parallel dies (open die forging), defects, Deep-drawing - analysis to correlate the initial and final dimensions of the job, estimation of the drawing force, defects, Bending - determination of work load, estimation of spring back, Punching and blanking – mode of metal deformation and failure, deformation model and fracture analysis, determination of working force, Friction and Lubrication in metal forming.

HERF processes – Explosive forming, Electrohydraulic forming, Electromagnetic forming.

[Total Teaching Hours – 45]

Text Books:

1. Stephan Timoshenko, and J. N. Goodier, Theory of Elasticity, McGraw Hill, 2010.
2. A. Ghosh and A. K. Mallik, Manufacturing Science, East west press, New Delhi, 2006.

References:

1. Robert H. Wagoner and Jean-Loup Chenot, Fundamentals of Metal Forming, John Wiley and Sons, 1996.
2. G. K. Lal, P. M. Dixit and N. Venkata Reddy, Modelling Techniques for Metal Forming Processes, Narosa Publishing House, 2011.
3. William F. Hosford and R. M. Caddell, Metal Forming Mechanics and Metallurgy, Prentice Hall, 1993.

Production planning & Control (PPC): Definition of PPC, Objectives of PPC, Functions of PPC, Organizations of PPC department, Types of production system and principles of sound production system. Generalized model of production system, national economy as a Leontief's input- output system, decisions in the life cycle of a production system, PPC in Service Sector **[02Hours]**

Operation Strategy: Business Strategy, Dimensions of operations for competitive advantage, Innovations Management, locating resources **[02 Hours]**

Forecasting: Elements and steps in forecasting, Types of forecasting, Demand forecasting using qualitative and quantitative methods, Errors in forecasting. **[04 Hours]**

Process Strategy: Process strategies, Process analysis and Design, Selection of equipment and technology and Process redesign **[04 Hours]**

Layout and Location Strategy: Types of layout. Design of layout, Factors affecting location decision. Mathematical model for facility location and layout. **[04 Hours]**

Capacity Planning: Definition and measurement of capacity, Adjusting capacity, Quantitative methods for capacity planning decision. **[04 Hours]**

Aggregate Planning: Purpose, inputs of aggregate plan, Aggregate planning processes and strategies, Methods for aggregate planning, Aggregate planning in services. **[04 Hours]**

Material Requirement Planning and ERP: Just in Time, MRP input and output, MRP structure, MRP management, Lot sizing Technique and Extension of MRP, JIT and MRP in services, JIT to Die exchange, ERP: Introduction, Implementation, Advantages. **[05 Hours]**

Operation Scheduling: Introduction to Scheduling and Shop floor planning and control; order sequencing rules and their performance based on different evaluation criteria; changeover costs and job sequence, Mathematical models of job sequencing. **[04 Hours]**

Inventory Control and Management: Introduction, EOQ Models with and without shortage, Multi item Deterministic Model, Dynamic and Fluctuating Models, Deterministic Model with price breaks and Probabilistic inventory models. Selective Inventory control. **[10 Hours]**

Green Manufacturing and Waste Management: Waste collection system, recycling of waste, waste disposal system, green manufacturing. **[02 Hours]**

[Total Teaching Hours – 45]

Text Books:

1. Jay Heizer, Barry Render and Jagadeesh Rajashekhar, Operations Management, Pearson Education, 2009.
2. Everett E. Adam, Ronald J. Ebert, Production and Operations Management, 5th edition, Prentice Hall of India, New Delhi, 2012.

References:

1. E. S. Buffa and R. K. Sarin, Modern Production / Operations Management, John Wiley & Sons, 1994.
2. Samuel Eilon, Elements of Production Planning and Control. New York: Macmillan; London: Collier-Macmillan, 1962
3. Lee J. Knajei & L. P. Ritzman, Operations Management, Pearson Education, Delhi, 2002.
4. R. Paneerselvan, Production & Operations Management, PHI, New Delhi, 2006.
5. S. K. Mukhopadhyay, Production Planning & Control – Text & Cases, PHI, New Delhi, 2011.
6. R. B. Khanna, Production & Operations Management, Prentice Hall of India, New Delhi, 2010.
7. Bedi Kanishka, Production and Operations Management, Oxford University Press, New Delhi, 2007.

M. Tech. (Manufacturing Engineering), Semester – I
ME 623: Manufacturing Lab

L	T	P	Credits
0	0	4	2

List of Experiments -

1. Exercises on grinding and surface measurement
2. Measurements in Universal Measuring Microscope, Profile Projector, and with various advanced instruments,
3. Flatness measurement using autocollimator,
4. Metallographic studies using Metallurgical Microscope,
5. Programming and measurements with CNC Coordinate Measuring Machine, surface texture analysis,
6. Experiments on non destructive evaluation using ultrasonic testers,
7. Exercises on virtual instrumentation.
8. Preparation of standard specimen and testing on UTM.

M. Tech. (Manufacturing Engineering), Semester – I, Elective-I
ME 650: Optimization Techniques

L	T	P	Credits
3	0	0	3

Introduction to Optimization, Single and Multivariable optimization methods, constrained optimization methods **[02 Hours]**

Linear programming – Formation, graphical method, simplex method, difficulties in simplex, duality, post optimization analysis, Transportation problem, trans shipment problem, Assignment problem, Travelling salesman problem. **[17 Hours]**

Integer programming-All integer, Mixed integer and zero -one programming. **[04 Hours]**

Geometric programming - concept - degree of difficulty - solution of unconstrained constrained non linear problems by geometric programming. **[02 Hours]**

Nonlinear Programming problem: Graphical method, Kuhn –Tucker conditions, Lagrangian method, quadratic programming, Beale's method, Wolfe's method, dynamic programming. **[16 Hours]**

Solving real life design problems such as welded beam design, speed reducer (gear train) design, heat exchanger design, etc., as well as linear and nonlinear problems using MATLAB **[04 Hours]**

[Total Teaching Hours – 45]

Text Books:

1. J. K. Sharma, Operations Research –Theory and Applications, Macmillan Publishers India Ltd., 4th Edition, 2009
2. F. S. Hillier and G. J. Lieberman, Introduction to Operations Research- Concepts and Cases, Tata Mcgraw Hill, 9th Edition, 2010.

References:

1. H. A. Taha, Opeartions Research: An Introduction, Pearson, 8th Edition, 2007.
2. R. Panneerselvam, Opeartion Research, PHI, 2nd Edition, 2010
3. S. S. Rao, Engineering Optimization– Theory and Practice, John Wiley and Sons, 4th Edition, 2009.

