Sanjay Ghodawat University Kolhapur
School of Technology
Structure for M. Tech. Mech. Engg. (Manufacturing Technology) Program (2018-19) R0

09/05/2018

ODD	First Year : Semester – I								
Course Code	**Course Title**	**L**	**T**	**P**	**C**	**Evaluation Scheme for (L T P)**			
						Component	**Exam**	**WT %**	**Pass**
MMT 501 (UC | ST) Version: 1.0	Research Methodology	**3**	**1**	**--**	**4**	**L (100)**	FEL	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
MMT 503 (PC | ST) Version: 1.0	Additive Manufacturing Technology & Management	**3**	**--**	**--**	**3**	**L (100)**	FEL	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
MMT 505 (PC | ST) Version: 1.0	Computer Aided Quality Control	**3**	**1**	**--**	**4**	**L (100)**	FEL	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
MMT 507 (PC | ST) Version: 1.0	Manufacturing Execution System	**3**	**--**	**--**	**3**	**L (100)**	FEL	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
MMT 509.X (PC | ST) Version: 1.0	Program Elective – I	**3**	**1**	**--**	**4**	**L (100)**	FEL	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
MMT 511 (PC | ST) Version: 1.0	Digital Manufacturing Lab	**--**	**--**	**4**	**2**	**P (100)**	FEP	50	Min 40
							ESE	50	
MMT 513 (PC | ST) Version: 1.0	CAD & PLM Lab	**--**	**--**	**4**	**2**	**P (100)**	FEP	50	Min 40
							ESE	50	
MMT 515 (PC | ST) Version: 1.0	Seminar – I	**--**	**--**	**2**	**1**	**P (100)**	FEP	50	Min 40
							ESE	50	
	TOTAL	**15**	**03**	**10**	**23**	**Total Hrs. : 28| Total Credits : 23**			

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09/05/2018

EVEN	First Year : Semester – II								
Course Code	**Course Title**	**L**	**T**	**P**	**C**	**Evaluation Scheme for (L T P)**			
						Component	**Exam**	**WT %**	**Pass**
MMT 502 (PC | ST) Version: 1.0	Automation & Robotics	**3**	**--**	**--**	**3**	**L (100)**	FEL	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
MMT 504 (PC | ST) Version: 1.0	Computer Aided Fixture & Tool Design	**3**	**--**	**--**	**3**	**L (100)**	FEL	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
MMT 506 (PC | ST) Version: 1.0	Manufacturing System Design & Simulation	**3**	**1**	**--**	**4**	**L (100)**	FEL	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
MMT 508 (PC | ST) Version: 1.0	Simulation of Manufacturing Processes	**3**	**1**	**--**	**4**	**L (100)**	FEL	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
MMT 510.X (PC | ST) Version: 1.0	Program Elective–II	**3**	**1**	**--**	**4**	**L (100)**	FEL	20	Min 40
							CAT I	15	
							CAT II	15	
							ESE	50	
MMT 512 (PC | ST) Version: 1.0	Automation & Robotics Lab	**--**	**--**	**4**	**2**	**P (100)**	FEP	50	Min 40
							ESE	50	
MMT 514 (PC | ST) Version: 1.0	Analysis & Simulation Lab	**--**	**--**	**4**	**2**	**P (100)**	FEP	50	Min 40
							ESE	50	
MMT 516 (PC | ST) Version: 1.0	Seminar – II	**--**	**--**	**2**	**1**	**P (100)**	FEP	50	Min 40
							ESE	50	
	TOTAL	**15**	**3**	**10**	**23**	**Total Hrs. : 28 | Total Credits :23**			

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09/05/2018

ODD	Second Year : Semester – III								
Course Code	**Course Title**	**L**	**T**	**P**	**C**	**Evaluation Scheme for (L T P)**			
						Component	**Exam**	**WT %**	**Min Pass %**
MMT 601 (PC | ST) Version: 1.0	Industry Internship				**4**	**P (100)**	ISE	50	50
							ESE	50	
MMT 603 (PC | ST) Version: 1.0	Dissertation Phase I				**4**	**P (100)**	ISE	100	50
MMT 605 (PC | ST) Version: 1.0	Dissertation Phase II				**8**	**P (100)**	ISE	50	50
							ESE	50	
	TOTAL				**16**	**Total Credits : 16**			

EVEN	Second Year : Semester – IV								
Course Code	**Course Title**	**L**	**T**	**P**	**C**	**Evaluation Scheme for (L T P)**			
						Component	**Exam**	**WT %**	**Min Pass %**
MMT 602 (PC | ST) Version: 1.0	Dissertation Phase III				**8**	Presentation & Demonstration	ISE	100	50
MMT 604 (PC | ST) Version: 1.0	Dissertation Phase IV				**8**	Viva Voce Exam	ESE	100	50
MMT 606 (PC | ST) Version: 1.0	Dissertation Outcome Dissemination				**2**	Publications and Patents	ESE	100	50
	TOTAL				**18**	**Total Credits : 18**			

Elective – I

EVEN SEM	Program Elective – I
MMT 509.1	Facilities & Layout Planning
MMT 509.2	Design for Manufacturing & Assembly
MMT 509.3	Optimization Techniques
MMT 509.4	Principles of Metal Cutting
MMT 509.5	Advanced Metal Casting Technology
MMT 509.6	Advanced Materials and Composites
MMT 509.7	Open Elective (Relevant course offered)

Elective – II

EVEN SEM	Program Elective – II
MMT 510.1	Intelligent Manufacturing Systems
MMT 510.2	Design & Analysis of Machine Tools
MMT 510.3	Advanced Metal Forming Technology
MMT 510.4	Advanced Welding Technology
MMT 510.5	Costing & Cost Control
MMT 510.6	MEMS & Nano-Technology
MMT 510.7	Open Elective (Relevant course offered)

SYLLABUS

MMT501: Research Methodology

Unit No.	**Contents**	Hrs
Unit 01	**Design of Experiments (DOE):** Objectives, strategies, Factorial experimental design, Designing engineering experiments, basic principles- replication, randomization, blocking, Guidelines for design of experiments, process of DOE. **Simple Comparative Experiments** Basic statistical concepts, random variable, sample mean and variance, degrees of freedom, standard normal distribution, statistical hypothesis, Two sample *t*-test, *P*-value, Confidence Intervals, Paired comparison.	06
Unit 02	**Single Factor Experiment**: Analysis of Variance (ANOVA) for fixed effect model; Total, treatment and error sums of squares, Decomposition of total sum of squares, ANOVA for Randomized complete block design to control effects of nuisance factors. **Two factor Factorial Design:** Basic definitions and principles, main effect and interaction, response surface and contour plots, Blocking, General arrangement for a two-factor factorial design; Models- Effects, means and regression	08
Unit 03	**Taguchi Techniques for Experimental Design**: Taguchi loss function, Average loss, nominal-the-best, smaller-the-best, larger-the-best, design process steps, selection of factors affecting- methods, factor levels, Test strategies- Full factorial experiment, fractional factorial experiment, Orthogonal arrays and their selection; Interaction effects, **Parameter Design**- Control and noise factors and parameter design, signal to noise ratio, types, parameter design strategy, tolerance design, robust design	05
Unit 04	**Research:** Definition of research, Applications of research and types, Research process and steps in it, Deductive and inductive reasoning; **Validity**-conclusion, internal, construct and external; Problem Solving – Types, Process and Approaches – Logical, Soft System and Creative; Creative problem solving process, Development of Creativity, Group Problem Solving Techniques for Idea Generation – Brain storming and Delphi Method.	05

MMT501: Research Methodology

Unit No.	Contents	Hrs
Unit 05	**Literature review :** Need, Procedure- Search for existing literature, Review the literature selected, Develop a theoretical and conceptual framework, Writing up the review. **Formulating a research problem :** Sources, Considerations, Steps in formulation of a problem, formulation of objectives. **Definition of variables :** Concepts, indicators and variables, Types of variables, Types of measurement scales. **Constructing the Hypothesis :** Null(Research) and alternative, one-tailed and two-tailed hypotheses, Hypothesis testing, errors in testing.	05
Unit 06	**Research Modeling**: Types of Models, Model building and stages, Data consideration and testing, Heuristic and Simulation modeling, Data collection methods, Surveys-types and method selection. **Research Proposal:** Contents-Preamble, the problem, objectives, hypothesis to be tested, study design, setup, measurement procedures, analysis of data, organization of report; Displaying data- tables, graphs and charts, **Writing a research report :** Developing an outline, Key elements- Introduction, Methods, Measurement section, Design & procedure section, Results, Conclusion section, Referencing of books and research papers, Report Writing- Prewriting considerations, Thesis writing, Formats of report writing, Formats of publications in Research journals.	08

MMT501: Research Methodology

Sr. No.	**Term Work**
01	Minimum three exercises using a statistical software (like MINITAB / SYSTAT or similar) for hypothesis testing involving Two sample *t*-test, *P*-value, Confidence Intervals, Paired comparison
02	Design of an experiment for an engineering application with two variables and 2 to 3 levels for the variables and analysis of variance for it- a case study.
03	One exercise on design of experiment using Taguchi technique and orthogonal arrays
04	Collection of research papers (at least five) published in referred / peer reviewed journals on any single research area related to mechanical engineering, preparing and presenting a review in front of the class. (The papers collected shall be different for each student.)

