Course: Metal Cutting Theory and Practice			Semester: I
Course Code: MET 5101	L T P	4 0 0	Credits: 4

Objective: To introduce the metal cutting parameters; and also to determine the physical and design interpretations of these parameters in the design of machine tools.

Syllabus

Mechanics of Metal Cutting **8**

Geometry of metal cutting process, chip formation, chip thickness ratio, radius of chip curvature, cutting speed, feed and depth of cut, types of chips chip breakers, orthogonal and oblique cutting processes, definition, forces and energy calculations (merchant's analysis), power consumed, MRR, effect of cutting variables on forces, force measurement using dynamometers.

Single Point Cutting Tool **5**

Various systems of specifications, single point cutting tool geometry and their inter-relation. theories of formation of built-up edge and their effect, design of single point contact tools throwaway inserts.

Multipoint Cutting Tool **9**

Drill geometry, design of drills, rake& relief angles of twist drill, speed, feed and depth of cut, machining time, forces, milling cutters, cutting speed & feed machining time- design from cutters; grinding- specifications of grinding of grinding wheel, mechanics of grinding, effect of grinding conditions on wheel wear and grinding ratio, depth of cut, speed, machining time, temperature power.

Tool Life and Tool Wear **8**

Theories of tool wear: adhesion, abrasive and diffusion wear mechanisms, forms of wear, tool life criteria and machinability index, types of sliding contact, real area of contact, laws of friction and nature of frictional force in metal cutting, effect tool angle, economics, cost analysis, mean co-effect of friction.

Cutting Temperature **10**

Sources of heat in metal cutting influence of metal conditions, temperature distribution, zones, experimental techniques, analytical approach, and use of tool work thermocouple for determination of temperature. temperature distribution in metal cutting; cutting fluids**:** functions of cutting fluids, types of cutting fluids, properties, selection of cutting fluids**;** cutting tool materials- historical developments, essential properties of cutting tool materials, types, composition and application of various cutting tool materials, selection of cutting tool materials.

Suggested Readings

1. Shaw M.C, *Metal Cutting Principles*, Oxford and IBH Publications, New Delhi, 1969.
2. Bhattacharya, *Metal Cutting Theory and Practice*, New central Book Agency pvt. Ltd., Calcutta, 2000.
3. Geoffrey Boothroyd and Knight. W.A, *Fundamentals of Machining and Machine tools*, Crc Press, New York, 2006.
4. Juneja. B. L and Sekhon.G.S, "Fundamentals of metal cutting and machine tools", New Age International pvt. Ltd., 2003.
5. Frank W. Wilson, *Fundamentals of Tool Design*, ASTME PHI 2010.
6. David Son, Lacain, Goud, *Tool Design*, Tata Mc Graw Hill.

Course: CNC Technology and Programming			Semester: I
Course Code: MET 5102	L T P	4 0 0	Credits: 4

Objective: To understand the fundamentals of the CNC technology and to understand the programming methods in CNC machines.

Syllabus

Introduction **8**

Computer numerical control machining: Axis standards, coordinate systems, CNC machine motions. CNC hardware basics: structure, drives, actuation systems, sensors and feedback devices.

Programming fundamentals **9**

Coding standards, preparatory functions, miscellaneous functions, programming features: tool length and radius compensation, tool nose radius compensation, canned cycles, branching logics, thread cutting, cut planning etc. fundamentals and programming of CNC turning center and CNC machining center, problems.

CNC Advanced Part Programming **10**

Automatically Programmed Tools (APT) language: Language structure, geometry commands, motion commands, post processor commands, compilation control commands, repetitive programming complete part program, problems. CAD/CAM aided CNC part programming: Use of WinNC, ELCAM and ELPULS for product design and manufacturing.

CNC Tooling **10**

Cutting tool material and characteristics, turning tool geometry, tooling system for turning, milling and wire cut EDM, tool presetting, automatic tool changers, work holding.

Suggested Readings

1. Stenerson Jon .S, Curran Kelly, *Computer Numerical Control: Operation and Programming*, Prentice Hall, 3rd edition 2007.
2. Mike Mattson, *CNC Programming: Principles & Applications*, Cengage learning, 1st edition 2013.
3. Fitzpatrick, *Machining and CNC Technology*, McGraw-Hill Higher Education, 3rd edition 2013.
4. Peterson Michael .J, *CNC Programming: Basics & Tutorial Textbook*, Create Space Independent Publishing Platform, 1st edition 2008.
5. Smid Peter, *CNC Tips and Techniques: A Reader for Programmers*, Industrial Press Inc., 1st edition 2013.

Course: Design and Analysis of Machine Tools			Semester: I
Course Code: MET 5103	L T P	4 0 0	Credits: 4

Objective: To introduce the tool design process, and also to design, develop, and evaluate cutting tools and work holders for a manufactured product.

Syllabus

Kinematics of Machine Tools **7**

Shaping of geometrical and real surfaces, developing and designing of kinematic schemes of machine tools, kinematics structures of lathe, drilling, milling, grinding, gear shaping and gear hobbing machines, kinematic design of speed and feed boxes, productivity loss, stepped and stepless regulation, clutched drive.

Strengths and Rigidity of Machine tool Structures **8**

Basic principles of design for strength, different types of structures, overall compliance of machine tools, design of beds, bases, columns, tables, cross rail for various machines, various types of guide ways, their relative advantages, materials for machine tool components including plastic guide way (PTFE).

Analysis of Spindles, Bearings, and Power Screws **8**

Design of spindles subjected to combined bending and torsion, layout of bearings, pre-loading, anti-friction slide ways, rolling contact hydrodynamic, hydrostatic, hydrodynamic design of journal bearings, magneto bearings, machine tool vibrations: effect of vibrations on machine tool, free and forced vibrations, machine tool chatter.

Computer- Aided Programming **8**

General information, APT programming, examples APT programming problems (2D machining only), NC programming on CAD/CAM systems, the design and implementation of post processors introduction to CAD/CAM software, automatic tool path generation.

Tooling for CNC Machines **9**

Interchangeable tooling system, present and qualifies tools, coolant fed tooling system, modular fixturing, quick change tooling system, automatic head changers, DNC systems and adaptive control- introduction, type of DNC systems, advantages arid disadvantages of DNC, adaptive control with optimization, adaptive control with constrains, adaptive control of machining processes like turning, grinding.

Suggested Readings

1. Mehta N.K, *Machine Tool Design and Numerical Control*, Tata McGraw Hill, 1997.
2. Sen and Bhattacharya, *Principles of Machine Tools*, Central book publishers, Calcutta 1995.
3. Basu S.K, *Machine Tool Design*, Oxford and IBH Publishing.