M. Tech. (Manufacturing Engineering), Semester – I, Elective-I ME 625: Advanced Manufacturing Systems	L 3	T 0	P 0	Credits 3

Introduction to Production and Layout System: Types of production systems, Types of plant Layout, advantages and disadvantages of various production systems and Layout **[02 Hours]**

Lean, Agile and Quick Response Manufacturing (QRM): Introduction, benefits from Lean, Agile and Quick Response Manufacturing, Difference between Lean, Agile and Quick Response Manufacturing **[03 Hours]**

The Methodology for Transforming your organization in Lean: Understanding products, processes, and Demand, Line lay out and work station Identification with process linking and balancing, The Kanban Strategies, Managing inventory with Kanban system. **[04 Hours]**

Project Management for Implementation: Team establishment, The lean implementation milestones checklist, Managing the Lean Manufacturing Line. **[04 Hours]**

Agile Manufacturing Enterprise Design: Enterprise Design, The Enterprise Design Process, Interdisciplinary Design, Management Accounting and Investment Appraisal. **[04 Hours]**

Agile Manufacturing Implementation: Skill And Knowledge Enhancing Technologies For Agile Manufacturing, Enablers of Agile Manufacturing, Agile Enterprise design strategies Implementation Framework, Issues, Problems, and Future Developments **[05 Hours]**

Rethinking Production and Materials Management for QRM: Reorganizing production, Structured methodology for implementing cellular Manufacturing, creative thinking for cellular manufacturing, capacity and lot sizing decisions, Materials and production planning in QRM Enterprise, The new Material control and Replenishment system for QRM, QRM approach to supplier relation. **[10 Hours]**

Rethinking office operation for QRM: Principles of quick response for office operations, Tools to implement quick response for office cell (Q-ROC) and system dynamics principle for quick response. **[04 Hours]**

QRM in Product Introduction: Extending QRM to new product introduction **[02 Hours]**
Creating QRM enterprises: Management Support, Organization structure, performance measurement, cost system, and steps to implement QRM. **[04 Hours]**

Reconfigurable Manufacturing system (RMS): Components, capabilities and challenges of Reconfigurable manufacturing system, technologies enabling reconfiguration. **[03 Hours]**

[Total Teaching Hours – 45]

Text Books:

1. Dennis P. Hobbs, Lean Manufacturing Implementation: A Complete Execution Manual for Any Size Manufacture, J. Ross Publishing, Inc. 2003.
2. A Gunasekaran , Agile Manufacturing: The 21st Century Competitive Strategy, 1st Edition, Elsevier publication, 2001.
3. Rajan Suri, Quick Response Manufacturing: A Companywide Approach to Reducing Lead Times, Productivity press, Portland, Oregon, 1998.

References:

1. Paul T. Kidd, Agile Manufacturing: Forging New Frontiers (Addison-Wesley Series in Manufacturing Systems, 1994.
2. Rajan Suri, It's About Time: The Competitive Advantage of Quick Response Manufacturing, Productivity press, Portland, Oregon, 2009.
3. Lonnie Wilson, How To Implement Lean Manufacturing, McGraw-Hill Professional, 2009.
4. Y. Koren, F. Jovane, T. Moriwaki, G. Pritschow, G. Ulsoy, and H. Van Brussel. Reconfigurable Manufacturing Systems, Annals of the ClRP Vol. 48(2), 1999, pp. 527-540.

M. Tech. (Manufacturing Engineering), Semester – I, Elective-I ME 627: Advanced Metrology and Computer Aided Inspection	L	T	P	Credits
	3	0	0	3

Basic Concepts of Measurement **[02 Hours]**
Terms used in measurement, Classification of measurements, Classification of measurement errors, Measuring instruments and their properties.

Uncertainty analysis: **[06 Hours]**
Measurement and error, Type A and Type B categories of uncertainty, Combined type A and type B, Evaluation of uncertainty.

Measurement of Length and Angle: **[04 Hours]**
Length measurement, Angle measurements, Direct and indirect methods, Instruments used.

Limits, Fits and Tolerance: **[08 Hours]**
Need for limit systems, Interchangability, types of interchangeability, Limits and fits, tolerance dimensions, Terns and definitions, published standards for limits and fits system, Types of fits, Design of limit gauges, Geometric tolerances – key aspects, symbols, tolerance frame, datum symbols, toleranced feature and interpreting drawing.

Form metrology: **[08 hours]**
Measurement of roughness, waviness, flatness, roundness, cylindricity, radius, screw, gear, Methods of improving accuracy & surface finish, Influence of forced vibration on accuracy, Dimensional wear of cutting tools and its influences on accuracy.

Computer Aided Metrology: **[10 Hours]**
Coordinate measurement machine (CMM), Applications, Advantages, Type of CMM & applications, Constructional features of CMM, Probes – Touch trigger probe and non contact trigger probers, operation and programming, Examination of surface texture, possible sources of error in CMM, Image Analysis and Computer Vision.

LASER Metrology: **[09 Hours]**
Types of laser, Laser in engineering metrology, methods of laser metrology, Laser interferometer, Laser alignment telescope, Laser micrometer, On-line and in-process measurements of small diameter, large displacement, Roundness and surface roughness using LASER, Micro profile and topography measurements, Testing of machine tools.

[Total Teaching Hours – 45]

Text Books:

1. J. F. W. Galyer and C. R. Shotbolt, Metrology for Engineers, Thomson Learning, 5th Edition, 1990.
2. I. C. Gupta, A Text Book of Engineering Metrology, Dhanpat Rai and Sons, 4th Edition, 1994.
3. C. Elanchezhian, B. V. Ramnath, T. S. Selwyn, Engineering metrology, Eswar press, Chennai, 2004.

References:

1. R. K. Jain, Engineering Metrology, Khanna Publishers, Delhi, 20th Edition, 2009.
2. J. D. Meadows and M. D. Meadows, Geometric Dimensioning and Tolerancing: Applications and Techniques for Use in Design: Manufacturing, and Inspection, Taylor & Francis, 1995.
3. C. Dotson, Dimensional Metrology, Delmar Cengage Learning, 1st Edition, 2009.

M. Tech. (Manufacturing Engineering), Semester – I, Elective-I ME 776: Design for Manufacture, Assembly and Environment	L	T	P	Credits
	3	0	0	3

Introduction **[07Hours]**

General design principles for manufacturability, Strength and mechanical factors, mechanisms selection, Evaluation method, Process capability, Feature tolerances, Geometric tolerances , Assembly limits –Datum features, Tolerance stacks.

Factors Influencing Form Design **[08 Hours]**

Working principle, Material, Manufacture, Design , Possible solutions, Materials choice, Influence of materials on form design , Form design of welded members, Forgings and castings.