Sr. No. **Reference Books**

01 Montgomery, Douglas C. (2007) – Design & Analysis of Experiments, 5/e. (New Delhi, Wiley Student Edition, Wiley India Pvt. Ltd.) ISBN: 978-81-265-1048-1
02 Montgomery, Douglas C. & Runger, George C. (2007) – Applied Statistics & Probability for Engineers, 3/e, . (New Delhi, Wiley Student Edition, Wiley India Pvt. Ltd.), ISBN: 978-81- 265-1424-3
03 Ranjit Kumar, (2006), Research Methodology- A Step-By-Step Guide for Beginners, (Pearson Education, Delhi) ISBN: 81-317-0496-3
04 Trochim, William M.K., (2003), 2/e, Research Methods, (Biztantra, Dreamtech Press, New Delhi), ISBN: 81-7722-372-0
05 Kothari, C.K., (2004), 2/e, Research Methodology- Methods and Techniques, (New Age International, New Delhi)
06 Ross, Philip J. (1996), 2/e, Taguchi Techniques for Quality Engineering, (McGraw Hill, New York)
07 Besterfield, Dale H. (2005), 3/e, Total Quality Management, (Pearson Education, New Delhi)

MMT503: Additive Manufacturing Technology and Management

Unit No.	Contents	Hrs
Unit 01	**Introduction:** Basic Principles of Advanced/Additive Manufacturing, Development of Additive Manufacturing Technology, Generalized Additive Manufacturing Process Chain.	05
Unit 02	**Additive Manufacturing Processes:** Photo-polymerization processes, Powder bed fusion processes, Extrusion based processes, Lamination Processes, Beam deposition processes, 3D Printing, Metal Technology & Processes.	07
Unit 03	**Design/Fabrication Processes:** Data Sources, Software Tools, STL File generation, Model Repair and Validation, build file creation, other data formats, Pre- & Post-processing, Software Issues, Rapid Tooling.	06
Unit 04	**Designing for Additive Manufacturing:** Multiple Materials, Hybrids, Composite Materials, current and future directions, Process & Material Selection, Direct Digital Manufacturing and Distributed Manufacturing. Related Technologies: Mold-making, Casting, Scanning.	06
Unit 05	**Applications of Additive Manufacturing:** Aerospace, Automotive, Manufacturing, Architectural Engineering, Art, Jewelry, Toys, Medical, Biomedical, Dental, Bio-printing, Tissue & Organ Engineering, Reverse Engineering.	05
Unit 06	**Future of Additive Manufacturing:** Intellectual Property, Product Development, Commercialization, Trends and Future Directions in Additive Manufacturing, Business Opportunities, Management issues.	03

MMT503: Additive Manufacturing Technology and Management

Sr. No. **Reference Books**

01 Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd Ed. (2015), Ian Gibson, David W. Rosen, Brent Stucker.
02 Laser Additive Manufacturing of High-Performance Materials, Dongdong Gu, Springer Publ. 2014
03 Understanding Additive Manufacturing, Andreas Gebhardt, Hanser Publishers, 2011.
04 Chua Chee Kai., Leong Kah Fai., Chu Sing Lim, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific, 2010.
05 Ian Gibson., David W Rosen., Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
06 Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.

MMT505: Computer Aided Quality Control

Unit No.	**Contents**	Hrs
Unit 01	**Automated Inspection Systems:** In-process gauging, Coordinate Measuring Machines –types and applications, Probes – various shapes, types and applications, programming of CMMs, Types of CMM software, Inspection routines / cycles on CMM for various measurements – manual and programmed, CNC machines as CMM.	06
Unit 02	**Machine Vision:** Introduction, low level and high level vision, sensing and digitizing, image processing and analysis, segmentation, edge detection, object description and recognition, interpretation, applications.	06
Unit 03	**Statistical Quality Control:** Definition and dimensions of quality, quality improvement, DMAIC process, Statistical methods for quality control and improvement, Statistical Process Control – Review of Plots, diagrams, Numerical representation and interpretation of mean, median, mode, variance, standard deviation, Normal and Binomial distributions; Control Charts, **Quality of product design** – Quality of product design – Quality Function Deployment, House of quality, case studies on QFD implementation; Taguchi methods in quality engineering – robust design, Taguchi loss function,	07
Unit 04	**Statistical Process Control** – SPC Tools and their use, chance and assignable causes of quality variation, Control Charts - their types and uses, control limits, sample size and sampling frequency, Analysis of patterns on control charts, Applications of SPC and quality improvement tools - Flow charts, operation process charts, and value stream mapping	06
Unit 05	**Control Charts for Variables:** $\bar{x}$ and R charts and their applications and interpretation, Control charts for $\bar{x}$ and s, **Control Charts for Attributes:** control chart for fraction non-conforming and its interpretation, control charts for non-conformities, Implementing control charts-guidelines,	06
Unit 06	**Process Capability Analysis:** Process capability, Process capability ratios (PCR), PCR and normality, Confidence intervals and tests on PCRs, Process capability analysis using control charts, Gauge and measurement system capability studies; Lean Manufacturing and Six Sigma practices.	06

MMT505: Computer Aided Quality Control

Sr. No. **Reference Books**

01 Introduction to Statistical Quality Control, Douglas C. Montgomery, 6/e. John Wiley & Sons, 2009
02 M.P.Groover, Industrial robotics- Technology, programming and Applications, McGraw-Hill, 1986
03 K. S. Fu, R. C. Gonzalez, C. S. G. Lee, Robotics: Sensing, Vision& Intelligence, Tata Mcgraw-Hill Publication, 1987.
04 Sharp K.W.B. Pitman , Practical Engineering Metrology, London
05 A.L. Grant, Statistical Quality Control, Tata McGraw Hill International, New York. 6/e.
06 Taher, Metrology, ELBS
07 R.C. Gupta, Statistical Quality Control, ,9/e.
08 Besterfield, Dale H. (2005), 3/e, Total Quality Management, (Pearson Education, New Delhi)
09 Groover M. P., Automation, Production Systems & C. I. M., 4/e, Pearson

MMT507: Manufacturing Execution System

Unit No.	**Contents**	Hrs
Unit 01	Introduction- Shortfalls for existing architectures and solutions, Production structures, MES, use of MES system in the company	06
Unit 02	MES for process capability, Company as information system, preparation for MES implementation, Innovative technologies in MES environment, Evaluation of cost effectiveness for MES.	07
Unit 03	MES in capital goods industry, MES-IT applications, Software architecture, Interfaces for integration and User interfaces	05
Unit 04	Building an MES system, Norms and guidelines, ISA, IEC, VDI, FDA, NAMUR, Recommendations- MESA, VDA, VDMA, ZDVI, Adjacent area – ERP & PLM. Production system oriented design.	06
Unit 05	Integrated production management with MES, Planning and Control, Quality assurance with MES	04
Unit 06	Personnel management with MES, Demands of future production management system.	04

Sr. No.	**Reference Books**
01	J. Kletti, Manufacturing Execution System - MES, Springer, 2007.
02	Heiko Meyer, Franz Fuchs, Klaus Thiel, Manufacturing Execution Systems, McGraw-Hill, 2009, ISBN 978-0-07-162602-6

Program Elective-I

MMT509.1: Facility Layout and Planning

Unit No.	**Contents**	Hrs
Unit 01	Introduction, nature, significance and scope of facility layout and design	02
Unit 02	Facility location: location analysis, single-facility and multi-facility location problems, location models, set covering problems, warehouse location problems, location allocation problems	06
Unit 03	Facility layout: definition, significance, objectives, steps in layout planning, quantitative techniques, computerized layout planning procedures	06
Unit 04	Group technology, Production Flow analysis, Rank Order Clustering, arranging machines in a GT cell, design of assembly and production lines, line balancing.	06
Unit 05	Material handling: definition, principles of material handling, unit load concept, Rigid and flexible material handling system design issues, equipment types and selection, packaging requirements and containers selection	06
Unit 06	Storage and warehousing: functions, objectives, and principles, facility services, Automatic storage and retrieval systems, equipment, design principles.	06

Sr. No.	**Exercises**
01	Six assignments based on syllabus (Numerical exercises expected) including industrial case studies.

Sr. No. **Reference Books**

01 Tompkins, J.A. and J.A. White, Facilities Planning, John Wiley, 2003.
02 Richard Francis. L. and John A. White, Facilities Layout and location-an analytical approach, Prentice Hall India, 2002.
03 James Apple, Plant layout and Material Handling, John Wiley, 1977.
04 Panneerselvam, R, "Production and Operations Management", Prentice Hall India, 2007
05 Groover M. P., Automation, Production Systems & C. I. M., 4/e, Pearson

Program Elective-I

MMT509.2: Design for Manufacturing and Assembly

Unit No.	Contents	Hrs
Unit 01	**Embodiment Design:** Steps, basic rule, principles, guidelines, design for ease of assembly, design for standards, design for maintenance; recycling; minimum risk; evaluating embodiment design. Design for minimum cost, DFM approach and Processes, DFM guidelines, DFMEA, PFMEA. **Tolerance Analysis**: Process capability process capability metrics, CP, CPK cost aspects, feature tolerances, geometric tolerances, surface finish, Tolerance Stacking, Cumulative effect of tolerances- sure fit law, normal law and truncated normal law.	06
Unit 02	**Interchangeability & Selective Assembly:** Interchangeable parts manufacture, standardization, mass customization, selective assembly, deciding the number of groups- Model-I: Group tolerances of mating parts equal; Model- II: total and group tolerances of shaft equal. Control of axial play – introducing secondary machining operations, laminated shims, examples. **Datum Systems**: Degrees of freedom, grouped datum systems – techniques	06
Unit 03	**True Position Theory:** Comparison between co-ordinate & convention method of feature location, tolerancing and true position tolerancing, virtual size concept, floating & fixed fasteners, projected tolerance zone, assembly with gasket, zero true position tolerance, functional gauges, paper layout gauging, compound assembly, ex.	06
Unit 04	**Design for Manufacture:** **A) Machining process:** Dimensional tolerance and surface roughness, Design and Redesigning of components for machining ease, General design recommendations for machined parts. **B) Casting and Forging Processes**- General design considerations, Selection of processes for DFMA. **C) Joining Processes-** General design considerations, Selection of processes for DFMA, Use of fasteners for DFMA **D) Sheet Metal Forming Processes-** Considerations for DFMA	06

Program Elective-I

MMT509.2: Design for Manufacturing and Assembly

Unit No.	**Contents**	Hrs
Unit 05	**Design for Assembly**: General design guidelines for Manual Assembly- Development of Systematic DFA Methodology- Assembly Efficiency- Classification System for Manual handling- Classification System for Manual Insertion and Fastening- Effect of part symmetry on handling time- Effect of part thickness and size on handling time- Effect of weight on handling time- Effect of symmetry , Further design guidelines.	06
Unit 06	**DFX Parameters** Design for Life Cycle, Design for Servicing, Design for Sustainability, Design for Environment, Design for X	06

Sr. No.	**Reference Books**
01	Harry Peck, "Designing for Manufacture", Pitman Publications, 1983.
02	G. Boothroyd, Peter Dewhurst, Winston Anthony Knight, "Product Design for Manufacture and Assembly", CRC press, 2011.
03	Matousek, "Engineering Design – A systematic Approach" Blackie & Son Ltd. London, 1974.
04	Ken Wallace, Lucienne T.M. Blessing, "Engineering Design – A systematic Approach" Springer, 2007
05	SPOTTS, M.F., "Dimensioning and Tolerance for Quantity Production", prentice Hall Inc., 1983.
06	Oliver R Wade, "Tolerance Control in Design and manufacturing" Industrial Press Inc., New York, 1967.
07	James G Bralla, "Hand "book of Product Design for Manufacturing", McGraw Hill Publication, 1983.
08	Trucks, H.E., "Design for Economic Production", Society of manufacturing Engineers, Michigan, 2nd Edition, 1987.
09	Geoffrey Boothroyd, Hand Book of Product Design, Marcel Dekker Inc., NY, 1992.