4. Acherkan N., *Machine Tool Design, Vol. I – IV*, Mir Publications.
5. Cyrll Donaldson, G.H.LeCain& V.C. Goold, *Tool Design*, Tata McGraw Hill, 1973.
6. CMTI, *Machine Tool Design Handbook*, McGraw-Hill

Course: Advanced Engineering Mathematics			Semester: I
Course Code: MAT 5101	L T P	3 1 0	Credits: 4

Objective: To familiarize the students to Complex analysis, statistical theory, finite element methods and calculus of variation.

Syllabus

Complex Integration **14**

Cauchy-Goursat Theorem (for convex region), Cauchy's integral formula, Higher order derivatives, Morera's Theorem, Cauchy's inequality and Liouville's theorem, Fundamental theorem of algebra, Maximum modulus principle, Taylor's theorem, Schwarz lemma.Laurent's series, Isolated singularities, Meromorphic functions, Rouche's theorem, Residues, Cauchy's residue theorem, Evaluation of integrals, Riemann surfaces.

Probability and Statistics **10**

Basic Probability Concepts, Discrete Random Variable, Expected Value and Variance of a Discrete Random Variable, Measure of Probability Function, Continuous Random Variable, Exponential Distribution, Mean and Variance of Continuous Distribution, Normal Distribution.

Finite Element Method **10**

Finite element formulation of boundary value problems, one and two dimensional finite element analysis.

Calculus of Variation **10**

Functions and their differentiation, Euler-Lagrange equation, Boundary value problems, Variational principles, Rayleigh-Ritz Methods

Suggested Readings:

1. E.Kreyszig, *Advanced Engineering Mathematics*, 9th ed., John Wiley (2005).
2. J. H. Mathews, and R. Howell, *Complex analysis for Mathematics and Engineering*, Narosa, 2005
3. V. Sundarapandian, *Numerial Linear Aalgebr*a, Prentice-Hall, 2008.
4. R. L.Burden and J. D. Faires, *Numerical Analysis*, Brooks/Cole, 2001
5. I. M. Gelfand and S. V. Fomin, *Calculus of Variations*, Prentice Hall, 1963
6. A. S. Gupta, *Calculus of Variations with Applications*, Prentice Hall, 1997
7. R. K. Jain, and S. R. K Iyengar, *Advanced Engineering Mathematics*, Narosa (2005).
8. M. D. Greenberg, *Advanced Engineering Mathematics*, Pearson Education (2007).
9. R. V. Churchill and J. W. Brown. *Complex Variables and Applications*, 6thed., McGraw-Hill (2004).

Course: Production Planning and control (Elective I)			Semester: I
Course Code: MET 5110	L T P	4 0 0	Credits: 4

Objective: To provide practicing engineers a foundation that helps the students to engage in continuous professional and organizational development in response to technological and system management challenges in manufacturing.

Syllabus

Strategy Planning **6**

Nature of production-inventory management systems, strategic, tactical and operational decisions, general discrete location-allocation problems, features and formulations, facility location models, median model, distribution model brown and Gibson model.

Tactical Planning **7**

Aggregate production planning, ways to absorb demand fluctuations, costs relevant to aggregate production planning, aggregate production planning models, Inventory management, EOQ decision rules, costs in an inventory system, simple lot size model.

Scheduling **8**

Operations scheduling, Flow shop jobs, 2 machine Johnson's rule, 2 Jobs-M machine, N-Jobs M machine Sequencing Job on parallel machine, Assembly Line Balancing, Project Scheduling, crashing of project network with cost trade off.

MRP & MRP-II **8**

Material Requirement Planning (MRP), working of MRP, use of MRP system, evolution from MRP to MRP II, master production scheduling, rough cut capacity planning capacity requirement planning, Lot sizing in MRP II system.

SCM & Quality Management **7**

Concept of supply management and SCM, flow in supply chains, key issues in supply chain management, decision phases in supply chain, concept of quality management, standards for quality management, statistical process control, Taguchi method of quality control.

Suggested Readings

1. H.G. Menon, *"TQM in New Product Manufacturing"*, Mc Graw Hill, 1992.
2. Hax and Candea, *"Production and Inventory Management"*, Prentice Hall, 1984.
3. Buffa, *"Modern Production Management"*, John Wiley, 1983.

Course: Rapid Prototyping systems (Elective I)			Semester: I
Course Code: MET 5111	L T P	4 0 0	Credits: 4

Objective: To introduce the fundamentals of rapid prototyping and automated fabrication, including the generation of suitable CAD models, and current rapid prototyping fabrication technologies.

Syllabus

Introduction **5**

Prototyping fundamentals, historical development, fundamentals of rapid prototyping, advantages and limitations of rapid prototyping, commonly used terms, classification of RP process, rapid prototyping process chain: fundamental automated processes, process chain.

Liquid-based Rapid Prototyping Systems **12**

Stereo lithography apparatus (SLA) models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies; solid ground curing (SGC)- models and specifications, process, working principle, applications, advantages and disadvantages, case studies solid-based rapid prototyping systems; laminated object manufacturing (LOM)- models and specifications, process, working principle, applications, advantages and disadvantages, case studies; fused deposition modeling (FDM), models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

Powder Based Rapid Prototyping Systems **10**

Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies; three dimensional printing (3dp) models and specifications, process, working principle, applications, advantages and disadvantages, case studies; rapid tooling- introduction to rapid tooling (RT), conventional tooling vs. RT, need for RT; rapid tooling classification- indirect rapid tooling methods, spray metal deposition, RT epoxy tools, ceramic tools, investment casting, spin casting, die casting, sand casting, 3d kel tool process; direct rapid tooling- direct aim, LOM tools, DTM rapid tool process, EOS direct tool process and direct metal tooling using 3dp.

Rapid Prototyping Data Formats **6**

STL Format, STL File problems, consequence of building valid and invalid tessellated models, STL file repairs: generic solution, other translators, newly proposed formats; Rapid Prototyping Software's: Features of various RP software's like magic's, mimics, solid view, view expert, 3 D view, velocity 2 , Rhino, STL View 3 Data Expert and 3 D doctor.

RP Applications **8**

Application, material relationship, application in design , application in engineering, analysis and planning, aerospace industry, automotive industry, jewelry industry, coin industry, GIS application, arts and architecture. RP medical and bioengineering applications: planning and simulation of complex surgery, customized implants & prosthesis, design and production of medical devices, forensic science and anthropology, visualization of biomolecules.

Suggested Readings

1. Chua C.K., Leong K.F. and LIM C.S, *Rapid prototyping: Principles and Applications*, World
2. Scientific publications, Third Edition, 2010.
3. Paul F. Jacobs, *Stereo lithography and other RP & M Technologies*, SME, NY 1996.
4. Lament wood, *Rapid automated*, Indus press New York.
5. Pham D.T and Dimov S.S, *Rapid Manufacturing*, Springer , 2001.
6. Terry Wohlers, *Wohler's Report 2000*, Wohler's Association 2000.