Component Design – Machining Consideration **[10 Hours]**

Design features to facilitate machining , Drills, Milling cutters, keyways, Doweling procedures, Counter sunk screws, Reduction of machined area , Simplification by separation, Simplification by amalgamation, Design for machinability, Design for economy, Design for clampability, Design for accessibility, Design for assembly.

Component Design – Casting Consideration **[10 Hours]**

Redesign of castings based on parting line considerations, Minimizing core requirements, machined holes, Redesign of cast members to obviate cores. Identification of uneconomical design, Modifying the design, Group technology, Computer Applications for DFMA.

Design for Environment **[10 Hours]**

Introduction, Environmental objectives, Global issues, Regional and local issues, Basic DFE methods, Design guide lines, Applications, Lifecycle assessment: Basic method, AT&T's environmentally responsible product assessment , Weighted sum assessment method, Lifecycle assessment method, Techniques to reduce environmental impact , Design to minimize material usage, Design for disassembly: Design for recyclability, Design for remanufacture, Design for energy efficiency, Design to regulations and standards.

[Total Teaching Hours – 45]

Text Books:

1. James G. Bralla, Design for Manufacturability Handbook, 2nd Edition, McGraw hill, 1999.
2. Joseph Fiksel, Design for Environment, 2nd Edition, McGraw hill, 2012.

References:

1. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
2. Dixon, R. John and Corroda Poli, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.
3. Kevien Otto and Kristin Wood, Product Design, Pearson Publication, 2004.

M. Tech. (Manufacturing Engineering), Semester – I, Elective-I	L	T	P	Credits
ME 771: Rapid Prototyping and Tooling	**3**	**0**	**0**	**3**

Introduction [**06 Hours]**
Need for time compression in product development, Product development conceptual design, Development, Detail design, Prototype , Tooling, Applications of RP.

Stereo Lithography Systems **[06 Hours]**
Principle, Process parameters, Process details, Machine details, Applications.

Laser Sintering Systems **[06 Hours]**
Principle, Process parameters, Process details, Machine details, Applications.

Fusion Deposition Modeling **[06 Hours]**
Principle, Process parameters, Process details, Machine details, Applications.

Laminated Object Manufacturing **[06 Hours]**
Principle, Process parameters, process details, Machine details, Applications.

Laser Engineering Net Shaping (LENS) **[10 Hours]**
Ballistic Particle Manufacturing (BPM), Principle, Introduction to rapid tooling, Direct and indirect method, Commercial softwares for RP, STL file generation.

Rapid tooling techniques (vacuum casting, DMLS, etc.) [**04 Hours]**

Introduction to reverse engineering **[01 Hour]**

[Total Teaching Hours – 45]

Text Books:

1. D.T. Pham and S.S Dimov, Rapid manufacturing, Springer -Verlag, London, 2001.
2. Chua Chee Kai, Leong Kah Fai, Lim Chu -Sing, Rapid Prototyping: Principles and Applications, 2nd edition, World Scientific, 2003, ISBN: 9812381201.

References:

1. Terry wohlers, Wohlers Report 2007, Wohlers Associates, USA, 2007.
2. Kenneth G. Cooper, Rapid Prototyping Technology: Selection and Application, CRC Press, 2001.
3. A. Ghosh, Rapid Protopyping: A Brief Introduction, Affiliated East West Press, 2006.

M. Tech. (Manufacturing Engineering), Semester – I, Elective-I ME 629: Industrial Tribology	L	T	P	Credits
	3	0	0	3

Surfaces, Friction and Wear **[12 Hours]**

Topography of Surfaces, Surface features, Surface interaction, Theory of Friction, Sliding and Rolling Friction, Friction properties of metallic and non -metallic materials, Friction in extreme conditions, Wear, types of wear, Mechanism of wear, wear resistance materials, Surface treatment, Surface modifications, Surface coatings.

Lubrication Theory **[08 Hours]**

Lubricants and their physical properties lubricants standards, Lubrication Regimes in Hydrodynamic lubrication, Reynolds Equation, Thermal, inertia and turbulent effects, Elastohydrodynamic (EHD) magneto hydrodynamic lubrication, Hydro static lubrication, Gas Lubrication, Solid lubrication.

Design of Fluid Film Bearings **[10 Hours]**

Design and performance analysis of thrust and journal bearings, Full, Partial, Fixed and pivoted journal bearings design, Lubricant flow and delivery, Power loss, Heat and temperature of steady and dynamically loaded journal bearings, Special bearings, Hydrostatic Bearing design.

Rolling Element Bearings **[08 Hours]**

Geometry and kinematics, Materials and manufacturing processes, Contact stresses, Hertzian stress equation, Load divisions, Stresses and deflection, Axial loads and rotational effects, Bearing life capacity and variable loads , ISO standards, Oil films and their effects, Rolling Bearings Failures.

Tribo Measurement and Instrumentation **[07 Hours]**

Surface Topography measurements, Electron microscope and friction and wear measurements, Laser method, Instrumentation, International standards, Bearings performance measurements, Bearing vibration measurement.

[Total Teaching Hours – 45]

Text Books:

1. Bharat Bhushan, " Introduction to Tribology", Johan Wieley & Sons, New Yeark, 2002
2. Basu S. K., Sengupta S. N. , Ahuja B. B., " Fundamental of Tribology", PHI Learning Pvt, Ltd, New Delhi, 2009

References:

1. A. Cameron, Basic Lubrication Theory, Ellis Horwood Ltd., UK, 1981
2. J. Halling (Editor), Principles of Tribology , Macmillian, 1984.
3. J. A. Williams, Engineering Tribology, Oxford Univ. Press, 1994.
4. M. J. Neale, Tribology Hand Book, Butterworth Heinemann, 1995.
5. T. A. Stolarski , Tribology in Machine Design, Industrial Press Inc., 1990.

Metal Casting and Joining Processes Lab (Semester-I)

List of Experiments -

1. Study of oxyacetylene cutting operation
2. Study of various types of coating in electrode welding
3. Effect of welding parameters on weld bead by
    a. Electric Arc welding
    b. Submerged arc welding
4. Microstructural observation of weldments of plain C-steel and alloy steels
5. Destructive and non destructive tests- X-ray, radiography, magnetic particles, dye penetration, ultrasonic, eddy current techniques.
6. Effect of RPM on properties of Al based metal matrix composites.
7. Tensile and hardness testing of Al based metal matrix composites.