Program Elective-I

MMT509.3: Optimization Techniques

Unit No.	Contents	Hrs
Unit 01	1. **Linear programming-extensions**: Revised simplex method, Dual Simplex method, Bounded variables method, primal-dual relationships, duality theorems, economic interpretation of dual, dual of transportation model, sensitivity analysis in LPP and transportation models, Karmarkar's interior point algorithm	08
Unit 02	**Dynamic programming**: formulation, recursive approach, Goal programming: formulation, graphical solution, algorithm	06
Unit 03	**Integer programming**: Formulation, Cutting plane algorithm, Branch and bound algorithm	06
Unit 04	**Classical Optimization**: Single and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers, Kuhn-Tucker Conditions	06
Unit 05	**Single-variable Optimization**: Unrestricted Search, Exhaustive Search, Dichotomous Search, Interval-halving Method, Fibonacci Method, Golden-section Method, Quadratic Interpolation Method, Newton Method, Quasi-Newton Method, Secant Method	08
Unit 06	**Conjugate Direction Method**, Steepest Descent Method, Newton's Method, Conjugate Gradient Method, Davidon-Fletcher-Powell Method **Introduction to Constrained Optimization**: Interior Penalty Function Method, Exterior Penalty function Method	06

Sr. No.	Reference Books
01	Introduction to Operations Research, Hillier and Lieberman, Tata McGraw Hill
02	Quantitative techniques in Management by N D Vora, 4/e, Tata McGraw Hill
03	Deb K (2004). Optimization for Engineering Design: Algorithms and Examples, Prentice Hall of India.
04	Rao S. S. (1996). Engineering optimization, Theory and Practice, New Age International Publishers
05	Ravindran A, Ragsdell K and Reklaitis G (2006). Engineering Optimization: Methods and Applications, 2/e, John Wiley and Sons Inc.

Program Elective-I

MMT509.4: Principles of Metal Cutting

Unit No.	Contents	Hrs
Unit 01	**Classification of Manufacturing Process**: Importance and perspective of machining process, Schematic Representation of machining system, Different types of motions to generate different shapes. **Mechanics of chip formation**: Orthogonal and oblique cutting, shear plane and shear strain, Computation of chip reduction coefficient, Velocity triangle, different process variables, actual feed and actual depth of cut, Different types of chips, computation of MRR for different processes.	06
Unit 02	**Cutting tool geometry:** ASA, ORS and NRS systems, conversion from one system to others, Cutting tool nomenclature. **Cutting force:** Theoretical **a**nalysis of cutting force, Merchant circle diagram, Theory of Ernst and Merchant 1st and 2nd Model, Theory of Lee and Shaffer model, Ploughing force and size effect, Dynamometry, Friction in metal cutting, Cutting energy and power in metal cutting.	06
Unit 03	**Cutting tool materials:** Properties, different types of cutting tool materials e.g. HSS, Carbides, Coated carbides, ceramics, Cermets, PCBN and Diamonds and other advanced cutting tool materials, ISO specification of modern throw away inserts. **Temperatures in metal cutting:** Heat generation and temperature distribution in metal cutting (Primary and secondary zone), Measurement of cutting temperature, Effect of process variables and tool geometry in temperature rise.	08
Unit 04	**Cutting fluid and surface roughness:** Need for cutting fluid, characteristics of an efficient lubricant, Different applications: flood, jet, mist and Z-Z cooling, Cutting fluid maintenance and its disposal, Concept of dry cutting. **Surface roughness:** Theoretical computation of surface roughness, Measurement of surface roughness, Modification of tool geometries for improved surface finish, Effect of process variables on surface roughness.	08
Unit 05	**Tool wear, Tool life and machinability:** Causes and mechanism of wear, Types of wear: Crater wear and flank wear, Tool life criteria, Effect of built-up-edges and tool geometries on wear, Concept of tool life, Taylor's tool life equation, Effect of process variables on tool life, Concept of machinability and machinability rating, Variables affecting machinability.	06
Unit 06	**Abrasive processes:** Grinding, Chip removal in grinding, Cutting force in grinding, Types of abrasive and specification of grinding wheel, Effect of variables on grinding performance. Types of abrasive machining and finishing processes: honing, lapping, super finishing and buffing.	06

Program Elective-I

MMT509.4: Principles of Metal Cutting

Sr. No. **Reference Books**

01 Metal Cutting Theory & Practice by A. Bhattacharya, New Central Book Agency Pvt. Ltd.
02 Fundamentals of machining and machine tools by Boothroyd, G. and Knight, W. A. (2006), 3/e, CRC Press, Taylor and Francis Group.
03 Metal Cutting Principles, Shaw by M. C. (2005), 2/e, New York: Oxford University Press.
04 Principles of Engineering Manufacture, Black, S. C., Chiles, V., Lissaman A. J. and Martin, S.J. (2004) 3/e, New Delhi: Viva Books Pvt. Ltd.
05 Fundamentals of Machining Processes, H. El-Hofy (2007), CRC Press, Taylor and Francis Group.
06 Production Technology by HMT, McGraw-Hill, India.

Program Elective-I

MMT509.5: Advanced Metal Casting Technology

Unit No.	Contents	Hrs
Unit 01	**Introduction**: Comparison of casting technology with other metal processing technologies, specifications of composition and purity of cast metals. **Casting Design & Pattern / Die Making**: Review of conventional method of casting and pattern design, pattern and die design considerations, Computer aided casting component design, Computer aided design and manufacturing of patterns and dies, advanced materials for patterns and dies - selection and applications, Use of simulation software for casting methoding and metal flow simulation, rapid pattern making	06
Unit 02	**Resin Coated Sands & Processing:** Properties of shell sand, no-bake sand systems, CO2 sand, cold box sand, their comparison, equipment for sand processing, developments in sand mullers and sand plants, sand reclamation - cost and environmental issues, types of reclamation methods, **Sand Molding & Core Making Practices:** High pressure molding technology, flaskless molding technology, magnetic molding, Core shooters used in shell core making and cold box process, Mold and core washes / coats – types, applications, selection and significance, Use of ceramic components and filters, their selection and significance.	08
Unit 03	**Permanent Mold & Special Casting Techniques:** Process parameters for Die casting- gravity, pressure and low pressure, Centrifugal casting, Vacuum casting, Investment casting, Squeeze casting; Advantages, limitations and applications	06
Unit 04	**Melting Practices:** Developments in melting practices with reference to energy saving, scale of production, homogeneity of melt, handling and dispensing of molten metal, automated pouring equipment, use of robots for metal pouring, Furnaces- types and selection criteria, lining materials. **Melting technology:** Melting technologies for steels, grey C.I., S.G. iron and compacted graphite iron, Al-Si alloys, Magnesium and Titanium based alloys; Inoculation, modification, de-oxidation, de-gassing, grain refinement treatments for various alloys, advanced methods for chemical analysis for metal compositions and temperature measurement.	08
Unit 05	**Post processing of Castings:** Fettling and shot basting techniques, salvaging of defective castings, heat treatment for ferrous and non-ferrous cast alloys, protective coating for castings.	04

Unit 06	**Quality & Productivity:** Casting defects and their classification, rejection analysis, remedial measures; instrumentation, mechanization and automation, Safety aspects in foundries, Environmental issues and regulations. **Management Information systems for Foundries:** Techniques for improvement in productivity, Total Preventive Maintenance, Just-In-Time production, 'Five S' for foundries; Costing of castings, QS standards for foundries, Information systems for inland and global customer development.	08

MMT509.5: Advanced Metal Casting Technology

Sr. No.	**Reference Books**
01	Principles of Metal Castings - Heine, Loper and Rosenthal (TMH)
02	Principles of Foundry Technology - P.L. Jain (TMH)
03	Advanced Pattern Making – Cox I.L. (The Technical Press, London.)
04	ASM Handbook – Vol. 15 Castings
05	Metal Castings – Principles & Practice - T.V. Ramana Rao. (New Age International Pvt. Ltd. Publishers.)
06	AFS and Control hand book – AFS.
07	Fundamentals of Metal Casting Technology - P.C. Mukherjee (Oxford, IBH)
08	The Foseco Foundryman's Handbook, -Foseco, CBS Publishers & Distributors ISBN **:** 9780750619394
09	The New Metallurgy of Cast Metals Castings – Campbell, CBS Publishers & Distributors, ISBN- 9788131200919
10	Fundamentals of Metal Casting – Flinn, Addison Wesley
11	Principles of Metal Manufacturing Processes, J. Beddoes & M.J. Bibby (Elsevier, Butterworth, Heinemann) (2003)