Course: Measurement systems and accuracy (Elective I)			Semester: I
Course Code: MET 5112	L T P	4 0 0	Credits: 4

Objective: To introduce students to fundamental theories and technologies for precision design, accuracy of numerical control systems, tolerances and fits, acceptance tests for machine tools, and dimensional wear.

Syllabus

Concepts of Accuracy **7**

Introduction, concept of accuracy of machine tools, Spindle and displacement accuracies, Accuracy of numerical control systems, Errors due to numerical interpolation, Displacement measurement system and velocity lags.

Geometric Dimension and Tolerance **7**

Interpretation, measurement and application of form tolerances, Datum system and targets, Tolerance of position, Tolerance zone conversions, Surfaces, features of size, datum features, Datum, Oddly configured and curved surfaces as datum features, Equalizing datum.

Surface and Form Metrology **8**

Flatness, roughness, waviness cylindricity etc. Methods of improving accuracy & surface finish, Influence of forced vibration on accuracy, Dimensional wear of cutting tools and its influences on accuracy

Precision Measuring Systems **14**

Units of length, Legal basis for length measurement, traceability, processing system of nanometer accuracies, LASER light source, LASER interferometer, LASER alignment telescope , LASER micrometer-on-line and in-process measurements of diameter and surface roughness using LASER, micro holes and topography measurements, in processing or in-situ measurement of position of processing point-post process and on-machine measurement of dimensional features and surface-mechanical and optical measuring systems. straightness and flatness measurement, optoelectronic measurement systems in metrology, optoelectronics devices contact and non-contact types applications tool wear measurement, 3D Surface roughness, Pattern generation studies.

Nano-Positioning Systems of Nano Accuracy & Repeatability **14**

Guide systems for moving elements, Servo control systems for tool positioning, Computer Aided digital and ultra-precision position control.

Computer Integrated Quality Assurance **10**

Concept of Total quality control & quality assurance, zero defects, Pokayoke Statistical evaluation of data using computer, CNC, CMM applications, Computer Aided measurement, data integration of 3D - CMM

Suggested Readings:

1. Murthy R.L, *Precision Engineering in Manufacturing*, New Age International(P) Limited publishers, 1996.
2. amesd. Meadows, *Geometric Dimensioning and Tolerancing*, Marcel Dekker Inc.1995.
3. Watson J., *Optoelectronics*, Van Nostrand Rein hold(UK)Co ltd.,1988
4. Robert.G. Seippel, *Optoelectronics for Technology and Engineering*, Prentice Hall NewJersey,1989
5. Ulrich-Rembold, Armbruster and Ulzmann, *Interface Technology for Computer Controlled Manufacturing Processes*, Marcel Dekker Pub. New York, 1993
6. G.G.Thomas., *Engineering Metrology*, Butterworth Publications.1974.
7. Norio Taniguchi, *Nano Technology*, Oxford university Press,1996.

Course: Advanced Tribology (Elective I)			Semester: I
Course Code: MET 5113	L T P	4 0 0	Credits: 4

Objective: To understand the nature of engineering surfaces, their topography and learn about surface characterization techniques.

Syllabus

Historical background Viscosity **7**

Viscometry, effect of temperature on viscosity, effect of pressure in viscosity, other physical properties of mineral oils, the generalized Reynolds equation, flow and shear stress, the energy equation, the equation of state, mechanism of pressure development.

Circumferential Flow **8**

oil flow through a bearing having a circumferential oil groove – heat generation and lubricant temperature, heat balance and effective temperature, bearing design, practical considerations, design of journal bearings, parallel surface bearing, step bearing -some situations under squeeze film lubrication, the mechanism of hydrodynamic instability -stiffness and damping coefficients, stability.

Elasto hydrodynamic Lubrication **6**

theoretical consideration, grubin type solution, accurate solution, point contact, dimensionless parameters, film thickness equations -different regimes in EHL contact, deep-groove radial bearings, angular contact bearings -thrust ball bearings, geometry, kinematics, stress and deformations, load capacity.

Surface Topography **6**

surface characterization, apparent and real area of contact, derivation of average Reynolds equation for partially lubricated surface, effect of surface roughness on journal bearings

Laws of friction **6**

friction theories, surface contaminants, frictional heating, effect of sliding speed on friction, classification of wear, mechanisms of wear, quantitative laws of wear, wear resistance materials.

Suggested Readings

1. B.C Majumdar, *Introduction to Tribology of Bearings*
2. Kenneth C Ludema, *Friction. Wear, Lubrication: A Text book in Tribology*, CRC Press,1st Edition
3. John Williams *Engineering Tribology* Cambridge University Press, 2005
4. Bharat Bhushan, Wiley *Introduction to Tribology*, 2nd Edition
5. Prasanta Sahoo, *Engineering Tribology*, PHI Learning
6. Stachowiak & Batchelor, Butterworth, Heinimann, *Engineering Tribology*, 2005

Course: Soft Computing Techniques (Elective I)			Semester: I
Course Code: MET 5114	L T P	4 0 0	Credits: 4

Objective: To introduce students to the fundamentals of neural networks, fuzzy systems, and optimization techniques.

Syllabus

Genetic Algorithms **10**

Introduction to genetic Algorithms (GA), goals of optimization, differences and similarities between genetic algorithm and traditional methods, schemata, terminology of GA, strings, structure, parameter set, coding, fitness function, data structures, GA operators, algorithm.

Simulated Annealing **8**

Introduction, algorithm, applications, Tabu search: introduction, algorithm, applications.

Fuzzy Logic **12**

The concept of uncertainty and associated solutions, fuzzy sets, basic properties and characteristics of fuzzy sets, fuzzy set operations, fuzzy reasoning, major components of a fuzzy logic system, design aspects of fuzzy systems, applications of fuzzy logic.

Artificial Neural Networks **14**

Basics of artificial neural networks (ANN), characteristics of ANN, historical development, terminology, models of neuron, topology, basic learning laws, overview of neural computing, neural approaches to computing, engineering approaches to computing, relationship of ANNs to other technologies, ANNs learning approaches, training set and test set, generalization, learning curves, applications of ANN in optimization, simple examples.

Suggested Readings

1. Deb. K., *Optimization for Engineering Design*, Prentice Hall of India (P) Ltd., New Delhi, 1998.
2. Goldberg, D.E., *Genetic Algorithms in Search, Optimization, and Machine Learning*, Addison,Wesley, 1989.
3. Schalkoff. R.J., *Artificial Neural Networks*, McGraw,Hill Companies Inc., 1997.
4. Sundareswaran. K., *A Learner's Guide to Fuzzy Logic Systems*, Jaico Publishing House, 2005.
5. Yegnanarayanan. B, *Artificial Neural Networks*, Prentice Hall of India, 1999.