Metal Cutting and Tool Design Lab (Semester – I)

List of Experiments:

1. Measurement of shear plane angle
2. Measurement of cutting forces in orthogonal cutting
3. Measurement of cutting forces in oblique cutting
4. Study of surface conditions during grinding process
5. Calculation of tool life during machining process
6. Measurement of tool chip interface temperature
7. Fabrication of single point cutting tool as per given tool signature
8. Study of tool wear on different cutting tools.
9. Design of stamping dies.

M. Tech. (Manufacturing Engineering), Semester – II	L	T	P	Credits
ME 618: Modern Manufacturing Processes	3	0	2	4

Introduction **[02 hours]**

Trends in modern manufacturing; characteristics and classification of modern manufacturing methods, considerations in the process selection.

Mechanical Processes **[12 hours]**

Introduction, principle, process description, process capabilities, material removal mechanism, parametric analysis, tool design, limitations, and applications of Ultrasonic Machining (USM), Abrasive Jet Machining (AJM), Water Jet Machining (WJM) and Abrasive Water Jet Machining (AWJM) processes.

Electrochemical & Chemical Processes **[08 hours]**

Fundamental principle, process description, process capabilities, mechanism of material removal, surface finish and accuracy, limitations, and applications of Electrochemical Machining (ECM), Electrochemical Grinding (ECG), Electrochemical deburring, Electrochemical honing and Chemical Machining (C M) processes.

Thermal Metal Removal Processes [**10 hours]**

Electrical Discharge Machining (EDM): Working principle, process description, process capabilities, power circuits, mechanism of material removal, selection of tool electrode and dielectric fluid, limitations, and applications. Wirecut electro discharge machining, powder mixed electro discharge machining process

Laser Beam Machining (LBM): Working principle, type of lasers, machining applications of lasers, mechanism of material removal, shape and material, applications and limitation.

Electron Beam Machining (EBM): Generation and control of electron beam, EBM systems, process analysis & characteristics, mechanism of material removal, shape and material, applications and limitations.

Plasma Arc Machining (PAM) and Ion Beam Machining (IBM): Process principle, analysis and characteristics of process, mechanism of material removal, shape and material, applications and limitations.

Hybrid Machining Processes **[04 hours]**

Concept, classification, process capabilities, and applications of various hybrid machining methods based on USM, EDM, ECM, etc.

Micromachining Processes **[05 hours]**

Introduction to micro machining methods; material removal mechanism and process capability of micro machining methods like micro -turning, micro-milling, micro-drilling, micro EDM, micro- WEDM, micro ECM, etc. ultra-precision machining, electrolytic in-process dressing and grinding.

Additive Processes **[04 hours]**

Introduction to additive manufacturing processes; classification; laminated object manufacturing process; adhesive manufacturing process; digital manufacturing process.

[Total Teaching Hours – 45]

Text Books:

1. P. C. Pandey and H. S. Shan, Modern Machining Processes, Tata Mcgraw Hill,New Delhi, 2003.
2. P. K. Mishra, Nonconventional machining, Narosa publishing house, 2011
3. V. K. Jain, Introduction to micro machining, Narosa publishing house, New Delhi, 1st Edition, 2010

References:

1. V. K. Jain, Advanced Machining processes, Allied publishers, New Delhi, 2008.
2. G. Benedict, Nontraditional manufacturing processes, Marcel Dekker, New York, 1st Edition, 1987.
3. J. A. McGeough, Advanced methods of machining, Chapman & Hall, London, 1st Edition, 1988
4. A. Ghosh and A. K. Mallik, Manufacturing Science, East-West Press, New Delhi, 2006.
5. D. T. Pham and S. S. Dimov,Rapid manufacturing, Springer-Verlag, 1st Edition, 2001.

M. Tech. (Manufacturing Engineering), Semester – II
ME 622: Computer Integrated Manufacturing

L	T	P	Credits
3	0	2	4

Introduction to CIM: Introduction to automation, Types of automation, Automation principles and strategies, Definition of CIM, CIM wheel, Evolution of CIM, Benefits of CIM, CIM hardware and software, Nature and role of the elements of CIM system, Development of CIM, Introduction to mechatronics. **[05 Hours]**

Computer aided manufacturing: Components of NC/CNC system, Specification of CNC system, Classification of CNC machines, Constructional details of CNC machines, Axis designation, Basic programming terms, Programming formats, Preparatory command, Miscellaneous functions, Reference points, Work offsets, Tool length offset, Cutter radius offset, Machine zero return, Part programming for milling - subroutines, canned cycles, mirror, Part programming for lathe - lathe cycles, Machining centres, CNC tooling, Introduction of commercial CAM software. **[15 Hours]**

Group technology: Definition, implementation considerations, benefits and applications, G.T. methods - visual search method, production flow analysis, Parts classification and coding, Design and manufacturing attributes, Concept of composite component, Rank order clustering, machine cell formation, Cell group tooling, Design rationalization, possibilities of integration with CAD/CAM . **[12 Hours]**

Flexible Manufacturing System: Introduction, General Considerations for FMS, types of FMS, Flexibilities, their measurements, Computer control in FMS, Automated material handling systems, AGVs, Automatic storage and retrieval systems, Manufacturing cells, cellular v/s flexible manufacturing. **[10 Hours]**

Emerging Technologies: Expert system, Machine vision, Lasers in machining. **[03 Hours]**

[Total Teaching Hours – 45]

Text Books:

1. Mikell P. Groover, Automation Production systems and Computer Integrated Manufacturing, Prentice-Hall, 2008.
2. P. Radhakrishnan, S. Subramanyan, and V. Raju, CAD/CAM/CIM, 3rd edition, New age International publishers, 2011.
3. S. F. Krar and A. Gill, CNC: technology and programming, Tata McGraw-Hill, 1990.

References:

1. Paul G Ranky, Computer Integrated Manufacturing, Prentice Hall International, 1986.
2. S. Kant Vajpayee, Principles of Computer Integrated Manufacturing, PHI, New Delhi.
3. David Bedworth, Computer Integrated Design and Manufacturing, Tata McGraw Hill, New Delhi, 1998.
4. Ranky, Paul G., Computer Integrated Manufacturing, Prentice Hall International, 1986.
5. P. Radhakrishan and S. Subramaniyam, CAD, CAM and CIM, New Age International, 2002.
6. P. N. Rao, CAD/CAM Principles and Applications, Tata McGraw Hill, 2nd Edition, 2006.

M. Tech. (Manufacturing Engineering), Semester – II
ME 624: Computer Aided Engineering

L	T	P	Credits
3	1	0	4

Computer Graphics : **[10Hours]**

Basics of Computer Aided Design, Introduction to Computer graphics, CAD/CAM hardware, 2D & 3D Transformations.

Plane Curves and Space Curves : **[10Hours]**

Parametric non parametric curves – cubic splines – Bezier curves, d – spline curves.