Program Elective-I

MMT509.6: Advanced Materials and Composites

Unit No.	Contents	Hrs
Unit 01	**Mechanical behavior:** Elastic – Plastic Behaviour in metals, Plastic deformation mechanism, Role of dislocations on plastic deformation, shear strength of perfect and real crystals - strengthening mechanisms – strain hardening / work hardening, Alloying / solid solutioning, Grain boundary strengthening, Poly phase mixture, Precipitation strengthening, Martensite strengthening, Fibre, particle and Dispersion strengthening, - Effect of Temperature, Strain, and Strain Rate on Plastic behaviour – super Plasticity.	06
Unit 02	**Modern metallic materials:** Dual Phase Steels, Micro Alloyed Steel, High Strength Low Alloy (HSLA)Steel, Transformation Induced Plasticity (TRIP) Steel, Maraging Steel, Intermetallics Ni and Ti Aluminides, Smart Materials, Shape Memory Alloys, Metallic Glass, Quasi Crystal and Nano Grystalline Materials.	05
Unit 03	**Non metallic materials:** Polymeric Materials - Structure, Properties and Applications of Engineering Polymers - Advanced Structural Ceramics, WC, TiC, TaC, Al2O3SiC, Si3N4, CBN, Diamond, Fibers, Foams, Adhesives and Coatings - Properties, Processing and Applications.	05
Unit 04	**Composite materials in engineering**, reinforcing materials: fibers, whiskers and particles. Fiber materials for composites, Fibers of glass, boron, carbon, organic, ceramic and metallic fibers, Matrix materials, Interfaces between matrix and fibers and other dispersed phases.	06
Unit 05	**Polymer matrix composites**, Characteristics and applications, Fabrication of polymer matrix composites, Metal matrix composites (MMC), Fabrication of MMCs by liquid state, solid state methods, powder metallurgy route and in site fabrication methods, Discontinuous reinforcement of MMCs, Ceramic matrix composites, Fabrication methods and applications.	06
Unit 06	Mechanical properties in composites, large particle composites and the rule of mixtures for elastic constants, Mechanical properties of fiber reinforced composites, Effect of fiber length, Critical fiber length, Strength of continuous and aligned fiber composites, Discontinuous and aligned fiber composites, Toughening Mechanism, Impact Resistance, Fatigue and Environmental Effects.	06

MMT509.6: Advanced Materials and Composites

Sr. No. **Reference Books**

01 Composite Materials: Engineering and Science, Matthews F.L., and Rawlings R. D., 1999, Woodhead Publishing Limited, Cambridge England.
02 Composite Materials-Functional Materials for Modern Technology, DDL Chung, Springer- Verlag Publications London
03 The nature and Properties of Engg. Materials, Jastrzebaski, John Wiley & Sons, New York.
04 Composite Materials Handbook, Mel M. Schwartz (R), 2nd Edition, 1992, McGraw-Hill, New York.
05 Fundamentals of Fiber Reinforced Composite Materials, A. R. Bunsell, J. Renard, 2005, IOP Publishing Ltd.
06 Composite Materials Science and Engg., Chawla K.K., Second Edition, 1998, Springer Verlag.

MMT511: Digital Manufacturing Lab

Unit No.	**Contents**	Hrs
Lab 01	**Introduction:** NC, DNC, CNC, Programmed Automations, Machine control unit, Part program, NC tooling. **NC Machine Tools:** Nomenclature of NC machine axes, Types of NC machine tools, Machining centres, Automatic tool changes (ATC), Turning centres.	02
Lab 02	**Machine Control Unit & Tooling:** Functions of MCU, NC actuation systems, Part program to command signal, MCU organization, Computerised numerical control, Transducers for NC machine tools, Tooling for NC machining centres and NC turning machines, Tool presetting, Tool length offset, nose radius and wear compensation,	02
Lab 03	**Manual Part Programming**: Part program instruction formats, Information codes: Preparatory function, Miscellaneous functions, Interpolations, Canned cycles. Manual part programming for milling operations, Turning operations, Parametric subroutines.	04
Lab 04	**Computer Aided Part Programming:** Generation of CNC part programs from CAD models, Pre-processor, Post-processor.	02
Lab 05	**Coordinate Measuring Machine (CMM)**: Types of CMM, types of probes - Determination of given geometry using coordinate measuring machine (CMM). Industrial Visit to study working of CMM	02
Lab 06	**3D Printing :** CAD Modeling for 3D Printing, File Formats for 3D Printing, Experiment on 3D Printing of a suitable component.	02

Sr. No. **Reference Books**

01 Numerical Control and Computer Aided Manufacturing by T.K. Kundra, P.N. Rao and N.K. Tewari, Tata McGraw-Hill Company Limited, New Delhi.
02 Numerical Control of Machine Tools by Yoram Koren and Joseph Ben-Uri, Khanna Publishers, Delhi.
03 Mikell P. Grover "Automation, Production Systems and Computer-Integrated Manufacturing", Pearson Education, New Delhi.
04 P. Radhakrishnan & S. Subramanyan "CAD/CAM/CIM" Willey Eastern Limited New Delhi.
05 Mikell P. Grover and Enory W. Zimmers Jr. "CAD/CAM", Pearson Education, New Delhi.
06 Hans B. Kief and J. Frederick Waters "CNC" Glencae Macmillan / McGraw Hill
07 Steve Krar and Arthar Gill "CNC Technology and Programming", McGraw Hill Pub. Company, New Delhi.
08 Nicholas John M. "Competitive Manufacturing Management", McGraw Hill International
09 P.N. Rao, N. K. Tewari et el "CAM" Tata Mc Graw Hill Pub. New Delhi.

MMT513: CAD and PLM Lab

Unit No.	**Contents**	Hrs
Lab 01	**Introduction:** CAD Modeling, Wire Frame Model, Surface Model, Solid Model, Transformations in CAD Modeling (Translation, Scaling, Rotation).	02
Lab 02	**3D Modeling:** 3D Modeling using any advanced CAD Software.	06
Lab 03	**Assembly Modelling**: Modeling of Assembly with minimum 5-6 components.	04
Lab 04	**Surface Modeling** : Surface modelling of a suitable component/ product	02
Lab 05	**Introduction to PLM** : Background, Overview, Need, Benefits, and Concept of Product Life Cycle, Product lifecycle management systems, Components / Elements of PLM, Emergence of PLM, Significance of PLM. **Product Organizational Structure**: Information, Standards, Vendors of PLM Systems and Components, Integration of the PLM system with other applications, Examples of PLM in use. The PLM Strategy. **Product Data** : Product and Product Data, Product Data Examples, Product Data Issues, Metadata, Product Data Models. **Deployment**: Problems in deployment. Stages of deployment, company's vision. PLM software and tools. Product Data security. **Product structure**: Workflow, Terminologies in workflow, The Link between Product Data and Product Workflow, PLM applications, PDM applications.	06
Lab 06	**Use of PLM Software** : Exercises/demonstration with any standard PLM Software	06

Sr. No.	**Reference Books**
01	P. Radhakrishnan & S. Subramanyan "CAD/CAM/CIM" Willey Eastern Limited New Delhi.
02	Mikell P. Grover and Enory W. Zimmers Jr. "CAD/CAM", Pearson Education, New Delhi.
03	Grieves, Michael, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
04	AnttiSaaksvuori, AnselmiImmonen, Product Life Cycle Management - Springer, 1st Edition (Nov.5, 2003)
05	Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realization, Springer-Verlag, 2004. ISBN 1852338105
06	Relevant recent technical articles, research papers, key note addresses, etc

MMT515: Seminar - I

(i) Students shall carryout an exhaustive literature review (research articles, technical articles, white papers, books etc.), on a chosen topic under the supervision of a Guide and present the findings in the form of a review paper in the department in front of a departmental faculty committee, as a part of the term work / POE.

(ii) The article must be published in a National / International Conference/Journal as a part of the term work / POE.

MMT502: Automation and Robotics

Unit No.	Contents	Hrs
Unit 01	**Automation:** Automated manufacturing systems, fixed /programmable /flexible automation, need; Basic elements of automated systems, Advanced automation functions, Levels of automation; Industrial control systems in discrete manufacturing industries, Low cost automation, **Transfer Lines:** Fundamentals, Configurations, Transfer mechanisms, storage buffers, control, applications; Analysis of transfer lines without and with storage buffers.	07
Unit 02	**Assembly Automation:** Types and configurations, Parts delivery at workstations- Various vibratory and non-vibratory devices for feeding and orientation, Calculations of feeding rates, Cycle time for single station assembly machines and partially automated systems; Product design for automated assembly.	05
Unit 03	**Robotic Systems**: Anatomy and work volumes, Classification. Drives & Control System- Hydraulic and Pneumatic actuators, electrical drives for robots, control loops, basic control system concepts and models, robot activation & feedback components, power transmission system. **Peripherals:** End effecters – types, mechanical electromagnetic, pneumatic grippers, tool as end effecter, robot end effecter interface. Sensors – position and velocity sensors, tactile sensors, proximity and range sensors, sensor based systems and applications.	08
Unit 04	**Robot Kinematics:** Introduction, forward, reverse & homogeneous transformations, manipulator path control, introduction to robot dynamics configuration of a robot controller.	05
Unit 05	**Programming for Robots:** Methods, robot program as a path in space, motion interpolation, characteristics of robot level and task level languages, robot languages, programming in suitable languages, Simulation of robot programs **Robot Intelligence and Task Planning**: Introduction, state space search, problem reduction, use of predictive logic, means – ends analysis, problem solving, robot learning, robot task planning.	08

MMT502: Automation and Robotics

Unit No.	**Contents**	Hrs
Unit 06	**Robotic Applications:** Applications in manufacturing -material transfer, machine loading and unloading, processing operations, assembly and inspections, robotic cell design and control, applications in other areas: toxic, hazardous and inaccessible, service industry.	05

Sr. No.	**Term Work**
	Minimum Six exercises from following.
01	Two Programming exercises for robots.
02	Three case studies of applications in industry involving working out the scheme with type of robots, other accessories with sequence and logic.
03	Three exercises using suitable robotic simulation software for handling applications.

Sr. No. **Reference Books**

01 Industrial Robotics: Technology, Programming & Applications- Groover, Weiss, Nagel, Ordey, McGraw Hill
02 Robotics: Control, Sensing, Vision & Intelligence. - Fu, Gonzalez, Lee (McGraw Hill)
03 Robotics Technology & Flexible Automation – S.R. Deb (TMH)
04 Handbook of Industrial Robotics – Ed. Shimon Y. Nof (John Wiley.)
05 Fundamental of Robotics, Analysis & Control – Robert J. Schilling (PHI)
06 Robotics for Engineers – Yoram Koren (McGraw Hill)
07 Introduction to Robotics: Analysis, Systems & Applications – Saeed B. Niku (Pearson)
08 Keramas, James G. (1998), " Robot Technology Fundamentals", ISBN: 981-240-621-2 (CENGAGE)
09 M.P.Groover, Industrial robotics- Technology, programming and Applications, McGraw-Hill, 1986
10 K.S.Fu, R.C.Gonzalez, C.S.G.Lee, Robotics: Sensing, Vision & Intelligence, Tata Mcgraw-Hill Publication, 1987.