Course: Advanced CAD			Semester: II
Course Code: MET 5201	L T P	4 0 0	Credits: 4

Objective: To develop an understanding of the basic principles underlying computer aided tools used in engineering applications with CAD software.

Syllabus

Introduction to CAD **6**

Definition of CAD, designs criteria, design tool, CAD tools, design analysis, functional areas CAD, and CAD softwares and their efficient use, geometric modelling: interpolation and extrapolation of curves, properties of splines, wire frame modeling: wire frame entities and modeling. Synthetic Curves: Hermite, Bezier and B-spline Curves and their properties.

Surface Modeling **4**

Analytic and synthetic surfaces, planar rule, surface of revolution, tabulated cylinder, synthetic Surface: Bi cubic, Bezier, B - spline and NURBS Surfaces.

Computer- Aided Programming **6**

General information, APT programming, examples of APT programming problems (2D machining only), NC programming on CAD/CAM systems, the design and implementation of post processors introduction to CAD/CAM software, automatic tool path generation.

Advanced Surfaces **8**

Coons, blending, sculptured surfaces, surface manipulation, displaying segmentation, trimming, intersection. Transformations**:** 2-D and 3-D transformations, homogeneous transformation and cancatenation.

3-D Modelling **8**

B - Rep, C-Rep, cell decomposition, spatial occupancy and enumeration, primitive instancing. Graphics Standards**:** IGES, STEP, ACIS and DXF. Design Applications**:** mechanical tolerances, mass properties, mechanical assembly, finite element modeling (mesh).

Collaborative Engineering **8**

Collaborative design, mockup design, morphology, behavioral and feature based modeling and analysis, sensitivity analysis, conceptual, bottom up and top down design approach.

Suggested Readings:

1. Zeid lbrahim, *CAD/CAM, Theory and Practice*, 2nd Edition, Mc Graw Hill international.
2. Rosers David, *Mathematical Elements for Computer Graphics*, 2nd Edition Tata Mc Graw Hill 2002.
3. Rao P.N, *CAD/CAM, Principles and Applications*, 3rd Edition Tata Mc Graw Hill 2010.
4. Hamington Steven, *Computer Graphics*, 2nd Edition Tata Mc Graw Hill 1987.

Course: Theory of Electro Mechanical Systems			Semester: II
Course Code: MET 5202	L T P	4 0 0	Credits: 4

Syllabus

Mechatronics systems, elements **8**

Levels of Mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of Mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

Solid state electronic devices **6**

PN junction diode, BJFET, DIA and TRIAC, analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications.

Hydraulic and pneumatic actuating systems **6**

Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems: Mechanical actuating systems and electrical actuating systems.

Digital electronics and systems **7**

Digital logic control, micro-processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

System and interfacing and data acquisition **7**

DAQS, SCADA, A to D and D to A conversions: Dynamic models and analogies, system response. Design of Mechatronics systems & future trends.

Suggested Readings

1. Ramchandran K.P and GK Vijya Raghavan, *Mechatronics Integrated Mechanical Electronics Systems*, WILEY India Edition, 2008.
2. Bolton.W, *Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering*, Pearson Education Press, 3rd edition, 2005.
3. Braga Newton .C, *Mechatronics Source Book*, Thomson Publications, Chennai.
4. Onwubolu Godfrey.C, *Mechatronics – Principles and Application*, Elsevier, 2006

Course: Advanced Mechanical Vibrations (Elective)			Semester: II
Course Code: ME 5210	L T P	4 0 0	Credits: 3

Objective: To introduce students to the fundamentals of vibration theory, mathematical models and real-world mechanical vibration problems.

Syllabus

Single Degree of Freedom Systems **12**

Undamped and damped free vibrations; forced vibrations coulomb damping; response to excitation; rotating unbalance and support excitation; vibration isolation and transmissibility-response to non-periodic excitations: unit impulse, unit step and unit ramp functions; response to arbitrary excitations, the convolution integral; shock spectrum; system response by the Laplace transformation method.

Two Degree Freedom Systems **8**

Principal modes- undamped and damped free and forced vibrations; undamped vibration absorbers.

Multi Degree Freedom Systems **10**

Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi- rotor systems and geared systems; Discrete- Time systems. Vibration measuring instruments: Vibrometers, velocity meters & accelerometers.

Frequency Domain Vibration Analysis **6**

Over view, machine-train monitoring parameters-Data base development-vibration data acquisition-trending analysis-failure- node analysis-signature analysis-root cause analysis.

Numerical Methods **6**

Raleigh's stodola's, Matrix iteration, Rayleigh- Ritz Method and Holzer's methods.

Suggested Readings

1. Grover, *Mechanical Vibrations*, Nem Chand and Bros.
2. Meirovitch, *Elements of Vibration Analysis*, TMH, 2001.
3. Thomson W.T, *Theory of Vibration with Applications*, CBC Publishers.
4. Schaum Series, *Mechanical Vibrations*, McGraw Hill.
5. Rao S.S, *Mechanical Vibrations*, Pearson, 2009.
6. Debabrata Nag, *Mechanical Vibrations*, Wiley.
7. Timoshenko S.P, *Vibration problems in Engineering*.
8. Ambedkar A.G, *Mechanical Vibrations and sound engineering*, PHI.

Course:	Metrology and Computer Aided Inspection (Elective)		Semester: II
Course Code: MET 5211	L T P	4 0 0	Credits: 4

Objective: To understand the importance of measurement and inspection in manufacturing industries and to operate and use advanced metrological devices with ease in industrial environments.

Syllabus

General Concepts of Measurement **8**

Definition, standards of measurement, errors in measurement, accuracy, precision, sensitivity and readability, calibration of instruments, selection and care of instruments.

Linear and Angular Measurements **10**

Length standard, line and end standard, slip gauges, micrometers, verniers, dial gauges comparators, various types, principle and applications, angular measuring instruments, bevel protractor, levels, clinometers, sine bar, angle dekkor, autocollimator.

Measurement of Form Errors, Surface Roughness and Measuring Machines **8**

Straightness, flatness, alignment errors, surface texture, various measuring instruments, run out and concentricity, Tool maker's microscope-metro scope

Measurement of Screw Threads and Gears **6**

Various elements of threads, 2 wire and 3 wire methods, gears elements, various errors and measurements.

Computer Aided and Laser Metrology **8**

Coordinate measuring machine, LASER micrometer, Introduction to Interferometer, optical LASER interferometers, applications.