3-D Modelling : **[10Hours]**

Solid modeling, modeling approaches-coordinate system-basic features-viewing/visualization-hidden line removal. Introduction to Computer Aided Drafting and modeling using software approach. Programming techniques in drafting/ modeling

Numerical Analysis : **[15Hours]**

Finite Difference Method and Finite Element Method-direct approach, variational approach and weighted residual approach, isoparametric elements, interpolation functions elemental matrix, assembly and boundary conditions, condensation, solution algorithms. Application of FEM in elastic plane stress, plane strain and anisymmetric problem. Application of FEM to thermal problems

[Total Teaching Hours – 45]

Text Books:

1. I. Zeid, Mastering CAD/CAM, Tata Mcgraw-Hill Education Private Limited, 2005.
2. A.D. Belegundu and T.R. Chandrupatla, Finite Elements in Engineering, Prentice Hall of India Private Ltd., 1997.
3. J.N. Reddy, An Introduction to the Finite Element Method, Tata Mcgraw-Hill Education Private Limited, 2005.

References:

1. D. Rogers, J.A. Adams , Mathematical Elements for Computer Graphics, Tata Mcgraw Hill Education Private Limited, 2002.
2. C. S. Krishnamoorthy, S. Rajeev, A. Rajaraman, Computer Aided Design: Software and Analytical Tools, Second Edition Narosa Publishing House, 2009.
3. V. B. Anand, Computer Graphics and Geometric Modeling for Engineers, John Wiley & Sons Inc. 1993.
4. S.S. Rao, Finite Element Method in Engineering, Elsevier Pergaman Press, 1997.
5. K. H. Huebner, D. L. Dewhirst, D. Smith, T. G. Byrom, The Finite Element Method For Engineers, 4TH ED , Wiley India Pvt Ltd , 2008.

6. C. S. Krishnamoorthy, Finite Element Analysis: Theory and Programming, Tata Mcgraw Hill Education Private Limited, 2001.
7. E.G. Thompson, Introduction to the Finite Element Method: Theory, Programming, And Applications, Wiley India Pvt Ltd, 2009.
8. R. D. Cook, D.S. Malkus, M.E. Plesha, R.J. Witt, Concepts And Applications Of Finite Element Analysis, 4th Edition, Wiley India Pvt Ltd, 2007.
9. P. Seshu, Textbook Of Finite Element Analysis, Prentice Hall of India Private Ltd., 2004

M. Tech. (Manufacturing Engineering), Semester – II	L	T	P	Credits
ME 626: Quality Engineering and Management	3	1	0	4

Q**uality Control**: Introduction to quality control and the quality system, Some philosophies and their impact on quality, Cost of quality, Quality audit. **[02 Hours]**

Statistical Concepts and Data analysis: Fundamentals of statistical concepts and techniques in quality control and improvement, Data analysis and sampling **[04 Hours]**

Control Charts: Statistical Process Control using control charts, Control charts for attributes and variables. **[04 Hours]**

Process capability analysis: Concepts and procedures of Process capability **[02 Hours]**

Acceptance Sampling: Acceptance sampling for attributes and variables. **[04 Hours]**

Reliability: Failure rate analysis, mean failure rate, mean time to failure, mean time between failure, Graphical representation of F_d, Z and R. Generalization in graphical form, integral form, Hazard models, systems reliability, availability, maintenance, overall equipment effectiveness, Total Productive Maintenance (TPM), Failure Mode and Effect Analysis (FMEA). **[03 Hours]**

Experimental Design: Fundamentals of experimental Design, Single, Multi factor and 2^k factor experiments, Two level fractional factorial design, Response surface method. **[04 Hours]**

Taguchi Methods: Quality loss function, Taguchi method, Design of experiments using orthogonal array, Data analysis from Taguchi and Multi level factor design. **[04 Hours]**

New Quality Concepts and initiatives : Total Quality Management (TQM) and its techniques, New Seven Management Tools, and Industrial Case studies on Costs of Quality, Five S, kaizen, Quality Circles, Quality Function Deployment (QFD), Poka Yoke, Total Productive Maintenance (TPM), Lean Manufacturing, Six Sigma, Lean Six Sigma, etc. Quality Management through Software. **[15 Hours]**

Quality Standards and Business Excellence Models: Quality System Standards, ISO 9000, ISO 14000, various Quality Awards and case studies. **[02 Hours]**

Manufacturing Excellence World Class Manufacturing (WCM) – Model and elements of WCM **[01 Hours]**

[Total Teaching Hours – 45]

Text Books:

1. Amitra Amitava, Fundamentals of Quality Control and Improvement, 2nd Ed., Prentice Hall of India, 2011
2. K. Krishnaiah and P. Shahabudeen, Aplied Design of Experiments and Taguchi Methods, Prentice Hall of India, 2012

3. Dale H. Besterfield, Carol Besterfield-Michna, Mary Besterfield-Sacre, Glen H. Besterfield, Hemant Urdhwareshe, Rashmi Urdhwareshe, Total Quality Management, , Pearson Education, 2012.

References:

1. A.V. Feizenbaum, Total Quality Control, Mc Graw Hill, 1987.
2. D.C. Montogomery, Design and Analysis of Experiments, John Wiley & Sons, 1984.
3. G. Taguchi, Introduction to Quality Engineering, Bedford: Asian Productivity Organization, 1986.
4. Kanishka Bedi, Quality Management, Oxford University Press, New Delhi, 2007.
5. K. Shridhara Bhat, Total Quality Management – Text & Cases, Himalaya Publishing House, Mumbai, 2010.
6. R. Ramakrishnan, Total Quality Management by, Eswar Press, Chennai, 2005.
7. Greg Brue and Rod Howes, Six Sigma, Tata McGraw – Hill, New Delhi, 2006.
8. James R. Evans and William M. Lindsay The Management and Control of Quality, Thomson South western, 2002.