MMT504: Computer Aided Fixture & Tool Design

Unit No.	Contents	Hrs
Unit 01	**Introduction:** Jigs and Fixtures, Flexible Fixturing, Materials for Tools, Fixture and Dies.	02
Unit 02	**Modular Fixture Systems**: Development of modular fixtures, T- slot based and Dowel pin based Modular Fixture systems, Interactive Computer Aided Fixture Design (I-CAFD) Structure, Locating / clamping Model Analysis and classification, Fixture Component Selection, Fixture component Assembly Manipulation.	10
Unit 03	**Group Technology based Computer Aided Fixture Design:** Fixture Design process analysis, Fixture Structure Analysis, Fixture Feature Analysis, Fixture Design Similarity Analysis, Representation of Fixturing Feature information, Automated Fixture configuration Design	06
Unit 04	**Geometric and Accuracy Analysis:** Geometric constraint conditions, Assembly Analysis, 3DFixture configurations, Locating Accuracy and Error analysis, clamp planning, Machining accuracy analysis.	04
Unit 05	**Metal Cutting Dies:** design considerations, die materials, Computer aided design of dies for metal cutting operations	07
Unit 06	**Drawing Dies:** Drawing dies, deep drawing dies, Die design considerations, CNC presses, Computer aided design of dies	07

Sr. No.	Exercises
01	Case Study of T- Slot based Modular Fixturing system.
02	Case Study of Dowel pin based Modular Fixturing system.
03	Computer Aided Fixture Design for Simple Component.
04	Die Design for Metal Cutting Dies
05	Die Design for drawing operation for a component.
06	Die Design for deep drawing operation for a component.

MMT504: Computer Aided Fixture & Tool Design

Sr. No.	Reference Books
01	Rong, Yeming; "Computer Aided Fixture Design", Marcel Dekker, ISBN 0-8247-9961-5
02	Metal Forming Handbook – Schuler, Springer- Verlag Berlin.
03	Dies for Plastic Extrusion – M.V. Joshi – McMillan.
04	Tool Design – C. Donaldson, LeCain&Goold (TMH)
05	Tool Design – H.W. Pollack (Taraporwalla)
06	ASM Handbook – Forming – ASME
07	Handbook of Die Design, 2/e – Suchy, I (McGraw Hill), 2006.
08	Design of Jigs and Fixtures – Hoffman (Pearson)
09	An Introduction to Jig & Tool Design, M.H.A. Kempster, (ELBS)
10	Jigs and Fixture Design Manual, Henrikson (Industrial Press, NY)
11	Die Design Fundamentals, J. R. Paquin, R. E. Crowley, Industrial Press Inc.
12	Jigs & Fixtures; Design Manual – (2/e), P.H. Joshi, (TMH) (2003)
13	A.Y. C. Nee, K. Whybrew& A. Senthilkumar, Advanced Fixture Design for FMS, Springer ISBN: 0879096357

MMT506: Manufacturing System Design and Simulation

Unit No.	Contents	Hrs
Unit 01	**Fundamentals:** System concept, Hierarchical structure, System design, Decision making procedure, System types in manufacturing environments; Manufacturing Systems: Structural aspects, transformational aspects, procedural aspects, Logistic Systems- Material flow: conversion / transportation / storage, **Product / Process Planning and Design:** Product Life Cycle, Planning of a new product, Product Design Aspects, Process and Operation Design, Optimum routing analysis using Dynamic Programming and Network Techniques	06
Unit 02	**Communication and Control in Manufacturing Systems:** Feedback control, feed forward control, control hierarchy, information flow within a control system, System modeling – prototype, procedure for system identification, IDEF system definition technique, IDEF model of an order handling manufacturing system (OHMS), OHMS model - Formulating production plan, Design and develop the product to order, Gathering production resources, producing products	06
Unit 03	**Manufacturing Optimization:** Criteria for Evaluation, Optimization of single stage Manufacturing, Optimization of multistage manufacturing system, Scope, basic mathematical models **Information Systems in Manufacturing**: Database structures, Shop Floor Data Collection Systems- Types of data, on-line and off-line data collection, Automatic data collection systems.	06
Unit 04	**Value Systems for Manufacturing** : Value and cost flow in manufacturing system, concept of cost and time-series value of money, Manufacturing cost and product cost structure – types of costs, product cost structure, computing the manufacturing cost, break-even analysis, Capital investment for manufacturing, evaluation methods	06
Unit 05	**Computer Simulation in Manufacturing System Analysis:** Characteristics, Simulation Models, Design and evaluation methodology of manufacturing systems, General design framework, Analysis of situation, Setting objectives, Conceptual modeling, Detailed design, Evaluation and Decision.	06
Unit 06	**Probability distributions; Factory Models** – Measured Data and System Parameters, Factory Performance, Deterministic Vs. Stochastic Models, Processing Time Variability, Multiple-Stage Single-Product Factory Models, Multiple Product Factory Models.	06

MMT506: Manufacturing System Design and Simulation

Sr. No. **Reference Books**

01 Katsudo Hitomi, (1998), "Manufacturing Systems Engineering", Viva Low Priced Student Edition, ISBN 81-85617-88-0
02 B. Wu, "Manufacturing Systems Design & Analysis: Context and Techniques" (2/e), Chapman & Hall, UK, ISBN 041258140X
03 Mikell P. Groover, (2002), "Automation, Production Systems and Computer Integrated Manufacturing", (2/e), Pearson Education, ISBN 81-7808-511-9
04 Manufacturing Systems Modeling and Analysis, Guy L. Curry · Richard M. Feldman, (2/e), Springer Publications, 2008 , ISBN 978-3-642-16617-4
05 Luca G. Sartori,(1998), " Manufacturing Information Systems", Addison Wesley Publishing Co.
06 N. Viswanadhan & Y, Narhari, (1998), "Performance Modeling of Automated Manufacturing Systems", Prentice Hall of India
07 Simulation Modeling and Analysis / Law, A.M. / McGraw Hill, 5/e, New York 2014.
08 Discrete Event System Simulation / Banks J. & Carson J.S., PH / Englewood Cliffs, NJ, 1984.
09 Simulation of Manufacturing Systems, Carrie A. / Wiley, NY, 1990.
10 Manufacturing Simulation with Plant Simulation and SimTalk, Steffen Bangsow, Springer, 2010
11 Simulation Modeling and SIMNET/Taha H.A./PH, Englewood Cliffs, NJ, 1987

MMT508: Simulation of Manufacturing Processes

Unit No.	Contents	Hrs
Unit 01	**Finite Element Method:** Introduction, Finite Element Procedures, Elements and shape function, element strain rate matrix, Elemental stiffness equation, Numerical integrations, Assemblage and Linear matrix solver, Boundary conditions, Direct / Iteration method, Time investment and Geometry updating, Rezoning	06
Unit 02	**Metal Shaping and Forming Processes:** Process Modeling, The finite element method, Solid formulation and hollow formation, metal casting, forming and FEM, Review of Metal forming and Casting process **Analysis and Technology in Metal Forming:** Flow stress of metals, Friction in metal forming, Temperatures in metal forming, Impression and closed die forging, Hot and cold extrusion, Hot and Cold forging and extrusion, Hot and cold Rolling, Wire Drawing, Sheet metal forming, fine blanking **Metal Casting:** Castability of important Ferrous and Non- ferrous metal, Shrinkage, Effect of Temperature, Effect of composition, Casting Design, FEA analysis, Die / pattern Design, Casting Simulation – Gating Design, Die / Pattern manufacture	08
Unit 03	**Plasticity and Visco-plasticity:** Introduction, Stress, strain and strain rate, The yield criteria, Equilibrium and Virtual work rate principle, Plastic potential and flow rate, Strain Hardening, Effective stresses and Effective strain, Visco-plasticity **Method of Analysis:** Introduction, Upper Bound method, Hills General Method, FEM	06
Unit 04	**Plane – Strain Problems:** Introduction, Finite Element formulation, Closed die forging with flash, Sheet Rolling, Plate Bending, Side pressing, **Axi-symmetric Isothermal Forging:** Finite Element formation, Pre-form design method, Die design, Shell nosing at room temperature, Plane strain rolling, Axially Symmetric forging	06

MMT508: Simulation of Manufacturing Processes

Unit No.	**Contents**	Hrs
Unit 05	**Steady State Processes of Extrusion and Drawing:** Introduction, Method of Analysis, Bar Extrusion, Bar Drawing, Multi pass bar drawing and Extrusion, Applications to process design	04
Unit 06	**Sheet Metal Forming:** Introduction, Plastic Anisotropy, In-plane deformation process, Axi-symmetric but of plane deformation, Axi-symmetric Punch stretching and deep drawing process, Sheet metal forming of General shapes, Square – cup drawing process	06

Sr. No.	**Exercises**
	(Using suitable software packages for the simulation.)
01	Forging simulation to predict die fill load, energy and defect formation for simple components
02	Extrusion simulation to validates design of extrusion dies and process, Simulation of metal flow and heat transfer
03	Casting simulation to predict fluid flow, hot spots- shrinkage, designing of Gating and rising
04	Forging pre-form and Die design and FEA
05	Casting Design and FEA
06	Sheet metal simulation for validating forming feasibility, predict blank sizing, minimizing material scrap, determine wrinkles, splits etc.