Suggested Readings

1. Gupta I.C, *A Text Book of Engineering Metrology*, Dhanpat Rai and Sons, 2000
2. Jain R.K and S.C.Gupta, *Engineering Metrology*, Dhanpat Rai and Sons, 2000.
3. Galyer G.N and Shotbolt C.R, *Metrology for Engineers*, ELBS Edn 1990.
4. *ASTME Handbook of Industries Metrology*, Prentice Hall of India Ltd., 1992.
5. Robert.G. Seippel, *Optoelectronics for technology and engineering*, Prentice Hall New Jersey,1989.
6. Parson. S, *Metrology and Gauging*, McDonald & Evans, 1970.
7. Smith,G.T., *Industrial Metrology*, Springer, 2002
8. Bewoor, A.K. and Kulkarni,V.A., *Metrology and Measurement*, Tata Mc Graw-Hill, 2009.

Course:	Micro and Nano Manufacturing Systems (Elective)		Semester: II
Course Code: MET 5212	L T P	4 0 0	Credits: 4

Objective: To understand the principles of various micro and nano manufacturing methods, along with their synthesis and applications.

Syllabus

Scope of Nano Technology **10**

Nano technology concepts and applications micro and nanofabrication, nano technology in India scope for microfabrication, rise nano technology fields commercialization issues of micro-nano technology

Microfabrication **18**

mechanical micromachining, physical fabrication methods, lithography, processing setup, nano lithography & manipulation, precision micro- and nano grinding, use of spectrometers & microscopes laser-based micro- and nanofabrication pulsed water drop micromachining, nano materials, synthesis of nanomaterials, bio materials, nano composites, development of nano particles

Innovative Applications on Present Devices **4**

Nanochips, nanotubes and nanowires, integration of chips and microprocessors, technology support, meeting social needs

Nano Design & CAD **6**

Computer Aided Nano Design, VLSI product detailing Finite Element Analysis of Microstructures, 3-D Molecular Modelling

Acceptability of Nano Workmanship **4**

Nano to millimeter Integration Atomic Scale Precision & Control, Promising Nano-centered Future

Suggested Readings

1. Mark J. Jackson, *Microfabrication &Nano manufacturing*, 3rd Edition
2. ASM, *Handbook on Machining.*
3. Bharat Bhusan, *Springer's Hand book of Nano-technology*.
4. WR Fahrner, *Nanotechnology and Nano electronics*, Springer International Z. Cui, Nanofabrication, Springer, 2008

Course: Supply Chain Management (Elective)			Semester: II
Course Code: MET 5213	L T P	4 0 0	Credits: 4

Objective: To familiarize students to corporate strategic objectives: reducing working capital, taking assets off the balance sheet, accelerating cash-to-cash cycles, increasing inventory turns, and so on.

Syllabus

Introduction to supply chain management **12**

Supply chain basics, decision phases in supply chain, supply chain flows, supply chain efficiency and responsiveness, supply chain integration, process view of a supply chain, uncertainties in supply chain, key issues in supply chain management, and drivers of supply chain performance. Supply chain coordination, bullwhip effect, developing relationships in the supply chain, resolving conflicts in supply chain relationships, role of information technology in supply chain

Demand forecasting in supply chain **8**

Role of forecasting in supply chain, components of a forecast, forecasting methods, estimating level, trend and seasonal factors, Holt's model, Winter's model, measures of forecast error

Role of aggregate planning in supply chain **6**

Aggregate planning strategies, managing supply and demand in supply chain.

Supply chain inventory **10**

Role of cycle inventory in supply chain, economies of scale, lot sizing for a single product, lot sizing for multiple products, quantity discounts, trade promotions, price discrimination. Role of safety stock in supply chain, determining appropriate level of safety inventory, inventory replenishment policies, measures of product availability.

Sourcing decisions in supply chain **4**

Supplier selection and contracts, design collaboration, making sourcing decisions in practice.

Transportation decisions **4**

Role of transportation in supply chain, factors affecting transportation decisions. Routing and scheduling in transportation

Logistics **6**

Definition, logistics and SCM, international considerations, inbound logistics, internal logistics and outbound logistics. Reverse logistics, green supply chain.

Suggested readings

1. Sunil Chopra and Peter Meindl, *Supply chain management - strategy planning and operation*, PHI

2. Handfield R. B., Nichols Jr. E. L., *Introduction to supply chain management*, Pearson
3. Education
4. Raghuram R. and Rangaraj N., *Logistics and supply chain management*, Macmillan,
5. 2001
6. Simchi-Levi, D., Kaminsky, P., and Simchi-Levi, E., *Designing & managing the supply*
7. *chain: concepts, strategies & case studies*, 2nd Edition, Tata McGraw-Hill, 2003
8. Agarwal D. K., *A text book of logistics and supply chain management*, Macmillan,
9. 2003
10. Srinivasan, G., *Quantitative models in operations and supply chain management*, PHI

Course:	Design and Analysis of Experiments (Elective)		Semester: II
Course Code: MET 5214	L T P	4 0 0	Credits: 4

Objective: To develop the guidelines for designing experiments and to recognize the key historical figures in the design of experiments.

Syllabus

Introduction **12**

Introduction to design of experiments, research methodology, The economics of reducing variation, quality characteristics and objective functions, Taguchi quality loss function, DOE process – steps and description, Typical test strategies, Better test strategies- full factorial experiments, fractional factorial experiments, standard orthogonal arrays and linear graphs.

Orthogonal arrays and Linear Graphs **12**

Construction of orthogonal arrays and modification of linear graphs, introduction to analysis of variance (ANOVA), analogy with Fourier analysis, No way ANOVA, one way ANOVA, two way ANOVA, three way ANOVA, signal to noise (S/N) ratio, sum of squares, degrees of freedom, F-test, p-value, pooling, percent contribution, interpretation, examples on ANOVA.

Levels and Noise Factors **12**

Control factors and their levels and noise factors. Two level experiments (2^K design), blocking and confounding, three level experiments (3^K design), mixed level experiments, multiple level experiments, polynomial effects, confirmation experiments, additive models, Latin squares and related designs, case studies.

Response surface methodology (RSM) **12**

First order model, second order model, stationary point, central composite design (CCD), Box-Behnken design, Face centered cubic design (FCCD), surface plots. Fitting regression models, model building, adequacy checking of models and case studies.

Suggested Readings

1. Phadake M. S, *Quality Engineering and Robust Design*, Prentice Hall, Englewood Cliffs, New Jersy, 1989.
2. Montgomery D. C, *Design and analysis of experiment*, Wiley, 5th edition, India, 2005.
3. Ross P.J, *Taguchi Techniques for quality engineering*, Tata Mc-Graw Hill, 2nd edition, 2005.