M. Tech. (Manufacturing Engineering), Semester – II
ME 628: Digital Prototyping LAB

L	T	P	Credits
0	0	4	2

Session 1: Conceptual Design presentation - Elements of design, Product development cycle overview, Market demands and trends for products, Product Lifecycle Management (PLM) overview, Course automotive seat design project introduction, Ideation and conceptual design phase introduction, Benefits and use cases of ideation and conceptual design, Demonstration of Assigned component if feasible, Market and Sales Requirements (Inputs and Analysis), Determine Product Requirements, Conceptual Thumb Nail Sketches, Conceptual Renderings

Session 2: Product Engineering- Introducing CAD, Benefits of Digital Prototype Design, General 3D Design Concepts, Exposure to Computer aided modeling software for Assigned Component, Sketching Part, Part Modeling, Work Features, Part Features

Session 3: Product Engineering- Design for manufacturing, Surfacing, Surfacing and modeling for point cloud data, Plastic Part Features

Session 4: Product Engineering- Top Down and Bottom Up Design Methods, Assembly Environment, Constraints, Standard Components, Manufacturing and Engineering Bill of Materials (BOMs)

Session 5: Product Engineering- Design Documentation Requirements, Importance and Benefits of design documentation, Specific need of documentation, Drawing Requirements (Detailed Drawings & Assembly Drawings), Sheet Setup, View Creation, Annotation Types, Annotation Placement

Session 6: Product Engineering, Design Changes and Automation - Designing for change, Automating the design and configurations, Parameters / relationships, Engineering Calculations, Logical programming

Session 7: Visualization- Design visualization throughout product development, Benefits of design visualization, Design finalization, Texture selection, Incorporating, Sales and Marketing aspects, Plastic Part Visualization

Session 8: Simulation (linear)- The role of simulation for design validation, Basics of software in support to FEA theory, Preprocessing: Meshing, assigning materials, Loads, Constraints etc., Solving Structural / thermal, Post processing for state of stresses and temp distribution

Session 9: Simulation (Non linear)- The benefits of non linear simulation part, Exposure to geometric, material, and contact (Nonlinear Problems)

Session 10: Kinematics Motion- Kinematics role in simulation and optimization, Theory and Benefits, Kinematics requirements, Joints, Forces, Assembly structure, Benefits of combining analysis information, Motion forces, Component FEA from motion forces

Session 11: Design Optimization and Change- Design Changes, Design Optimization, Model Relationships, Simulation Results

Session 12: Presentation- Benefits for field service and manufacturing, Story Board, Annotations and Descriptions, Snapshots, Assembly instruction video

Session 13: Team Project Assignment initiation

Session 14: Team Project Assignment Practice

Session 15: Team Project Assignment Completion and submission

M. Tech. (Manufacturing Engineering), Semester – II, Elective - II **ME 632: Materials and Metallurgy**	**L** **3**	**T** **0**	**P** **0**	**Credits** **3**

Introduction: **[02 Hours]**
Introduction to engineering properties of materials and applications, Property parameters for selection, Material Selection and processing.

Metals and Alloys: **[05 Hours]**
Solid solutions, solubility limit, phase rule, binary phase diagrams, intermediate phases, intermetallic compounds, Iron-iron carbide phase diagram, heat treatment of steels, cold, hot working of metals, recovery, recrystallization and grain growth, Pearlitic, Martensitic& Bainitic transformation, effect of alloy elements on phase diagram, TTT diagram, CCT diagram, Annealing, normalizing, hardening& tempering, hardenability, precipitation hardening, Microstructure, properties and applications of ferrous and non-ferrous alloys.

Advanced Material and Tools: **[09 Hours]**
Smart materials exhibiting ferroelectric, piezoelectric, optoelectric, semiconducting behavior, lasers and optical fibers, photoconductivity and superconductivity, nanomaterials , , biomaterials, superalloys, shape memory alloys Metallography (Optical TEM, SEM), X Ray Diffraction, Mechanical Properties, Thermal analysis.

Extractive Metallurgy: **[06 Hours]**
General methods of extraction, (Pyro-metallurgy – calcinations, roasting and smelting, Hydrometallurgy – leaching, solvent extraction, ion exchange, precipitation, and electrometallurgy – electrolysis and electro-refining).

Performance of Materials in Service: **[04 Hours]**
Service Performance, Failure, Corrosion-types(Atmospheric, Pitting, Stress Corrosion),Control and Prevention, Protective Coatings, Performance of Metals and Ceramics at High Temperature.

Strengthening Mechanism: **[04 Hours]**
Dislocation (elementary concepts only), edge / screw dislocation, partial dislocation, stacking fault, dislocation lock, dislocation pile up, Hall Petch relation, grain boundary structure, Strengthening mechanism, strength vs. toughness (ductility), thermo mechanical processing, micro alloyed steel, ultra high strength steel, superalloy.

Polymer Based Composite Materials: **[08 Hours]**
Definition of composite material – Classification - Application – Merits and Demerits. Properties of constituents & composites. Reinforcement Form, matrix description-Manufacturing Processes for composites such as hand lay, filament winding, pultrusion, RTM, DMC etc –defects in manufacturing– non destructive evaluation of polymer composite- interface- statistical distribution of fiber strength– shear strength of interfacial bond evaluation by fiber pull out etc– fracture and toughness of composites–mechanical testing of composite and constituents

Stress strain relationship for different type of materials Concept of volume and **[07 Hours]**

weight fraction of fiber & matrix – Density and void fraction – fiber packing - Evaluation of elastic modulies – Ultimate strength of lamina – Experimental evaluation using Standards test methods – semi Empirical models for prediction.

[Total Teaching Hours – 45]

Text Books:

1. R. E Small Man, A.H.W Ngan, Physical Metallurgy and Advanced Materials, seventh edition,Butterworth-Heinemann, 2007.
2. Reza Abbaschian, Lara Abbaschian, Robert E. Reed-Hill, Physical Metallurgy Principle, Fourth edition, CENGAGE Learning, 2009.

References:

1. William F. Smith, Javed Hashemi, Ravi Prakash, Material Science and Engineering, Fourth edition, Mcgraw Hill, 2009.
2. R. W. Cahn, P. Hassen, Physical Metallurgy,fourth edition, North Holland Publishing,1996-02-08.
3. B.D Cullity, Elements of X ray Diffraction- Third edition, Prentice Hall, 2001.
4. R.E Smallman & R. J Bishop Metals and Material Science-process, application, fifth Edition, Butterworth-Heinemann,1995.
5. Ghosh A and H.S Ray Priciples of Extractive Metallurgy, second edition, New Age International, 1991.
6. G Dieter,Mechanical Metallurgy,third edition, McGraw-Hill, 1986.
7. Bhagwan D. Agarwal, Lawrence J. Broutman, K. Chandrashekhara, Analysis And Performance of Fiber Composites, third edition, John Wiley & Sons, 2006.