Sr. No. **Reference Books**

01 Mechanical Metallurgy (2/e)– by Dieter (McGraw Hill)
02 Metal Casting – Dr. B. Ravi – (Prentice Hall of India)
03 Metal Forming & Finite Element Method – by Shiro Kobjashi Oxford University.
04 Technology of Metal Forming Processes, -Surender Kumar (EEE)(PHI)
05 Theory of Plasticity- Amitav Chakraborty, McGraw Hill

Program Elective-II

MMT510.1: Intelligent Manufacturing Systems

Unit No.	Contents	Hrs
Unit 01	**Latest advancements in Cloud Technologies, CPS and IoT Applications :** Introduction to Cloud Computing: Historical Evolution and Background, Concept, Technologies, Cloud Platforms, Tools, Challenges **Cloud Manufacturing** : Historical Evolution and Background, Concept, Technologies, Research Initiatives, Applications, Challenges	06
Unit 02	**Latest advancements in CPS and IoT Applications and Challenges in Cyber Security :** Introduction, Key Enabling Technologies in CPS and IoT, Wireless Sensor Network, Could Technologies, Big Data, Industry 4.0, RFID Technology, Key Features and Characteristics of CPS and IoT, Applications of CPS and IoT, Service Oriented Architecture, Could Manufacturing, Cyber-Physical Production Systems, IoT-Enabled Manufacturing System, CPS in Cloud Environment **Challenges in Cyber security** : Introduction, Internet of Things, Remote Equipment Control, Security Concerns and Methods, Security Concerns, Security Methods and Architecture, Cyber-Physical Systems, Future Outlook	08
Unit 03	**MULTI-AGENT SYSTEMS AND MOBILE AGENTS :** • An agent-based approach to holonic manufacturing systems • Mobile Agent Technology in Support of Sales Order Processing in the Virtual Enterprise **MULTI-AGENT SYSTEMS IN SCHEDULING :** • Multi-agent perspectives to agile scheduling • Decentralized resource allocation planning through negotiation • Scheduling in a Multi-Agent Environment **BUILDING MULTI-AGENT SYSTEMS :** • Agents and objects: Towards component integration for manufacturing systems re-engineering • Analytical design methodology of agent oriented manufacturing systems • Agent-based manufacturing: A database point of view **INTELLIGENT SUPERVISION SYSTEMS :** • Application of machine learning techniques in water distribution networks assisted by domain experts • Fuzzy cognitive map model for supervisory manufacture systems	06

Program Elective-II

MMT510.1: Intelligent Manufacturing Systems

Unit No.	Contents	Hrs
Unit 04	**COLLABORATIVE WORK :** • Telework Business Process Co-ordination - The supporting tool engineering Iifecyde • The "coach" methaphor in CSCW decision making system design **KNOWLEDGE BASED SYSTEMS IN DESIGN :** • Modeling expertise for selecting manufacturing technology • Some artificial intelligent techniques to design robotic systems **PLANNING AND SCHEDULING :** • A CIM application of a multi-agent system • Simultaneous design and process planning by indicators • Solving resource-constrained project scheduling problems using tabu search	06
Unit 05	**MODELING IN MANUFACTURING :** • Object oriented modeling of product oriented manufacturing systems • Enhanced production flow schema for modeling the complex resource sharing system • AOP3S: A balanced approach to model distributed manufacturing systems **MANUFACTURING INFORMATION SYSTEMS :** • Perspective: A standards-based manufacturing information system • An approach for real-time applications engineering • Information systems for eco-effective manufacturing **PRODUCT DATA MANAGEMENT :** • Rule-based management of product data in CIM systems • Integrating manufacturer and customer: The fun STEP way • Integrated product model centered design in a virtual design office	04

Program Elective-II

MMT510.1: Intelligent Manufacturing Systems

Unit No.	Contents	Hrs
Unit 06	**ANTHROPOCENTRIC APPROACHES IN MANUFACTURING :** • Information systems requirements specification through the mediation of technical and organizational perspectives • Representation of human intent in product models • Assistance systems supporting operators in manufacturing **QUALITY MANAGEMENT :** • Knowledge based methods and tools for TQM in small batch flexible manufacturing and complex assembly • Computer aided part programming for improved part quality and productivity **PATTERN RECOGNITION AND DIAGNOSTICS :** • An intelligent pattern recognition algorithm and its application in cutting tool condition monitoring process • Vision-based sensors for production control - The experience gathered in applications **THEORETICAL ASPECTS OF DESIGN :** • A contribution to algebraic approach for a CAD/CAPP specification • Interactive design of integrated systems • Human integration and participation in time constraint workshops with limiting transportation resources	06

Sr. No.	Reference Books
01	Intelligent Systems For Manufacturing: Proceedings of the BASYS'98 - 3rd IEEE/IFIP, International Conference on Information Technology for BALANCED AUTOMATION SYSTEMS in Manufacturing Prague, Czech Republic, August 1998
02	Industrial Internet of Things : Cyber Manufacturing Systems, Springer Series in Wireless Technology, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat
03	Andrew Kusiak,, "Intelligent Manufacturing Systems", Prentice Hall , 1990.
04	Simons, G.L, "Introducing Artificial Intelligence", NCC Pub, 1990.
05	Rich,E., "Artificial Intelligence", Mc Graw Hill, 1986

Program Elective-II

MMT510.2: Design & Analysis of Machine Tools

Unit No.	Contents	Hrs
Unit 01	**Introduction:** Classification of machine tools based on their construction, precision, control, drives and rate of production (General purpose machines, special purpose machines and CNC machine tools), **Kinematics of Machine Tool**: - Classification of kinematic systems used for motions of various elements of machine tools.	06
Unit 02	**Drive Systems**: - Selection of cutting speeds, and speed range, method of speed regulation, stepped, step-less, mechanical, electrical, hydraulic methods of speed regulation and their comparison. Stepped drives of machine tools- Gear drives, Gear box design, graphical representation of gear box operation with ray diagram, structure diagram, deviation diagram. Drives for CNC machine tools- AC and DC servomotors, Stepper motors.	06
Unit 03	**Analysis for Strength and Rigidity**: Consideration used in design for strength and rigidity, Structural analysis of various elements of machine tools such as beds, frames, slides, tables and screws, Structural design of beds for lathes, milling and drilling machines	06
Unit 04	**Dynamics of Machine Tools:** Effects of vibration, determination of natural frequency of vibration of machine structures, sources of vibration, analysis of single degree of freedom chatter, Vibration analysis of machine tool structure by partial differential equations, finite element analysis (FEA) techniques, Testing of machine tools	07
Unit 05	**Design of Spindles:** Various types of spindles, spindles support, friction/anti-friction bearings, hydro and aerostatic bearings; friction and antifriction screws, friction and anti friction slide ways, design calculations of spindles- deflection of spindle, optimum spacing between spindle support.	07
Unit 06	**Control systems**:- Various controls introduced on machine tools and their importance, various systems such as mechanical, electrical, electronics, optical, pneumatic/hydraulic systems used for position control, their application in automation, various stages of automation, devices for CNC machines - feedback devices, controllers **Special Purpose Machines**: Requirement analysis, design considerations, drives, transmission and controllers, Modular design of machine tools	07

MMT510.2: Design & Analysis of Machine Tools

Sr. No.	**Reference Books**	
01	N.K Mehta, (2005), Machine Tool Design & Numerical Control- TMH.	
02	Sen & Bhattacharya, (2005), Principles of Machine Tools, - New Central Book Agencies	
03	Yoram Koren, (2005) Computer Control of Machine Tools, McGraw Hill.	
04	Nagpal, G.R., (2003), Machine Tool Engineering, - Khanna Publications	
05	S.K. Basu & D. K. Pal (2001), Design of Machine Tool Design, - Oxford IBH Publishing Co.	
06	Machine Tool Design Handbook – CMTI, TMH	
07	Machinery's Handbook, (24/e) Ed. Henry H. Ryfeel, Industrial Press Inc.	
08	P. H. Joshi, (2007) Machine Tools Handbook: Design and Operation - McGraw Hill	
09	Yoshimi Ito, (2008), Modular Design of Machine Tools, McGraw Hill	

Program Elective-II

MMT510.3: Advanced Metal Forming Technology

Unit No.	**Contents**	Hrs
Unit 01	**Fundamentals**: Various forming processes, their significance with respect to other manufacturing processes, Classification based on volume, stage, complexity; Requirements for near net shape manufacturing. Mechanics of metal working, stress strain relationship, yield criteria, Equilibrium in Cartesian, cylindrical and spherical coordinates, Slab method and lower and upper bond methods for load, their significance in investigating and modeling of metal working operations; plastic work, work hardening, strain rate and temperature, deformation zone geometry, formability, forming limit diagrams. Workability in sheet metal forming, forging, rolling, and in extrusion and wire drawing. Friction and Lubrication in: Rolling, Drawing, Forging, Extrusion, Drawing of Wire.	08
Unit 02	**Forging**: Equipments: Hammers, Presses, interaction between forging process and equipment, Forging materials and practices or processes: Light alloys, titanium alloys and heat resistance alloys. Effect of forging variables on properties; Forging die design: Design principles, Preform design considerations, Die materials.	06
Unit 03	**Rolling**: Classification of Rolling Processes, Rolling mills, Hot- Rolling, Rolling of Bars and Shapes; Forces and Geometrical relationship in Rolling, Simplified analysis of rolling load: variables, problems and defects in rolled products, Rolling mill control, Theories of cold rolling, hot rolling, torque and power, Roll pass design	06
Unit 04	**Extrusion**: Classification of extrusion processes, extrusion equipment, hot extrusion, defects in extrusion, Analysis of the extrusion process, cold Extrusion and cold forming, hydrostatic extrusion, extrusion of tubing, Production of seamless pipe and tubing.	07
Unit 05	**Wire Drawing**: Introduction, wiredrawing, analysis of wiredrawing and Residual stress in wire, wire drawing dies. **Sheet Metal Forming**: Introduction, forming methods, shearing and blanking, bending, stretch forming, deep drawing, forming limit criteria, Defects in formed parts.	07
Unit 06	**Latest Trends in Forming**: Isothermal forging, Near net shape manufacturing, thermo- mechanical	07

treatments, High Energy Rate Forming (HERF), super plastic forming technology, hydro forming, Laser beam forming, fine blanking,