Course: Advanced Manufacturing Processes (Elective)			Semester: II
Course Code: MET 5215	L T P	4 0 0	Credits: 4

Objective: To enhance the knowledge in the field of manufacturing systems through the analysis of basic unconventional processes.

Syllabus

Surface treatment **6**

Scope, cleaners, methods of cleaning, surface coating types, and ceramic and organic methods of coating, economics of coating, electro forming, chemical vapour deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

Non-Traditional Machining **8**

Introduction, need, AJM, Parametric Analysis, Process capabilities, USM –Mechanics of cutting, models, Parametric Analysis, WJM –principle, equipment, process characteristics, performance, EDM – principles, equipment, generators, analysis of R-C circuits, MRR, Surface finish, WEDM.

Laser Beam Machining **8**

Principle of working, equipment, material removal rate, process parameters, performance characterization, applications, Plasma Arc Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications

Electron Beam Machining **6**

Principle of working, equipment, material removal rate, process parameters, performance characterization, applications, Electro Chemical Machining – Principle of working, equipment, Material removal rate, process parameters, performance characterization, Applications.

Processing of Ceramics **4**

Applications, characteristics, classification .Processing of particulate ceramics, Powder preparations, consolidation, drying, sintering, Hot compaction, Area of application, finishing of ceramics.

Processing of Composites **3**

Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

Fabrication of Microelectronic devices **9**

Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in microelectronics, surface mount technology, Integrated circuit economics, E-Manufacturing, nanotechnology, and micromachining, High speed Machining.

Suggested readings

1. Kalpakijian, *Manufacturing Engineering and Technology*, Adisson Wesley, 1995.
2. Lindburg R. A, *Process and Materials of Manufacturing*, 4th edition, PHI 1990.
3. Chang Liu, *Foundation of MEMS*, Pearson, 2012.

Course: Facility Planning and layout (Elective)			Semester: II
Course Code: MET 5216	L T P	4 0 0	Credits: 4

Objective: To introduce students to the basic concepts of facility layout planning and mass production management.

Syllabus

Introduction **12**

Types of manufacturing processes, overview of plant design, plant location, location factors, location theory, nature, significance and scope of facilities layout planning. plant layout: need for layout, objectives, types of layout, layout design process, layout design cycle, data collection, equipment requirement, activity analysis, REL Diagram, employee requirement, development of layout, block plan, selection, specification, evaluation.

Single Facility Location Problems **12**

Rectilinear distance problems, squared Euclidean distance problems and Euclidean distance problems, contour lines (iso-cost lines). introduction to multifacility location problems: formulation of problems, LP formulation with rectilinear distance.

Computerized Layout Planning **10**

Basic Philosophy in computerized Layout Planning, Construction and Improvement Algorithms, Major features of Improvement Algorithms, major Features of computerized algorithms, such as ALDEP, CORELAP, CRAFT, FRAT, and MAT. Formulation of Layout Problems: Quantitative, Qualitative, and multi-objective, Limitation of computerized layout planning, flow dominance, complexity rating, solution efficiency.

Mass Production Management (Line Balancing) **9**

Basic idea of assembly line balancing, Optimization of number of stations with given production rate, Minimization of cycle time with fixed number of stations, Line Balancing Algorithms**:** Kilbridge and Wester, Rank Positional Weight method, COMSOAL, Moodie and Young method.

Suggested readings

1. Francis, R.L. and White, J.A., Facility Layout and Location: An Analytical Approach, Prentice-Hall
2. Inc., New Jersey, 1974.
3. Moore, J.M., Plant Layout and Design, Macmillan Company, New York, 1970.
4. Wild, R., Mass Production Management, John Wiley and Sons, New York.
5. Apple, J.M., Plant Layout and Material Handling, John Wiley and Sons, New York.
6. Tompkins and White, Facilities Planning, John Wiley and Sons, New York.

Course: Financial Management (Elective)			Semester: III
Course Code: MET 6110	L T P	4 0 0	Credits: 4

Objective: To introduce the concepts of accounting, financial policies and planning and management.

Syllabus

Cost Management Concepts **10**

Concepts of cost, cost behavior and CVP relationships, cost functions, methods of measuring cost functions, applications.

Product Costing Systems **10**

Job costing, process costing, variable and absorption costing, standard costing, variance analysis, ABC costing.

Accounting **10**

Conceptual basis of accounting, Balance sheet, classify assets, liabilities and equity items, construction of a balance sheet, balance sheet changes, preparation of profit & loss account, funds and cash flow statement, forms of ownership

Financial Management **12**

Working with financial statements, ratio analysis, time value of money, stock valuation, bond valuation, Capital budgeting, traditional techniques, discounted cash flow techniques, risk analysis. Cost of capital and long term financial policy: Raising capital, cost of capital, Financial and operating leverage, capital structure theories, dividends theories, short-term financial planning, working capital, planning and management.

Suggested readings

1. Khan M.Y. and Jain P.K, *Financial Management*, 3rd edition, Tata McGraw Hill 2003.
2. Ramachandran, N and Ram Kumar Kakani, *Financial Accounting for Management*, 2nd
3. edition, Tata McGraw-Hill(2005).
4. Khan and Jain, *Management and Cost Accounting*, 2nd edition, Tata McGraw Hill Delhi.
5. Pandey I.M., *Financial Management*, 8th edition, Vikas publishing house 2003.
6. Prasanna Chandra, *Financial Management*, 4th edition., Tata McGraw Hill 2003.
7. Jawahar Lal, *Financial Accounting*, 2nd edition., Wheeler publishing 2000.
8. Horngreen, *Cost Accounting – A Managerial emphasis*, 11th edition Pearson Education, Asia, 2002.
9. Horngreen, *Introduction to management Accounting*, 11th edition, Pearson Education, Asia, 2002.

Course: Flexible Manufacturing Systems (Elective)			Semester: III
Course Code: MET 6111	L T P	4 0 0	Credits: 4

Objective: To introduce students to the concepts of product life cycle and explain how automation and control technologies relate to the various phases of the cycle.

Syllabus

Flexibility and Automation **10**

Flexibility and automation, different types of flexibilities in manufacturing, volume variety relationships for understanding manufacturing systems, different types of FMS, building blocks of flexible manufacturing systems; work stations, storage retrieved systems, material handling systems and computer control system. machining of FMS; horizontal & vertical matching centers, automatic storage and retrieved systems, FMS control systems

Group Technology and Cellular Manufacturing **7**

Part families formation, selection of classifications and coding systems, production flow analysis, cellular manufacturing computer aided process planning

Layout **8**

Layout consideration for flexible manufacturing, scheduling of flexible manufacturing systems

FMS Simulation **6**

Future developments in FMS, case studies on FMS

Suggested Readings

1. Nanua Singh, *Systems Approach to Computer Integrated Design and Manufacturing Automation, Production Systems*
2. Groover M.P, *Automation, Production Systems and Computer Integrated Manufacturing*
3. Maleki R.A, *Flexible Manufacturing Systems*
4. Nand K. Jha, *Hand Book of Flexible Manufacturing Systems*

Course: Finite Element Analysis (Elective)			Semester: III
Course Code: MET 6112	L T P	4 0 0	Credits: 4

Objective: To develop proficiency in the application of the finite element method (modeling, analysis, and interpretation of results) to realistic engineering problems through the use of a major commercial general-purpose finite element codes.