M. Tech. (Manufacturing Engineering), Semester – II, Elective-II
ME 634: Composites: Design and Manufacturing

L	T	P	Credits
3	0	0	3

Definition of composite material – Classification - Application – Merits and Demerits. Properties of constituents and composites. Metal-matrix composites- Ceramic-matrix composites- Polymer-matrix composites. Reinforcement Form –short fiber composites, textile composites, hybrid composite etc - matrix description. **[05 Hours]**

Manufacturing Processes for composites such as hand lay, filament winding, pultrusion, RTM, DMC etc. **[05 Hours]**

Defects in manufacturing– non destructive evaluation of polymer composite- interface-statistical distribution of fiber strength – shear strength of interfacial bond evaluation by fiber pull out etc – fracture and toughness of composites – mechanical testing of composite and constituents – fiber test – neat resin test – composite material testing for tensile, compression, in plane shear, inter laminar shear, flexural, inter laminar fracture, creep, vibration etc. **[10 Hours]**

Stress strain relationship for different type of materials – Engineering constants for lamina – strength failure theories – hygrothermal stresses and strain - Concept of volume and weight fraction of fiber & matrix – Density and void fraction – fiber packing - Evaluation of elastic modulies – Ultimate strength of lamina – Experimental evaluation using Standards test methods – semi Empirical models for prediction.
Laminate – Code for laminate and stacking sequence – Strength, stiffness and hygrothermal properties of laminate. Evaluation of elastic moduli, coefficient of thermal and moisture expansion for laminate. **[15 Hours]**

Failure criteria for laminate – Design of Laminated composite structure and components – importance of constituents and their selection - stiffened structure-stiffener types- stiffener design- Laminate joints - Sandwich composite – Environmental effects – Inter laminar stresses - impact resistance – Fracture resistance – Fatigue resistance. **[10 Hours]**

[Total Teaching Hours – 45]

Text Books:

1. R.F. Gibson, Principles of Composite material mechanics, McGraw-Hill, Inc, Newyork, International edition 1994.
2. Robert M Jones, Mechanics of composite material, Taylor & Francis 2nd edition, Newyork, Indian Print 2010.

References:

1. A.K. Bhargava and C.P.Sharma, Mechanical Behaviour and testing of materials, PHI Publication New Delhi, 2011.
2. Autar K Kaw, Mechanics of composite materials, Taylor and Francis, 2nd edition, Indian Print 2009.
3. Bryan Harris, Engineering composite materials, Woodhead publishing limited, 2nd edition, Cambridge, England, 2006.

M. Tech. (Manufacturing Engineering), Semester – II, Elective-II
ME 770: Industrial Robotics

L	T	P	Credits
3	0	0	3

Introduction and Robot Kinematics [08 Hours]

Definition need and scope of Industrial robots, Robot anatomy, Work volume, Precision movement, End effectors, Sensors. Robot Kinematics, Direct and inverse kinematics, Robot trajectories, Control of robot manipulators, Robot dynamics, Methods for orientation and location of objects.

Robot Drives and Control [10 Hours]

Controlling the Robot motion, Position and velocity sensing devices , Design of drive systems, Hydraulic and Pneumatic drives , Linear and rotary actuators and control valves , Electro hydraulic servo valves, electric drives , Motors, Designing of end effectors, Vacuum, magnetic and air operated grippers.

Robot Sensors [10 Hours]

Transducers and Sensors, Sensors in Robot, Tactile sensor, Proximity and range sensors , Sensing joint forces, Robotic vision system, Image gribbing, Image processing and analysis , Image segmentation, Pattern recognition, Training of vision system.

Robot Cell Design and Application [07 Hours]

Robot work cell design and control, Safety in Robotics, Robot cell layouts, Multiple Robots and machine interference, Robots cycle time analysis, Industrial application of robots.

Robot Programming, Artificial Intelligence and Expert Systems [10 Hours]

Methods of Robot Programming, Characteristics of task level languages lead through programming methods, Motion interpolation, Artificial intelligence, Basics, Goals of artificial intelligence, AI techniques, Problem representation in AI, Problem reduction and solution techniques, Application of AI and ES in Robots.

[Total Teaching Hours: 45]

Text Books:

1. K.S. Fu, R. C. Gonzalez and C.S.G. Lee, obotics Control, Sensing, Vision and Intelligence, McGraw Hill, 2008.
2. D. Richard, Klafter, and A. Thomas, Chmielewski, Michael Negin, Robotics Engineering – An Integrated Approach, Prentice-Hall of India Pvt. Ltd., 2009.
3. A. Ghosal, Robotics Fundamental Concepts and Analysis, Oxford University Press India, 2006.

References:

1. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw -Hill, 2009.
2. M. P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey, Industrial Robotics Technology, Programming and Applications, McGraw Hill, Int. 2008.
3. Timothy Jordanides et al, Expert Systems and Robotics, Springer –Verlag, New York, 2007.
4. S. K. Saha, Introduction to Robotics, Tata Mcgraw Hill Education Private Limited, 2008.
5. J. J. Craig, Introduction to Robotics: Mechanics and Control, 3/e, Pearson Education, 2009

M. Tech. (Manufacturing Engineering), Semester – II, Elective-II	L	T	P	Credits
ME 636: Intelligent Manufacturing Systems	3	0	0	3

Concepts of Artificial Intelligence: **[10 Hours]**

Origin of Artificial Intelligence, Human and machine Intelligence, Branches of artificial intelligence, Programming in AI environment, Emergence of expert systems, Applications in Engineering and Manufacturing

Intelligent Manufacturing Systems – System components, System Architecture and Data Flow and System Operation

Knowledge Based Systems/Expert Systems: **[10 Hours]**

Expert systems: Expert system process, characteristics and components of expert systems,

Knowledge Acquisition: Knowledge acquisition phases, Methods of extracting knowledge from experts, Knowledge acquisition meetings, Group knowledge acquisition,

Knowledge Representation: Characteristics of knowledge, Knowledge representation models, Concepts of knowledge sets and Reasoning models.

Expert system justification and future directions for expert systems

Machine Learning: **[08 Hours]**

Machine Learning – Concept, Artificial Neural Networks, Biological and Artificial Neuron, Types of Neural Networks, Applications in manufacturing

Use of probability and fuzzy logic for machine thinking

Knowledge Based Group Technology: **[10 Hours]**

Group Technology: Models and Algorithms – Visual method, Coding method, Cluster analysis method

Knowledge based group technology – Group technology in automated manufacturing system, Structure of knowledge based system for group technology (KBSGT) – Database, Knowledge base, Clustering algorithm

Industrial Applications of AI: **[08 Hours]**

Intelligent system for design, equipment selection, scheduling, material selection, maintenance, facility planning and process control

[Total Teaching Hours: 45]

Text Books:

1. A. B. Badiru, Expert Systems Applications in Engineering and Manufacturing, Prentice-Hall, New Jersey, 1992.
2. Andrew Kussiak, Intelligent Manufacturing Systems, Prentice Hall, 1990.