MMT510.3: Advanced Metal Forming Technology

Sr. No.	**Reference Books**	
01	George E. Dieter - Mechanical Metallurgy, McGrew Hill	
02	G. E. Dieter - Workability Testing Techniques, American Society for Metals, Metals Park, 1984	
03	Metal Forming Handbook, -Schuler, Springer-Verlag Berlin Heidelberg New York, (2008) ISBN 3- 540-61185-1	
04	R. Sharan, S.N. Prasad - Forging Design and Practice	
05	Forging Equipment, Material and Processes, J. Altan, F. W. Boulger - Metals Ceramic Information Center, Columbus 1973.	
06	Roll Forming Handbook, - Geotge T. Halmos, (CRC Press, Taylor & Francis), (2006) ISBN 0-8247- 9563-6	
07	Metal Forming Fundamentals & Applications – Alan T, American Society of Metals, Metal Park 1983	
08	Metal Forming Mechanics & Metallurgy, Hosford WF and Cadell R.M. , Prentice Hall, Englewood Cliffs, 1993	
09	ASM Hand Book - Forming and Forging, 9/e, Volume 14, (1998)	

Program Elective-II

MMT510.4: Advanced Welding Technology

Program Elective-II

MMT510.5: Costing & Cost Control

Unit No.	Contents	Hrs
Unit 01	**Introduction:** (a) Concept of cost, cost unit, cost center, classification of cost, different costs for different purposes. (b) Definition of costing, cost-price-profit equation, desirable conditions for a costing system. **Cost Estimating:** Definition, purpose and functions of estimation, role of estimator, Constituents of estimates, estimating procedures.	08
Unit 02	**Estimation of Weight and Material Cost:** a) Process of breaking down product drawing in to simpler elements or shapes, estimating the volume, weight and cost b) Review of purchasing procedure, recording of stock and consumption of material by LIFO, FIFO, Weighted average method	06
Unit 03	**Machine hour rate:** definition, constituents, direct cost, indirect cost, steps for estimation of machine hour rate for conventional machines, CNC lathe and machining center **Labour Cost** – Direct and indirect labour, Workmen classification, Definition of wages, Methods of remuneration	06
Unit 04	**a) Estimation of fabrication cost** : Constitutes, direct cost, indirect cost, Procedure of estimation of fabrication cost; **b) Estimation of foundry cost:** Constitutes, direct cost, indirect cost, Procedure of estimation foundry cost **c) Estimation of forging cost:** Constitutes, direct cost, indirect cost, Procedure of estimation of forging cost. **d) Estimation of machining cost:** Constituents, direct cost, indirect cost, Procedure of estimation of machining cost.	07
Unit 05	**Overheads:** Elements of overheads, classification, general considerations for collection, analysis of overheads, different methods for allocation, apportionment, absorption of overheads, **Cost Accounting Methods:** Job costing, Batch costing, Unit costing, Process costing, Contract costing, Activity based costing	07
Unit 06	**Cost Control**: Use of cost data for policymaking and routine operation, control techniques such as budgetary control, standard cost, variance analysis, marginal cost and break even analysis; **Cost Reduction Areas:** Procedures and systems in product, methods and layouts, administrative and marketing, rejection analysis, cost of poor quality, value analysis and value engineering, Zero Base Budgeting	07

MMT510.5: Costing & Cost Control

Sr. No.	Reference Books
01	Principles & Practice of Cost Accounting – N. K. Prasad (Book Syndicate Pvt. Ltd.)
02	Costing Simplified: Wheldom Series – Brown & Owier (ELBS)
03	Cost Accounting: B. Jawaharlal (TMH)
04	Cost Accounting: R.R. Gupta.
05	Cost Accounting, 13/e - B. K. Bhar, (Academic Publishers, Kolkata)
06	Cost Accounting: Jain, Narang (Kalyani Publishers)
07	A Text Book of Estimating and Costing Mechanical – J.S. Charaya & G. S. Narang (Satya Prakashan)
08	Mechanical Estimation and Costing – TTTI, Chennai (TMH)
09	Theory & Problems of Management & Cost Accounting – M.Y. Khan, P. K. Jain (TMH)

Program Elective-II

MMT510.6: MEMS & NANOTECHNOLOGY

Unit No.	Contents	Hrs
Unit 01	**Introduction:** Micro-Electro-Mechanical Systems (MEMS), Microsystems and their products, miniaturization, applications, mechanical MEMS, thermal MEMS, micro-opto electro-mechanical systems, magnetic MEMS, radio frequency (RF) MEMS, micro fluidic systems, bio and chemo devices, Nanotechnology – definition, Nano scale, consequences of the Nano scale for technology and society, need and applications of Nano electromechanical systems (NEMS)	04
Unit 02	**Micro Fabrication Processes & Materials:** Materials for MEMS – substrate and wafers, silicon as a substrate material, crystal structure, single crystal and polycrystalline, mechanical properties, silicon compounds, silicon piezo-resistors, gallium arsenide, quartz, piezo-electric crystals, polymers, packaging materials; **Fabrication Processes** – Bulk micromanufacturing, photolithography, photoresists, structural and sacrificial materials, X-ray and electron beam lithography, Thin film deposition – spin coating, thermal oxidation, chemical vapour deposition (CVD), electron beam evaporation, sputtering; Doping – diffusion, ion implantation; Etching – wet etching, dry etching; Surface micromachining, bulk vs. surface micromachining; Wafer bonding – glass-frit, anodic and fusion bonding; LIGA process and applications.	08
Unit 03	**Microsensors and actuators:** Sensing and actuation, Chemical sensors, Optical sensors, Pressure sensors, Thermal sensors – thermopiles, thermistors, micromachined thermocouple probes, thermal flow sensors, MEMS magnetic sensor, Piezoelectric material as sensing and actuating elements – capacitance, piezomechanics, Piezoactuators as grippers, microgrippers, micromotors, microvalves, micropumps, microaccelerometers, microfluidics, shape memory alloy based optical switch, thermally activated MEMS relay, microspring thermal actuator, data storage cantilever.	06
Unit 04	**Microsystem Design:** Design constraints and selection of materials, selection of manufacturing process, selection of signal transduction technique, electromechanical system and packaging.	04
Unit 05	**Nano materials:** Molecular building blocks to nanostructures – fullerenes, Nano scaled biomolecules, chemical synthesis of artificial nanostructures, molecular switches and logic gates, Nano composites;	08

Carbon nanotubes - structure, single walled, multi walled, properties of carbon nanostructures and their synthesis, Potential applications of Nano structures.

Unit 06 **Nano finishing Techniques**: Abrasive flow machining, magnetic abrasive finishing, magneto-rheological finishing, elastic emission machining, ion beam machining, chemical mechanical polishing, Nano manipulation, Nanolithography, Top-down versus bottom –up assembly, Visualization, manipulation and characterization at the Nano scale; Applications – in Energy, Tribology, Informatics, medicine, etc. 08

Sr. No. **Reference Books**

01 Bharat Bhushan (Ed.), (2004), Handbook of Nanotechnology, Spinger-Verlag Berlin Heidelberg New York, ISBN 3-540-01218-4
02 Hsu, Tai-Ran, (2003), MEMS & MICROSYSTEMS: Design & Manufacture, TMH, ISBN:0-07-048709-X
03 Mahalik, N. P., (2007), MEMS, TMH, ISBN: 0-07-063445-9
04 Mahalik, N.P. (Ed.) (2006), Micromanufacturing & Nanotechnology, Springer India Pvt. Ltd., ISBN: 978-81-8128-505-8 (Distributed by New Age International, New Delhi)
05 Nanosystems: Molecular Machinery, Manufacturing & Computation, K E Drexler, (Wiley), (1992), ISBN 0471575186
06 P.Rai- Choudhury, Handbook of Microlithography, Micromachining & Microfabrication, SPIE,1997.
07 David Ferry, Transports in Nanostructures, Cambridge University Press, 2000.
08 Poole, Charles & Owen, Frank J., - Introduction to Nanotechnology, Wiley (India) Pvt. Ltd. ISBN: 978-81-265-10993
09 Various Internet resources: www.nanotechweb.org, www.nano.gov, www.nanotec.org.uk

MMT512: Automation and Robotics Lab

Unit No.	Contents	Hrs
Lab 01	Simulation and analysis of hydraulic and pneumatic circuits using suitable software	04
Lab 02	Design, assembly and testing of hydraulic / pneumatic circuits for applications like, (i) Loading / Unloading (ii) Material Handling, (iii) Simple assembly tasks (iv) Inspection	06
Lab 03	Simulation of robotic systems	04
Lab 04	Exercises for robot programming and implementation for different applications	04

Reference Books

01 Industrial Robotics: Technology, Programming & Applications- Groover, Weiss, Nagel, Ordey, McGraw Hill
02 Robotics: Control, Sensing, Vision & Intelligence. - Fu, Gonzalez, Lee (McGraw Hill)
03 Robotics Technology & Flexible Automation – S.R. Deb (TMH)
04 Handbook of Industrial Robotics – Ed. Shimon Y. Nof (John Wiley.)
05 Fundamental of Robotics, Analysis & Control – Robert J. Schilling (PHI)
06 Robotics for Engineers – YoramKoren (McGraw Hill)
07 Introduction to Robotics: Analysis, Systems & Applications – Saeed B. Niku (Pearson)
08 Keramas, James G. (1998), " Robot Technology Fundamentals", ISBN: 981-240-621-2
(CENGAGE)
09 M.P. Groover, Industrial robotics- Technology, programming and Applications, McGraw-Hill, 1986
10 K.S.Fu, R.C.Gonzalez, C.S.G.Lee, Robotics: Sensing, Vision& Intelligence, Tata Mcgraw-Hill Publication, 1987.

MMT514: Analysis and Simulation Lab

Unit No.	Contents	Hrs
Lab 01	Design and Analysis of Plant Layouts for given configurations	04
Lab 02	Design and Simulation of suitable manufacturing systems	04
Lab 03	Performance analysis of simulated manufacturing systems	04
Lab 04	Simulation of production scheduling systems	04
Lab 05	Simulation of manufacturing processes using suitable software.	04

Sr. No.	Reference Books
01	Mechanical Metallurgy (2/e)– by Dieter (McGraw Hill)
02	Metal Casting – Dr. B. Ravi – (Prentice Hall of India)
03	Metal Forming & Finite Element Method – by Shiro Kobjashi Oxford University.
04	Technology of Metal Forming Processes, -Surender Kumar (EEE)(PHI)
05	Theory of Plasticity- Amitav Chakraborty, McGraw Hill

MMT516: Seminar - II

(i) Students shall carryout an exhaustive literature review (research articles, technical articles, white papers, books etc.), on a chosen topic under the supervision of a Guide and present the findings in the form of a review paper in the department in front of a departmental faculty committee as a part of the term work / POE. Alternatively results of an experimental work for the purpose of research carried out under the supervision of a Guide may be presented in the same manner.