Syllabus

Introduction to FEM **8**

Basic concepts, application of FEM, general description, advantages of FEM, comparison of FEM with other methods : finite difference method, variational method, Galerkin Method, basic element shapes, interpolation function, virtual energy principle, treatment of boundary conditions, solution of system of equations, basic equations of elasticity, strain displacement relations.

1-D structural problems **4**

Axial bar element – stiffness matrix, load vector, temperature effects, quadratic shape function, analysis of trusses – plane truss and space truss elements.

Analysis of beams and frames **3**

Hermite shape functions, stiffness matrix, load vector problems, analysis.

2-D problems **4**

CST, force terms, stiffness matrix and load vector, boundary conditions, isoparametric element, quadric element, shape functions, numerical Integration, 3-D problems, tetrahedron element, Jacobian matrix, stiffness matrix.

Axis Symmetric formulations **4**

Finite Element Modeling, triangular element, problem modeling and boundary conditions.

Dynamic considerations **4**

Dynamic equations, consistent mass matrix, Eigen values, Eigen vector, natural frequencies, mode shapes, modal analysis.

Applications of FEM in Analysis of Manufacturing process **8**

Applications of FEM in various metal forming process- Extrusion, deep drawing , closed die forming etc. Metal mechanics: Eulers and Lagrange approach, applications of FEM in solidification of castings, applications of FEM in welding.

Computer Implementations **6**

Pre-processing, mesh generation, elements connecting, boundary conditions, input of material and process characteristics, solution and post processing, overview and application packages.

Suggested Readings

1. Reddy J.N, *An Introduction to the Finite Element Methods,* McGrawHill, NewYork.
2. Tirupathi K. Chandrupatla and Ashok D. Belagundu, *Introduction to finite elements in engineering*.
3. Rao S.S, *An Introduction to Finite Element Methods*, Pegamon, New York.
4. Alavala, *Finite Element Methods*, PHI
5. Aienkowitz O.C, *The Finite element method in Engineering Science*, Mc Graw Hill.
6. Robert Cook, *Concepts and applications of finite element analysis*.
7. Bathe K.J, *Finite Element Methods in Engineering analysis*.
8. Kobayashi.S, Soo-ik-oh and Altam.T, *Metal forming and the finite elements methods*, Oxford university press, 1989

Course: Tool Design(Elective)			Semester: III
Course Code: MET 6113	L T P	4 0 0	Credits: 4

Objective: To design, develop, and evaluate cutting tools and work holders for a manufactured product and to use CAD and conventional techniques in creating tool drawings.

Syllabus

Kinematics of Machine Tools **12**

Shaping of geometrical and real surfaces, developing and designing of kinematic schemes of machine tools, kinematics structures of lathe, drilling, milling, grinding, gear shaping and gear hobbing machines. Kinematic design of speed and feed boxes. Productivity loss. Stepped and stepless regulation, clutched drive.

Strengths and Rigidity of Machine tool Structures **12**

Basic principles of design for strength. Different types of structures. Overall compliance of machine tools. Design of beds, bases, columns, tables, cross rail for various machines. Various types of guide ways, their relative advantages. Materials for machine tool components including plastic guide way (PTFE)

Analysis of Spindles, Bearings, and Power Screws **10**

Design of spindles subjected to combined bending and torsion, layout of bearings, pre - loading. anti - friction slide ways, rolling contact hydrodynamic, hydrostatic, hydrodynamic design of journal bearings, magneto bearings, machine tool vibrations: effect of vibrations on machine tool. free and forced vibrations, machine tool chatter.

Tooling for CNC Machines **10**

Interchangeable tooling system, present and qualifies tools, coolant fed tooling system, modular fixturing, quick change tooling system, automatic head changers, DNC Systems and adaptive Control; Introduction, type of DNC systems, advantages and disadvantages of DNC, adaptive control with optimization, adaptive control with constrains, adaptive control of machining processes like turning, grinding.

Suggested Readings

1. Mehta N.K, *Machine Tool Design and Numerical Control*, Tata McGraw Hill, 1997.
2. Sen. and Bhattacharya, *Principles of Machine Tools*, Central book publishers, Calcutta 1995.
3. Basu S.K, *Machine Tool Design*, Oxford & IBH Publishing Co Pvt.Ltd.
4. Yorenkoren, *Computer Control - Manufacturing Systems*, McGraw-Hill, 1983.

Course: Industrial Robotics (Elective)			Semester: III
Course Code: MET 6114	L T P	4 0 0	Credits: 4

Objective: To be familiar with the automation and brief history of robot and applications, and Robot Programming methods & languages of robot and their applications in robots.

Syllabus

Introduction **8**

Automation and Robotics, robot anatomy, robot configuration, motions joint notation work volume, robot drive system, control system and dynamic performance, precision of movement. Control System and Components: basic concept and modal controllers control system analysis, robot activation and feedback components. Positions sensors, velocity sensors, actuators sensors, power transmission system.

Motion Analysis and Control **7**

Manipulator kinematics, position representation forward transformation, homogeneous transformation, manipulator path control, robot dynamics, configuration of robot controller.

End Effectors **9**

Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design. Sensors: desirable features, tactile, proximity and range sensors, uses sensors in robotics. Machine Vision: functions, sensing and digitizing-imaging, devices, lighting techniques, analog to digital single conversion, image storage, image processing and analysis-image data reduction, segmentation feature extraction. Object recognition, training the vision system, robotics application.

Robot Programming **8**

Lead through programming, robot programming as a path in space, motion interpolation, WAIT, SINONAL AND DELAY commands, branching capabilities and Limitations. Robot Languages: textual robot Languages, generation, robot language structures, elements in function.

Robot Cell **8**

Design and Control: Robot cell layouts-Robot centered cell, in-line robot cell, considerations in work design, work and control, inter locks, error detection, work wheel controller. Robot Application: material transfer, machine loading/unloading. Processing operation, assembly and Inspection, feature application.

Suggested Readings

1. Groover M. P, Weiss Mitchell, *Industrial Robotics*, Pearson Education, 1986.
2. Craig John J., *Introduction to Robotic Mechanics and Control*, Pearson Education, 3rd edition.
3. Fu K S, Gonzalez R.C, Lee C.S.G., *Robotics*, McGraw Hill.
4. D. Klafter Richard, *Robotic Engineering*, Prentice Hall Publications, 1988.