References:

1. Robert Levine et al., A Comprehensive guide to AI and Expert Systems, McGraw Hill Inc, 1986.
2. Brent M. Gordon (Editor), Artificial Intelligence: Approaches, Tools and Applications, Nova Science Publisher, New York, 2011.
3. J. Paulo Davim (Editor), Artificial Intelligence in Manufacturing Research, Nova Science Publisher, New York, 2010.

M. Tech. (Manufacturing Engineering), Semester – II, Elective-II ME 638: Logistics and Supply Chain Management	L 3	T 0	P 0	Credits 3

Logistics and Supply Chain Management: Logistics Management-An Introduction, Key actors, Classification of Logistics Applications, Total logistics cost, Logistics to supply cahin Management **[02 Hours]**

Building a Strategic Framework to Analyze Supply Chains: Historical evolution of supply chain, Understanding the supply chain, supply chain performance: achieving strategic fit, supply chain drivers and metrics and case studies **[06 Hours]**

Designing the Supply Chain Network: Designing distribution networks and applications to e-business, network design in the supply chain, network design in an uncertain environment, and case studies. **[08 Hours]**

Planning Demand and Supply in a Supply Chain: Demand forecasting strategy in a supply chain, aggregate planning in a supply chain, sales and operation planning: Planning supply and demand in a supply chain, and case studies **[08 Hours]**

Planning and Managing Inventories in a Supply Chain: Managing economies of scale in a supply chain: cycle inventory, managing uncertainty in a supply chain: safety inventory, determining the optimal level of product availability, and case studies **[08 Hours]**

Designing and Planning Transportation Networks: Transportation strategy in a Supply Chain, and case studies **[05 Hours]**

Managing Cross-Functional Drivers in A Supply Chain: Sourcing decisions in a supply chain, pricing and revenue management in a supply chain, information technology in a supply chain, coordination in a supply chain, and case studies. **[08 Hours]**

[Total Teaching Hours – 45]

Text Books:

1. Sunil Chopra and Peter Meindel. Supply Chain Management: Strategy, Planning, and Operation, Pearson Education, 2010.
2. Martin Christopher. Logistics and Supply Chain Management: Strategies for Reducing cost and Improving Services, Pearson Education, 2010.
3. David Simchi Levi, Philip kaminsky, and Edith Simchi Levi. Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies. Irwin McGrawHill, 2000.

References:

1. Jeremy F. Shapiro. Modeling the Supply Chain. Duxbury Thomson Learning, 2001.
2. N. Viswanadham and Y. Narahari. Performance Modeling of Automated manufacturing Systems. Prentice Hall of India, 1998.

3. N. Viswanadham. Analysis of Manufacturing Enterprises. Kluwer Academic Publishers, 2000.
4. R.B. Handfield and E.L. Nochols, Jr. Introduction to Supply Chain Management. Prentice Hall, 1999.
5. Sridhar Tayur, Ram Ganeshan, Michael Magazine (editors). Quantitative Models for Supply Chain Management. Kluwer Academic Publishers, 1999.
6. W.J. Hopp and M.L. Spearman. Factory Physics: Foundations of Manufacturing Management. Irwin, McGraw-Hill, 1996.

M. Tech. (Manufacturing Engineering), Semester – II, Elective-II ME 640: Industrial Safety, Laws and Patent Acts	L	T	P	Credits
	3	0	0	3

Introduction: concept of safety, Health v/s wealth, dead & live resources, industrialisation & accidents, classifications, safety philosophy, physiological aspects, attitude, moral motivation, environment, problems etc. **[05 Hours]**

Accident Causation & Precautions: Causation or occurrence, accident problems, need for safety, reasons for accident prevention, factors impeding safety, basic terms in accident prevention, theories of accident causation, conceptual model theories, and principles of accident prevention. **[05 Hours]**

Statistics of Safety: Nature, sources & need of statistics, magnitude of problems, accident cost to person, management and to society, cost complication procedure, measurement of safety performance accident classification, industrial classification, Performa of accident statistics, tables. **[05 Hours]**

Safety Management: Concept, policy, responsibility, organisation, safety department tracing, awareness, motivation, hoarding, safety programs. **[05 Hours]**

Safety Design, Layout of Plant, Equipments & Machines: Safety factors, good housekeeping, effective treatments, ventilation, lighting, drinking water, material handling, fire protection, Indian standards, factors of sik selection, hazardous process, maintenance etc. **[05 Hours]**

Safety Norms in Various Industries: Textile industries, Diamond industries, food process industries, Pharmaceutical industries, Mine industries, Electronic industries, construction industries, chemical process, industries, petroleum industries, Engineering industries. **[05 Hours]**

Patent Act: Definition of patent, patentable classification, patent application, PCT norms for patents, patents organization, non patentability, specifications, types of patent, copy right, trade mark, case studies. **[05 Hours]**

Case studies: Electrical hazards, chemical hazards **[05 Hours]**

Industry Laws: Introduction to factory act 1948, trade union act, industrial dispute act, pay and wage act, ESI 1948, workman compensation act, 1923, Indian electricity rules, 1956, Indian boiler act 1923, first aid act etc. **[05 Hours]**

[Total Teaching Hours – 45]

Text Books:

1. K. U. Mistry, Course in Industrial safety, NKM Publisher, Ahemdabad, 2012.
2. K. C. Jain and L. N. Agarwal, Production Planning Control and Industrial management, Khanna Publisher, 1990.

References:

1. T. R. Banga and S. C. Sharma, Industrial organization and Engineering Economics, 24th Edition, Khanna Publisher.
2. Patent and copy right – TIFAC-DOC- 020

Modern Manufacturing Processes Lab (Semester – II)

List of Practicals:

1. Effect of process parameters on material removal rate during electro discharge machining process
2. Effect of process parameters on quality of cavity during electro chemical machining process
3. Design of horn for ultrasonic machining process
4. Cutting of different materials during water jet machining
5. Study of overcut during micro electro discharge machining process
6. Exercise on micro turning/micro milling
7. Exercise of laser cutting process
8. Assignments

Computer Integrated Manufacturing Lab (Semester – II)

List of Experiments:

1. Demonstration of CNC Milling machine with user interface and calculating the Co - ordinates of given geometry in absolute end increment mode for cutter path.
2. Introduction of G codes and M codes and write the CNC part programming for a given geometry using linear, Circular interpolation .
3. Write the CNC programming for a given geometry using Mirror and Subroutine.
4. Write the CNC programming for a given geometry using Tool Radius Compensation and Peck drilling cycles.
5. Introduction and programming of all canned cycle of milling machine.
6. Demonstration and study of CNC Lathe machine with sample programming.
7. Write CNC programming for given geometry (Lathe) using stock removal cycles
8. Demonstration of FMS setup.