(ii) The article must be published in a National / International Conference/Journal as a part of the term work as a part of the term work / POE.

SEMESTER III

MTM 601: INDUSTRY INTERNSHIP

All the students enrolled for M. Tech. program irrespective of their program of study are required to undergo 4 weeks industry internship in industries pertaining to the respective domain of their program. This internship is aimed at giving sufficient exposure to the students regarding the working of business, various functional areas, norms of work, organization structure, products and services along with the work procedure and systems. This help the students to visualize the inter connectivity between what they learn in classes (theory) to the real world of work. It also helps to understand the expectation of industries regarding Code of Conduct, time management, commitment, planning and scheduling the work activities and meeting and analytical and critical thinking skills required. the schedule. Industry internship is to be done by the students at the end of semester II (during the vacation) or students have option to carryout internship in the company where they will take up dissertation work.

Industry Internship Program with Dissertation

It is full one year two semester program in the second year of the program semester III and IV This course aims at giving students hands on experience to imbibe in them the skills and competencies required to make them competent post graduates for employment as per the expectation of the industry where the students are expected to work as interns and carry out the individual project assigned to them by the company. The students learning progress is monitored by both industry person concerned and the supervisor assigned.

OUTCOME EXPECTED AT THE END OF INTERNSHIP

After the successful completion of the internship the student should be able to,

1. Understand the functioning of the company in the terms of inputs, transformation process and the outputs (products and services)
2. Develop an attitude to adjust with the company culture, work norms, code of conduct.
3. Understand and follow the safety norms, Code of conduct.
4. Demonstrate the ability to observe, analyze and document the details as per the industry practices.
5. Understand the processes, systems and procedures and to relate to the theoretical concepts-studied.
6. Analyze the company with respect to its competitors.

7. Carry out SWOT analysis of the company
8. Improve the leadership abilities, interpersonal communication.
9. Demonstrate project management and finance sense

WORK DIARY

Each student should maintain a work which contains details regarding internship, do's and don'ts and evaluation scheme. Students is required to write the dairy regularly and get it signed by the industry guide periodically during the visit the faculty assigned to the student should be able to go through the dairy to access the work done and write the remarks/ instruction. At the end of the internship, the duly completed dairy shall be submitted to the department.

CODE OF CONDUCT:

The students should strictly abide by the rules and regulations of the company with respective to safety, timing, discipline. Any violation of the norms will view seriously and the institute may take strict action in such situation and student may face a severe setback in both his academics and career.

EXPENSES OF THE INTERSHIP TRAINING and DISSERTATION IN COMPANY:

All the expenses of the training like travelling, boarding and lodging should be borne by the students. However, if the company offers, they are eligible to get subsidized canteen facility, transport facility.

EVALUATION OF INTERNSHIP: (4 CREDITS)

The assessment of the internship will be done jointly by the industry and the faculty assigned to the students. The tentative scheme of assessment will be as follows.

Sr. No	Evaluation Parameters	Weight %
1	Punctuality, behavior and following code of conduct (to be assessed by the company personal)	20%
2	Initiative, observation and interest in learning new things (faculty in charge)	20%
3	Familiarization with specific Department/shop/function assigned to student (to be assessed by the company personal)	20%
4	Final evaluation based on presentation of work, internship report (By DPGC committee and Supervisors)	40%

Minimum 50% score is mandatory for successful completion of internship or else the extension will be given to make the student to come up to the expectation.

MTM 603: DISSERTATION PHASE I (SYNOPSIS SUBMISSION SEMINAR)

Dissertation is a program requirement for M. Tech wherein under the guidance of a supervisor/ co-supervisor from the industry in case of industry sponsored projects, a second year student is required to some innovative/ contributory/ developmental work with the application of knowledge earned while undergoing various theory and laboratory courses. A student has to exhibit both analytical and practical skills through dissertation work.

A student is expected to carry out intensive literature survey/ identification of a major issue or problem in case of industry projects with observations and discussions in the area of interest specific to the domain in consultation with the dissertation supervisor and industry co- supervisor. The objectives and scope of the dissertation will be expected at a higher level and the use of the new analytical and computer based tools for solving the identified problem is recommended.

A student is required to submit the dissertation synopsis duly signed by supervisor and co- supervisor to the M. Tech Co- coordinator of the department who schedules the synopsis presentation seminar in the DPGC (Departmental Program Committee).

The dissertation synopsis seminar presentation comprises of the following details:

- A Dissertation title
- General introduction to the area of the topic
- Relevance of the dissertation work
- Literature review/ prior work done in the area
- Dissertation objectives and scope
- Expected outcomes
- Methodology
- Phases of work and representation on a Gantt chart with deadlines
- Resources required to complete the work
- Commitment from the student (Ethical conduct)
- References

Based on the report and the presentation, the DPGC will give approval to the dissertation/ give suggestions/ suggest changes/modifications, additional scope, etc. specific to make dissertation to come to the expected level of PG requirement. The student will incorporate the suggestions and resubmit the same for approval.

The final copy of the synopsis with approval seal will be issued to the student, supervisor and the co-supervisor of the company which becomes the guiding document for the dissertation.

The Evaluation Guidelines:

1. Based on the initiative, the novelty and the skill in identifying the problem and collecting and analyzing the information and co-Supervisor: 50 %
2. Presentation, scope, outcomes, research compilation, relevance DPGC: 50%

MTM 605: DISSERTATION PHASE II

Followed by approval of the synopsis, this phase aims at completing at least 40 % of the dissertation work specified in the synopsis.

Phase II evaluation consists of a progress review based on the efforts put in by the student to carry out the work and results obtained thereof to seek suggestions and improvements and to ascertain that the student is going in the right direction.

This phase consists of both the In- semester evaluation by the supervisor and DPGC (ISE) and the end semester evaluation (consisting of presentation followed by demonstration) by a panel of examiners appointed by the COE of the university based on the panel of experts approved by BOS submitted to the COE.

The Evaluation Scheme	Weight %
Supervisor and co- supervisor	25
DPGC of the program department	25
Panel of Examiners [Chairman, internal supervisor, external expert]	50

In the DPGC Evaluation, if the progress is not found satisfactory, the student will be given the grace period of 4 weeks to work on the dissertation and present it to the committee again and on approval the ESE will be conducted. In this case, the student has to suffer one grade penalty and the next semester Phase III starts only on satisfactory completion of Phase II.

SEMESTER IV

MTM 602: DISSERTATION PHASE III

This stage marks the final progress review which indicates the completion of all the defined phases of the dissertation satisfactorily on the periodic progress reviews by supervisor and co- supervisor. A student by this time has used an opportunity to present his dissertation work in a reputed international/national conference to receive the feedbacks/ comments on the work and any new dimension to be incorporated to make the work novel and worthy of publishing in peer reviewed journals and should also prepare a journal paper based on the complete work of dissertation with results, discussions and conclusions.

A student is required to prepare the draft dissertation report as per the format of the university and with approval of supervisor and co- supervisor submit the same to the PG program coordinator of department.

The Program coordinator will schedule the presentation of student (Pre submission) before the DPGC members once the student has completed all the academic requirements for the prescribed program.

1. Submission of Draft Dissertation Report
2. Completion of internship
3. Completion of the online/self-study.
4. Earning 100% credits of Sem. I to III
5. Proof of presentation of the work in the International Conference (Certificate publication and draft paper in a template for an identified journal/uploading of same in peer reviewed journal)

Based on the recommendation of DPGC, the dissertation is processed further. Viva-Voce examination is to be scheduled preferably with the same external expert appointed for the Dissertation Phase II by COE.

The successful completion of the Viva- voce, the panel of examiners recommends the candidate as successfully completed and submits the evaluation in the sealed envelope.

Evaluation Scheme for Phase III

Sr. No	Evaluator	Weight %	Min. Passing %
1	Supervisor and Co supervisor	50	50
2	DPGC Committee	50	

If the DPGC committee is of the opinion that a student is required to work further to achieve the stated objectives and incorporate some additional work, an extension based on the work is given to the student to complete the work and the student is required to re-submit the dissertation and a presentation is to be given to DPGC. The DPGC will take a final decision on whether to schedule the final exam or give additional extension of the work.

MTM 604: DISSERTATION PHASE IV

Evaluation Scheme for Phase IV

Evaluator	Weight %	Min. for Passing %
External Viva-voce examination by a panel (ESE)	100	50%

MTM 606: Dissemination of Outcomes of Dissertation

It is mandatory on the part of the student to,

1. Participate and present a paper in a reputed national/ international conference organized by the premium institutions/ professional bodies. It is recommended to participate and publish in conferences whose proceedings are published by IEEE, Elsevier Springer, Materials Today or any other reputed conferences.
2. A paper for a peer reviewed journal is to be prepared as per the journal format and uploaded to the journal website. It is desirable that at least the paper will be selected in initial review regarding Scope and it enters the second phase of editor
3. If the work of a student is novel and patentable in this case, a student need not have to bring his research findings in public domain through publication but he can file the patent. Student should be able to get provisional registration of patent with patent office.
4. In case of NDA with company when student is pursuing his dissertation, publication may not be possible in public domain. These cases are to be treated as special cases. A rubric is developed for evaluation.

The evaluation of the dissertation work of a student shall be carried out in four phases: First and third phase being evaluated for ISE by Department Post Graduate Committee (DPGC) while second and fourth phase by DPGC for ISE and by a panel of examiners for ESE. Except for phase I evaluation i.e. evaluation based on synopsis submission seminar, a student shall be evaluated for all other phases for his/her understanding, the work done and his/her presentation followed by demonstration.
DPGC shall consist of three faculty members from the department, Guide assigned to a student being one of the members. A panel of examiners for ESE shall consist of Chairman (who shall be one of the DPGC members and shall monitor the process as per norms), an Internal Examiner (who shall be the Guide) and an External Examiner (who shall be a subject expert from outside the institute).