Course: Plant Layout and Material Handling (Elective)			Semester: III
Course Code: MET 6115	L T P	4 0 0	Credits: 4

Objective: To understand the design of plant layout and the relationship of the same with material handling systems.

Syllabus

Introduction **10**

Classification of layout, advantages and limitations of different layouts, layout design Procedures, overview of plant layout.

Process Layout & Product Layout **12**

Selection, specification, implementation and follow up, comparison of product and process layout, heuristics for plant layout, ALDEP, CORLAP, CRAFT, group layout, fixed position layout, quadratic assignment model, branch and bound method.

Basic Material Handling System **20**

Introduction, material handling systems, material handling principles, classification of material handling equipment, relationship of material handling to plant layout, selection, material handling method, path, equipment, functional oriented system, methods to minimize cost of material handling – maintenance of material handling equipment, safety in handling, ergonomics of material handling equipment, design, miscellaneous equipments.

Suggested Readings

1. Mahapatra P B, *Operations Management*, PHI
2. Arora K C & Shinde, *Aspects of Material Handling*, Lakshmi Publications
3. Francis RL, Leon F. McGinnis, Jr.John, *Facility Layout & Location an analytical approach*, PHI.
4. Panneerselvam R, *Production and Operations Management*, PHI
5. Ray, Siddhartha, *Introduction to Material Handling*, New Age.
6. James A. Tompkins, John A White, *Facilities Planning*, Wiley India Edition

Course: Inventory Control (Elective)			Semester: III
Course Code: MET 6116	L T P	4 0 0	Credits: 4

Objective: To enhance the knowledge in various aspects of inventory methods their applications in industries; and also focus on resource planning.

Syllabus

Introduction **6**

Importance of inventory in production distribution system, purchasing functions, procedures value analysis in purchasing, vendor selection, rating and development, buying seasonal commodities, purchasing under uncertainty, purchasing capital equipment's, public buying, stores management, location & layout, stores system, scrap disposal.

Inventory System **6**

Concept, function, inventory cost, inventory models assuming certainty & risk, quality discount, economical order quantity, economical manufacturing batch size, safety stock, joint ordering policy- probabilistic inventory system: (Q, R) and (R, S) policies.

Inventory Management **4**

ABC analysis, VED analysis, perpetual inventory system, periodic inventory system, Japanese inventory system.

Material Requirement Planning **6**

Bill of material, level coding, master production scheduling, gross requirement determination, net requirements, lot size determination techniques(Wagner-Whitin, Silver-Meal heuristic, Part-periodic balancing), offsetting, safety stock in MRP.

Manufacturing Resource Planning **8**

MRP under certainty constraints, capacity requirement planning, just-in-time concept: pull & push system, essential conditions of JIT application, practical implementation of JIT through Kanban & other systems.

Physical distribution of Materials **10**

Finished product-classification, product features, brand decisions, packaging decisions, labelling decisions, product line decision, distribution channel nature, function, channel behavior, physical distribution-warehousing, transportation, placing products- retailing & wholesaling, advertising-media selection, sales promotion personal selling.

Suggested Readings

1. Riggs J.L, *Production System*, John Wiley & Sons.
2. Gopalkrishanan P and Sundaresan M, *Material Management,* PHI.
3. Buffa and Sarin, *Modern Production/ Operation Management*, John Wiley & Sons.
4. Vollman & Berry, *Manufacturing Planning and Control*, Prentice Hall.

5. Peterson and Silver, *Decision System for Inventory Management and Production Planning*, John Wiley & Sons.

ICAI Tech School

The ICFAI University, Dehradun

Mechanical Engineering Department

M.Tech. Industrial Manufacturing Engineering
Program Structure

Year	First Semester	Units	Second Semester	Units
1	**MET 5101** Metal Cutting Theory & Practice	4	**MET 5201** Advanced CAD	4
	MET 5102 CNC Technology & Programming	4	**MET 5202** Theory of Electro Mechanical Systems	4
	MET 5103 Design & Analysis of Machine Tools	4	**Elective II**	4
	MEL 5104 Advanced Engineering Mathematics	4	**Elective III**	4
	Elective I	3	**MEL 5203** CAD Laboratory (L1)	2
	MET 5105 CNC Laboratory	2	**MEL 5204** Mechatronics Laboratory (L2)	2
Year	**Third Semester**	**Units**	**Fourth Semester**	**Units**
2	**Elective IV**	4	**TS 6202** Seminar	1
	Elective V	4	**TS 6201** Dissertation	20
	TS 6102 Seminar	1		
	TS 6101 Dissertation	10		

List of Elective Courses:

ELECTIVE I

Sl. No.	Course Code	Course Title	L	T	P	C
1.	MET 5110	Production Planning and Control	4	0	0	4
2.	MET 5111	Rapid Prototyping systems	4	0	0	4
3.	MET 5112	Measurement systems and accuracy	4	0	0	4
4.	MET 5113	Advanced Tribology	4	0	0	4
5.	MET 5114	Soft Computing Techniques	4	0	0	4

ELECTIVE II & III

Sl. No.	Course Code	Course Title	L	T	P	C
1.	MET 5210	Advanced Mechanical Vibrations	4	0	0	4
2.	MET 5211	Metrology & Computer Aided Inspection	4	0	0	4
3.	MET 5212	Micro & Nano Manufacturing	4	0	0	4
4.	MET 5213	Supply Chain Management	4	0	0	4
5.	MET 5214	Design & Analysis of Experiments	4	0	0	4
6.	MET 5215	Advanced Manufacturing Processes	4	0	0	4
7.	MET 5216	Facility Planning and Layout	4	0	0	4

ELECTIVE IV & V

Sl. No.	Course Code	Course Title	L	T	P	C
1.	MET 6110	Financial Management	4	0	0	4
2.	MET 6111	Flexible Manufacturing Systems	4	0	0	4
3.	MET 6112	Finite Element Analysis	4	0	0	4
4.	MET 6113	Tool Design	4	0	0	4
5.	MET 6114	Industrial Robotics	4	0	0	4
6.	MET 6115	Plant Layout and Material Handling	4	0	0	4
7.	MET 6116	Inventory Control	4	0	0	4

Consolidated Credits

Category	I Sem	II Sem	III Sem	IV Sem	Total
Core courses	16	08	00	00	**24**
Electives	04	08	08	00	**20**
Lab Courses	02	04	00	00	**06**
Seminar	00	00	01	01	**02**
Dissertation	00	00	10	20	**30**
Total	**22**	**20**	**19**	**21**	**82**